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HOT BRICK III AIRWORTHINESS EVALUATION
OV-1D AIRPLANE

FINAL REPORT

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

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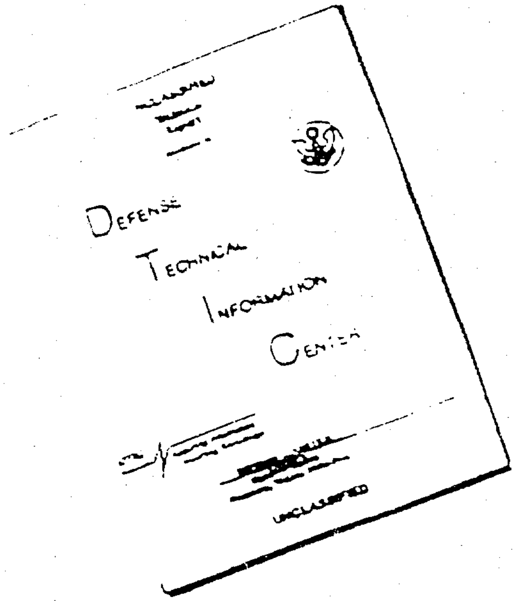

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The United States Army Aviation Engineering Flight Activity conducted an airworthiness evaluation of the OV-1D (Mohawk) airplane modified with a HOT BRICK III infrared countermeasure device from 11 to 22 February 1974 at Fort Rucker, Alabama, and from 17 July to 7 August 1974 at Edwards Air Force Base, California. During the test program 20 productive hours were flown. Structural and handling qualities tests were conducted, with emphasis placed

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20. Abstract

on the low-speed high gross weight regime. Structural testing was limited to flutter tests of the wing store that contained the 150-gallon fuel drop tank modified with the HOT BRICK III device, the wing at the HOT BRICK III store station, and the right wing tip. Handling qualities tests included a stall investigation, determination of control margins with high asymmetric loads, single-engine minimum trim and control airspeeds, and static lateral-directional stability. Other tests included takeoff performance and an airspeed system calibration. A large discrepancy existed between the takeoff performance data presented in the operator's manual and that obtained with the test aircraft. If the data from this evaluation are representative of the OV-1D, then a deficiency exists, in that the takeoff performance data presented in the operator's manual is extremely optimistic. Four shortcomings were associated with operating the OV-1D airplane at the heavy gross weight in the all-stores (E) configuration. The contribution of the HOT BRICK III device to these shortcomings is minimal. The handling qualities of the OV-1D HOT BRICK III airplane are similar to the standard OV-1D airplane in the all-stores (E) configuration. An adequate stall warning should be provided. Further testing should be accomplished to provide accurate takeoff performance data.

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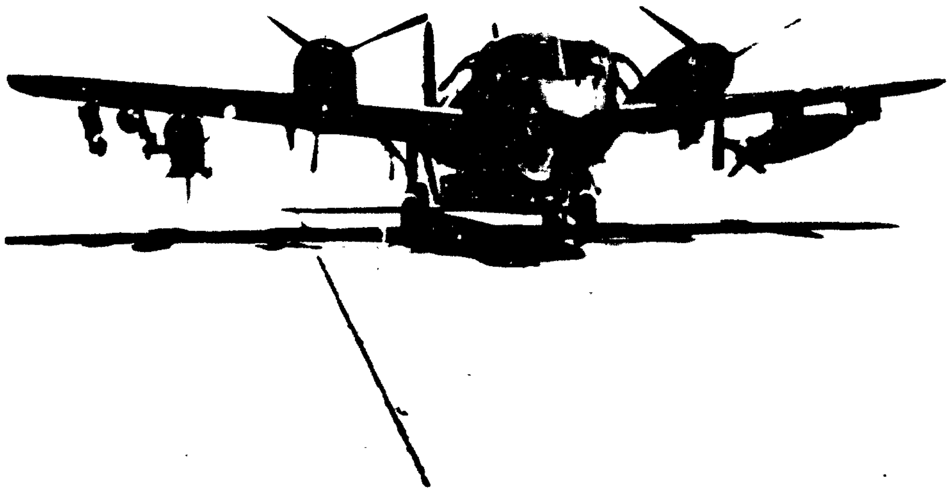
PREFACE

During the OV-1D HOT BRICK III testing the aircraft was maintained by personnel from the United States Army Aviation Test Board, Fort Rucker, Alabama. Additionally, the following United States Army Aviation Engineering Flight Activity personnel provided significant contributions to the test.

CPT Robert N. Ward, Aeronautical Engineer
1LT Richard D. Becker, Automatic Data Processing Officer
SP4 Paul R. Bonin, Aeronautical Engineering Assistant
Kathleen M. Dorris, Aeronautical Engineering Technician
Walter S. Hall, Electronics Technician
Dean S. Smith, Aircraft Mechanic

DEDICATION

This report is dedicated to the memory of Major Frederick D. Daniloff and Captain Kenneth F. Schrantz Jr, who were fatally injured on 22 February 1974 during the conduct of this evaluation.



OV-1D Airplane, US Army Serial Number 69-17000.

TABLE OF CONTENTS

INTRODUCTION

BACKGROUND

1. The HOT BRICK III is an active infrared countermeasure (IRCM) device developed by Sanders Associates (SA) and is installed on the OV-1D airplane in a modified Sargent-Fletcher 150-gallon external fuel tank. As a subcontractor to SA, Grumman Aerospace Corporation (GAC) modified an OV-1D airplane to accept the device and conducted a limited airworthiness evaluation. The United States Army Aviation Systems Command (AVSCOM) requested the United States Army Aviation Engineering Flight Activity (USAAEFA) to conduct airworthiness verification tests on the OV-1D/HOT BRICK III system (ref 1, app A). The original test airplane (SN 69-17018) crashed during conduct of the evaluation by USAAEFA at Fort Rucker, Alabama, in February 1974. A second airplane (SN 69-17000) was modified and the tests were completed at Edwards Air Force Base, California, in August 1974.

TEST OBJECTIVE

2. The objective of this evaluation was to identify any airworthiness problems or flight characteristics changes in the aircraft caused by installation of the HOT BRICK III system. The test data will serve as a basis for a safety-of-flight release for HOT BRICK III system testing.

DESCRIPTION

3. The test airplanes were production OV-1D's (SN's 69-17018 and 69-17000), modified to accept the HOT BRICK III system. A detailed description of the OV-1D airplane is contained in the operator's manual (ref 2, app A). Appendix B gives a detailed description of the test aircraft external equipment.

4. The HOT BRICK III is an open loop IRCM device utilizing a mechanically mounted IR source. The IR transmitter assembly is coupled with a modulator assembly and is mounted on a modified 150-gallon external fuel tank. The IR source consists of a ceramic radiating element heated by the combustion of JP-4 fuel. The fuel for the equipment is drawn from a 15-gallon fuel tank mounted inside the modified 150-gallon fuel tank. The system requires 28 volts direct current (VDC) and is operated from the pilot control box (PCB) located in the cockpit. The HOT BRICK III device is further described in appendix B.

5. The OV-1D/HOT BRICK III airplane was tested in two external stores configurations which are presented in table 1. Table 2 defines the various airplane configurations used during the HOT BRICK III tests.

Table 1. External Stores Test Configurations.

Configuration	Stores Loading	
	Station	Store
B, with HOT BRICK III	1	—
	2	—
	3	150-gallon drop tank
	Fuselage	—
	4	150-gallon drop tank with HOT BRICK III
	5	—
	6	—
E, with HOT BRICK III	1	ALQ-67 fuse jammer
	2	—
	3	150-gallon drop tank
	Fuselage	APS-94 SLAR[1]
	4	150-gallon drop tank with HOT BRICK III
	5	LS-59A flasher pod
	6	ALQ-80 radar jammer

[1]SLAR: Side-looking airborne radar.

Table 2. Airplane Test Configurations.

Configuration	Symbol	Landing Gear Position	Flap Position (deg)	Power
Takeoff	TO	Down	15	Takeoff
Cruise	CR	Up	Zero	For level flight
Power approach	PA	Down	45	For level flight

TEST SCOPE

6. The OV-1D/HOT BRICK III test program was conducted at Fort Rucker, Alabama, from 11 to 22 February 1974 and at Edwards Air Force Base, California, from 17 July to 7 August 1974. Nineteen test flights were conducted, with a total of 20 hours. Testing was conducted primarily in the all-stores (E) configuration at a gross weight of 18,000 pounds, an aft center-of-gravity (cg) location (29 percent mean aerodynamic chord) (MAC) and at pressure altitudes of 7500 and 14,000 feet. The evaluation was performed within the limitations of the operator's manual as modified by the safety-of-flight release (ref 3, app A). The results of the test were compared with the information contained in the appropriate sections of the operator's manual. In addition, compliance with the appropriate sections of military specification MIL-F-8785(ASG) (ref 4) was determined.

TEST METHODOLOGY

7. Engineering flight test techniques used during this evaluation are discussed briefly in the Results and Discussion section of this report and in appendix D. Appendix C contains listings of the test instrumentation, the parameters that were recorded on magnetic tape, and those displayed on the pilot panel. An airspeed calibration was accomplished using radar space positioning (figs. 1 and 2, app C). Data analysis methods are also presented in appendix D.

RESULTS AND DISCUSSION

GENERAL

8. An evaluation of the OV-1D HOT BRICK III airplane was performed to determine the airworthiness of the OV-1D airplane when modified with the HOT BRICK III device. Structural and handling qualities tests were conducted, with emphasis placed on the low-speed high gross weight regime. Structural testing was limited to flutter tests of the wing store that contained the 150-gallon fuel drop tank modified with the HOT BRICK III device, the wing at the HOT BRICK III store station, and the right wing tip. Handling qualities tests included a stall investigation, determination of control margins with high asymmetric loads, single-engine minimum trim and control airspeeds, and static lateral-directional stability. Other tests included takeoff performance and an airspeed system calibration. A large discrepancy exists between the takeoff performance data presented in the operator's manual and that obtained with the test aircraft. If the data from this evaluation are representative of the OV-1D, then a deficiency exists, in that the takeoff performance data presented in the operator's manual is extremely optimistic. Four shortcomings were associated with operating the airplane at heavy gross weights in the all-stores (E) configuration. The contribution of the HOT BRICK III device to these shortcomings is minimal. The handling qualities of the OV-1D/HOT BRICK III airplane are similar to the standard OV-1D in the all-stores (E) configuration. An adequate stall warning should be provided. Further testing should be accomplished to provide accurate takeoff performance data.

TAKEOFF PERFORMANCE

9. Takeoff performance testing was not a part of the original test program. During initial takeoffs, poor performance was encountered with the test aircraft. For this reason, takeoff performance was evaluated for the all-stores (E) configuration with HOT BRICK III and approximately 18,400 pounds gross weight. The distances were estimated by aligning the airplane opposite a runway-remaining marker and observing the closest marker at liftoff and when at 50 feet, as indicated by the radar altimeter. These markers were spaced at 1000-foot intervals along the runway and distances were estimated to the nearest 500 feet. The pilot technique and procedure used for takeoffs and climbs were those presented in chapters 3 and 14 of the operator's manual. A large discrepancy between the takeoff performance data presented in the operator's manual and that obtained during the conduct of this evaluation existed. During this evaluation, the test aircraft required approximately twice as much takeoff distance than that presented in the operator's manual. In addition, rotation to takeoff pitch attitude at the recommended airspeed could not be achieved. The minimum rotation airspeed was approximately 10 knots calibrated airspeed (KCAS) greater than recommended.

10. The degraded takeoff performance of the test aircraft was initially attributed to substandard engine performance. An analysis of engine performance revealed discrepancies between the torquemeters and engine test stand power available after overhaul (app D). From this analysis, it was concluded that the torquemeters were inaccurate and the engines were developing specification power. Other factors which may have contributed to the degraded takeoff performance are as follows:

a. Above-normal roughness of the propeller blades due to high operating time (1010 hours) and being painted with low reflective lacquer (FSN 8010-083-6588).

b. Above-normal roughness of the fuselage caused by application of low reflective lacquer (FSN 8010-083-6588).

c. Increased drag caused by wing stores (the contribution of the HOT BRICK III device to this increase is considered minimal).

d. The high gross weight requires higher takeoff airspeed and therefore a longer takeoff distance.

e. The right tire was deformed by high asymmetric weight distribution of the wing stores and this deformation increased rolling resistance (photos A and B).

f. Additional control surface and trim deflections required by the high asymmetric weight and drag of the wing stores.

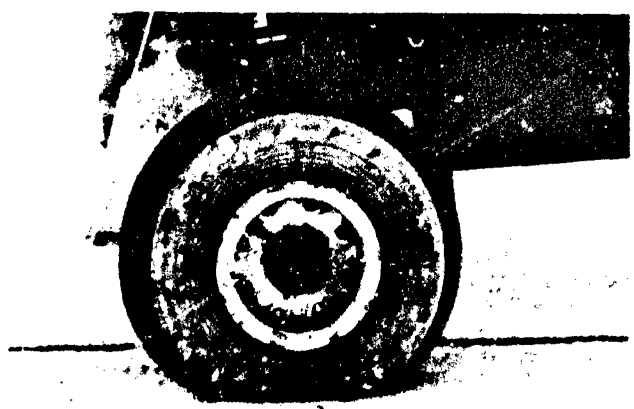


Photo A. Right Main Tire.

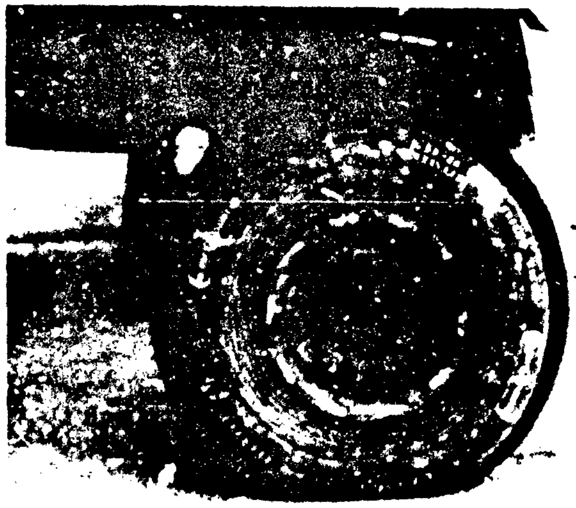


Photo B. Left Main Tire.

11. The reason for the discrepancy between the takeoff performance of the test aircraft with that presented in the operator's manual could not be determined. If the takeoff performance obtained during this evaluation is representative of the OV-1D airplane, then the presentation of extremely optimistic high gross weight and ambient temperature takeoff performance data in the operator's manual is a deficiency and, if relied upon, could result in takeoff accidents. Further testing is required to verify/provide accurate takeoff performance data for inclusion in the operator's manual. In addition. if the takeoff performance noted is verified through additional testing, it is a shortcoming, and takeoff performance should be improved.

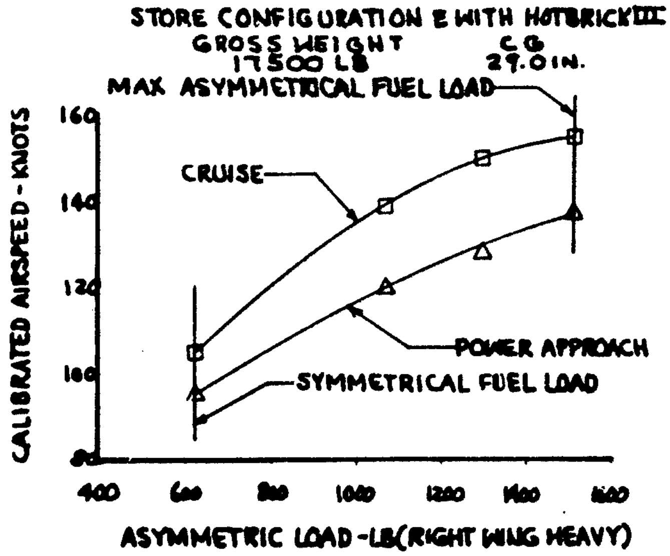
HANDLING QUALITIES

Control Margins

12. Lateral control margin tests were conducted in the CR and PA configurations to determine the minimum trim airspeed and lateral control margin with an asymmetric wing loading. The normal loading in the all-stores (E) configuration with the HOT BRICK III device installed results in 620 pounds more weight (140,800 in.-lb total aircraft moment) on the right wing than on the left wing. In the event of a right wing fuel transfer pump failure, a 1520-pound (307,300 in.-lb total aircraft moment) right-wing-heavy condition is possible with the left drop tank empty (except for trapped fuel) and the right drop tank full.

The variation of minimum trim airspeed with an asymmetric load is shown in figure A and in figure 1, appendix E. The control margins at various airspeeds for symmetrical and maximum asymmetrical fuel loads are shown in figures 2 through 5.

FIGURE A
MINIMUM TRIM AIRSPEED WITH ASYMMETRIC LOAD
OV-1D USA S/N 17000
STORE CONFIGURATION E WITH HOTBRICK III



13. After determining the minimum trim airspeed to be 155 KCAS for the CR configuration and 136 KCAS for the PA configuration at the 1520-pound asymmetric load condition, airspeed was decreased to a target airspeed of 97 KCAS in the PA configuration. Approximately 30 percent of aileron control remained at this airspeed. A left lateral force of only 5 pounds was required to maintain wings level at 97 KCAS.

14. Landings were easily accomplished with a 1200-pound (247,545 in.-lb total aircraft moment) right-wing-heavy condition using an approach airspeed of 120 knots indicated airspeed (KIAS) and approximately 100 KIAS touchdown airspeed. The discussion in the operator's manual on operations with high asymmetric wing loadings is satisfactory for the OV-1D/HOT BRICK III airplane. The lateral control margins and lateral trim capability of the OV-1D/HOT BRICK III airplane were satisfactory with asymmetric wing loads of up to 1520 pounds.

Static Lateral-Directional Stability

15. The static lateral-directional stability of the OV-1D/HOT BRICK III airplane was evaluated in the TO, CR and PA configurations at airspeeds from 86 to 138 KCAS and the conditions listed in paragraph 6. The test results are presented in figures 6 through 12, appendix E. The static lateral-directional stability was essentially unchanged from previous results presented in the Army Preliminary Evaluations (refs 5 and 6, app A). Although the pedal position gradient was approximately linear, lightening of the pedal forces was apparent at low airspeeds in the PA configuration. This slightly increased the pilot effort required to establish and maintain a steady-heading sideslip. Within the scope of this test, the static lateral-directional stability is satisfactory.

Dual-Engine Stalls

16. Stall characteristics were evaluated in the all-stores (E) configuration with HOT BRICK III at 18,000 pounds gross weight in the TO, CR, and PA configurations at an aft cg. Altitude effects on the stall airspeed (V_S) were evaluated by performing the stall series at two altitudes: 7500 and 14,000 feet pressure altitude. The test technique was to trim for level flight at approximately $1.2V_S$, obtained from the operator's manual for the test configuration. Then airspeed was slowly decreased at a rate of 1 knot per second or less until achieving a stall. Stall was defined by a mild uncontrollable nose-down pitching motion. A comparison of the test data with the stall airspeeds from the operator's manual is presented in table 3 and in figure 13, appendix E. Time histories of the stalls are presented in figures 14 through 16.

Table 3. Dual-Engine Stall Airspeed.

Configuration	Gross Weight (lb)	Pressure Altitude (ft)	Calibrated Stall Airspeed (kt)	
			Test Data	Operator's Manual
TO	17,930	7600	77.5	77
	17,860	14,020	77.5	76.5
CR	18,050	8180	85.5	85
	18,110	14,860	87.5	85.5
PA	17,860	7740	71.0	72
	17,590	15,000	72.5	71

17. Control effectiveness about all three axes during the approach to the stall was excellent. The stall was characterized by a mild nose-down pitching with no tendency to roll. Stall recovery was easily accomplished by releasing the back pressure on the control stick. The stalls occurred without warning.

18. The lack of stall warning on the OV-1D/HOT BRICK III airplane would be hazardous, especially during a short field landing approach and obstruction takeoff, where a stall could result. The lack of stall warning is a shortcoming and fails to meet the requirements of paragraph 3.6.3 of MIL-F-8785(ASG). Stall warning should be incorporated to provide the crew with an adequate cue to approaching the stall angle of attack.

Single-Engine Control Margins

19. The single-engine control margins were evaluated in the TO, CR, and PA configurations at the conditions listed in paragraph 6. The variation of trim and control position with airspeed is presented in figures 17 through 22, appendix E. The critical trim control for all test conditions was the rudder trim. The airspeed at which full trim was required in the CR configuration for either propeller feathered was approximately 145 KCAS. For the TO and PA configurations, this airspeed was approximately 140 KCAS for the left propeller feathered and 150 KCAS for the right propeller feathered. At 120 KIAS in the TO and PA configurations, approximately 30 to 40 pounds pedal force was required with either propeller feathered and approximately 2 pounds left aileron force was required with the right propeller feathered. Within the scope of this test, the OV-1D/HOT BRICK III airplane single-engine control margins are satisfactory.

Single-Engine Minimum Control Airspeed

20. The single-engine minimum control airspeed (V_{MC}) was evaluated in the TO, CR, and PA configurations at the conditions listed in paragraph 6. A comparison of the V_{MC} from the test data with the data from the operator's manual is presented in table 4 and in figures 23 through 25, appendix E. Time histories of the approach to V_{MC} for the three airplane configurations at the two test altitudes of 7500 and 14,000 feet are presented in figures 26 through 32.

21. The V_{MC} was defined by stall for all configurations tested. The stalls were relatively mild, but without warning. For all configurations, the stall airspeed was higher with the right propeller feathered; therefore, the right engine is the critical engine in the all-stores (E) configuration with HOT BRICK III. Previous testing without HOT BRICK III had indicated that the left engine would be critical; however, the increase in asymmetric load and drag caused the change. Adequate control existed about all three axes approaching the stall, except in the CR configuration with the right propeller feathered. For this configuration, full left aileron control was required at the stall. Stall recovery was accomplished by releasing the control stick back pressure and reducing power on the operating engine. There was no tendency toward poststall gyrations.

Table 4. Single-Engine Minimum-Control Airspeed.

Configuration	Propeller Feathered	Gross Weight (lb)	Pressure Altitude (ft)	Calibrated Minimum-Control Airspeed (kt)	
				Test Data	Operator's Manual
TO	Left	17,800	8120	87.5	96
		17,800	13,580	89.5	98.5
	Right	17,760	7820	92.5	Not available
		17,680	14,640	94.5	Not available

22. The lack of cues to the approaching V_{MC} and the stall at V_{MC} without warning is a shortcoming. As discussed in paragraph 18, lack of stall warning would be hazardous during the approach to a landing and obstruction takeoff. This condition is further aggravated by the higher stall airspeeds for the single-engine configuration. Adequate stall warning should be provided.

23. During the evaluation to determine V_{MC} for the PA configuration with the left propeller feathered, a rudder force reversal was encountered. In this configuration, approximately 110 pounds of right pedal force were required just prior to the single-engine stall airspeed. At this point, the pedal force required changed to a 50-pound left pedal force. This characteristic would increase pilot workload in an emergency situation. The rudder force reversal in the PA configuration with the left propeller feathered is a shortcoming.

24. During the single-engine testing, it was apparent that the OV-1D airplane does not have a single-engine capability at 18,000 pounds gross weight for the conditions tested. In the event of an engine failure at the high gross weight, the fuel drop tanks (including the HOT BRICK III device) may have to be jettisoned. Jettison of HOT BRICK III would mean the loss of IRCM protection. Single-engine performance should be improved.

FLIGHT FLUTTER TESTS

25. Tests were conducted at 5000 feet pressure altitude to determine the flutter characteristics of the OV-1D/HOT BRICK III airplane in configurations B and E. The method of excitation was a lateral stick pulse (rudder and longitudinal stick pulses did not produce adequate excitation). The test results are presented in figures 33 through 40, appendix E. In configuration B, the damping ratio was

reduced at airspeeds above 260 KIAS. Testing was terminated at 300 KIAS when damping ratios reduced to 0.04 at two locations (right wing tip forward and HOT BRICK III aft). In configuration E, the damping ratio remained above 0.05 at all airspeeds tested (up to 330 KIAS) except for the forward end of the HOT BRICK III tank in the vertical direction. At this location, the damping ratio was decreased to 0.04 at 330 KIAS. In both configurations, there were no flutter problems encountered and the OV-1D/HOT BRICK III exhibited satisfactory flutter characteristics for normal flight conditions up to the airspeeds tested.

CONCLUSIONS

GENERAL

26. The following conclusions were reached upon completion of testing:

a. The OV-1D airplane used during this evaluation exhibited substantially degraded takeoff performance as compared to the operator's manual. The reason for this discrepancy could not be determined within the scope of this test.

b. The handling qualities and performance of the OV-1D airplane have not been significantly changed by installation of the HOT BRICK III device.

c. The right engine inoperative is the critical engine in the all-stores (E) configuration.

d. One apparent deficiency associated with the operator's manual was noted and four shortcomings were identified with the airplane in the all-stores (E) configuration.

DEFICIENCY AND SHORTCOMINGS

27. The following apparent deficiency associated with the operator's manual was identified. If the takeoff performance obtained during this evaluation is representative of the OV-1D airplane, then the takeoff performance chart presented in chapter 14 is extremely optimistic and, if relied upon, could result in takeoff accidents (para 11).

28. The following shortcomings with the OV-1D/HOT BRICK III airplane in the all-stores (E) configuration were identified:

a. Apparent inadequate takeoff performance at an 18,400-pound gross weight (para 11).

b. Lack of stall warning at high gross weights (para 18).

c. Single-engine minimum control airspeed occurs at the stall airspeed without adequate cues to the approaching stall (para 22).

d. A rudder force reversal occurs in the PA configuration when approaching a stall with the left propeller feathered (para 23).

SPECIFICATION COMPLIANCE

29. Within the scope of this test, the OV-1D/HOT BRICK III airplane failed to meet the requirement of paragraph 3.6.3 of MIL-F-8785(ASG), in that the approach to stall was not accompanied by a stall warning, which should occur between 1.05 and 1.15 times the stalling speed in the CR configuration and between 1.05 and 1.10 times the stalling speed in the PA configuration (para 18).

RECOMMENDATIONS

30. The apparent deficiency identified during this evaluation must be corrected (para 11).*

31. The shortcomings should be corrected (paras 11, 18, 22, and 23).

32. Further testing is recommended to provide accurate takeoff performance data (para 11).

33. Adequate stall warning should be provided (paras 18 and 22).

34. Single-engine performance should be improved (para 24).

APPENDIX A. REFERENCES

1. Letter, AVSCOM, AMSAV-EFT, 30 October 1973, subject: Test Request for OV-1D/HOT BRICK III Evaluation.

2. Technical Manual, TM 55-1510-204-10/5, *Operator's Manual, OV-1D Aircraft*, February 1970.

3. Letter, AVSCOM, AMSAV-EF, 4 February 1974, subject: Safety-of-Flight Release for OV-1D/HOT BRICK III.

4. Military Specification, MIL-F-8785(ASG), *Flying Qualities of Piloted Airplanes*, Amendment 2, 17 October 1955.

5. Final Report, USAASTA, Project No. 68-43, *Army Preliminary Evaluation, Production OV-1D (Mohawk)*, March 1970.

6. Final Report, USAASTA, Project No. 70-03, *Army Preliminary Evaluation II, Production OV-1D (Mohawk), Performance and Handling Qualities*, March 1971.

APPENDIX B. DESCRIPTION

1. The test aircraft were production OV-1D airplanes, serial numbers 69-17018 and 69-17000, modified to accept the HOT BRICK III stores and controls described below. The HOT BRICK III system is an open loop IRCM set utilizing a mechanically mounted IR source (fig. 1). The IR transmitter assembly is coupled with a modulator assembly and is mounted on a modified 150-gallon fuel tank (fig. 2). The IR source consists basically of a ceramic radiating element heated by the combustion of JP-4 fuel with ambient air. Both combustion and cooling air are drawn from a common inlet mounted on the pod shell. A flow control valve maintains an approximately constant mass flow through the combustor, regardless of flight airspeed or altitude. A fuel group pumps and regulates the fuel supply. The fuel for the equipment is drawn from a 15-gallon fuel tank mounted inside the modified 150-gallon fuel tank. The small internal tank is filled from the larger tank as long as there are more than 100 gallons of fuel in the large tank. When the fuel level of the large tank drops below 100 gallons, there is still sufficient fuel for the system in the small tank. With the modified 150-gallon fuel tank the maximum fuel available to the engines is 135 gallons from that tank.

2. The physical characteristics of the OV-1D/HOT BRICK III system are as follows:

Device Physical Dimensions	
Basic diameter (no scoops)	17.2 in.
Overall length (no scoops)	46 in.
Device Basic Weights	
Device	230 lb
Device fuel tank and fuel	128 lb
Modified External Stores	
Overall length	178.25 in.
Weight of modified stores	140 lb
Weight of ballast	164 lb
Weight empty	534 lb
Weight of fuel (JP-4)	971 lb
Weight loaded	1505 lb
Weight increase loaded (HOT BRICK store vs standard 150-gallon drop tank)	+382 lb

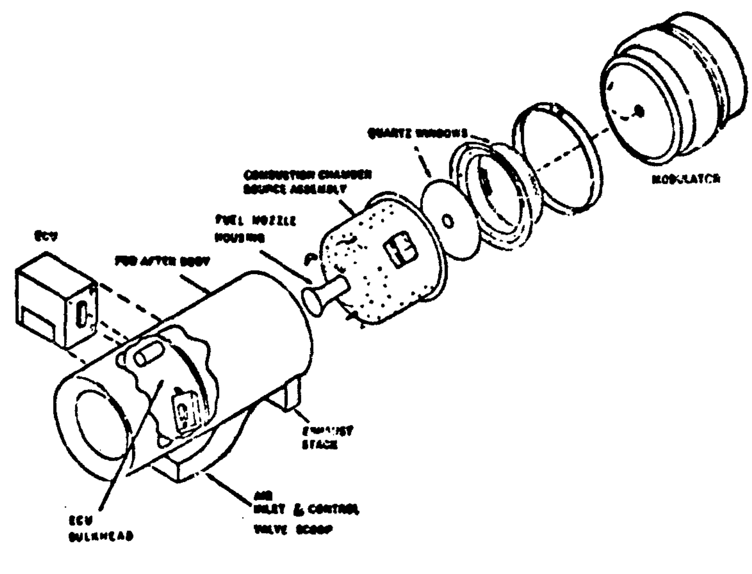


Figure 1. OV-1D HOT BRICK System.

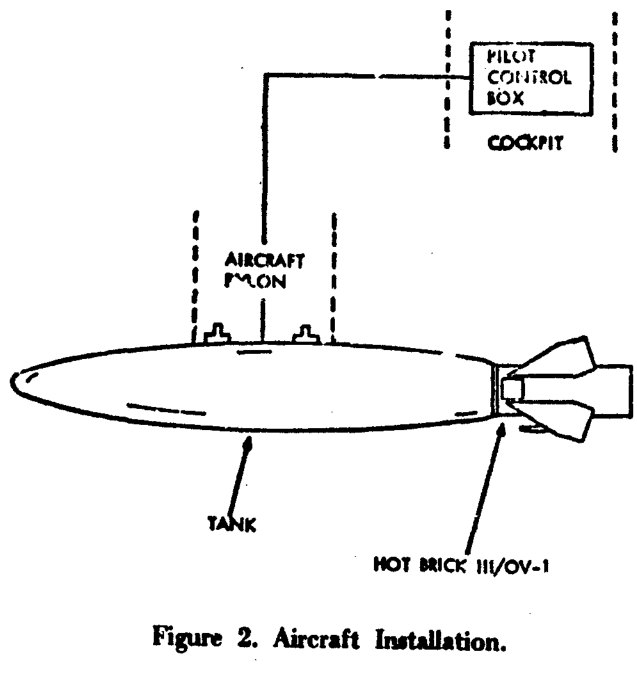


Figure 2. Aircraft Installation.

APPENDIX C. INSTRUMENTATION

GENERAL

1. Instrumentation for the OV-1D/HOT BRICK III airplane was installed, calibrated, and maintained by personnel of the Test and Evaluation Command (TECOM) at Fort Rucker, Alabama, and by USAAEFA at Edwards Air Force Base, California.

TESTING AT FORT RUCKER

2. During testing accomplished at Fort Rucker, the instrumentation listed below was installed. The instrumentation package used an oscillograph recorder. Supplemental data were obtained from standard cockpit indicators and voice recording. In addition, photo coverage from the chase aircraft was provided.

Cockpit

3. The existing ship's system instruments were used during this test to record engine and flight data. In addition, a panel-mounted maneuvering accelerometer was installed. These instruments were calibrated prior to the test by TECOM. A cassette voice recorder was used to record pilot qualitative comments.

Instrumentation Package

4. Parameters recorded were coordinated with TECOM to minimize instrumentation changes after the USAAEFA tests. The following parameters were required for the USAAEFA tests:

HOT BRICK III Device:

High-frequency modulation
Low-frequency modulation
Combustion indication
Combustion temperature
Run indication
Fault indication
Ignition indication

Aircraft Flutter Tests:

HOT BRICK store normal acceleration forward
HOT BRICK store normal acceleration aft
HOT BRICK store lateral acceleration forward
Left wing tip normal acceleration forward
Right wing tip normal acceleration forward
Right wing tip normal acceleration aft
Center-of-gravity normal acceleration
Correlation counter

TESTING AT EDWARDS AIR FORCE BASE

5. During testing at Edwards Air Force Base, the following instrumentation was installed. A magnetic tape recorder was installed in the aircraft. A boom was mounted on the SLAR antenna extending approximately 5 feet forward from the nose of the SLAR (photo 1). Angle-of-sideslip and angle-of-attack vanes and a high-speed pitot-static tube were mounted on the boom. The parameters recorded and/or displayed together with the location are listed below.

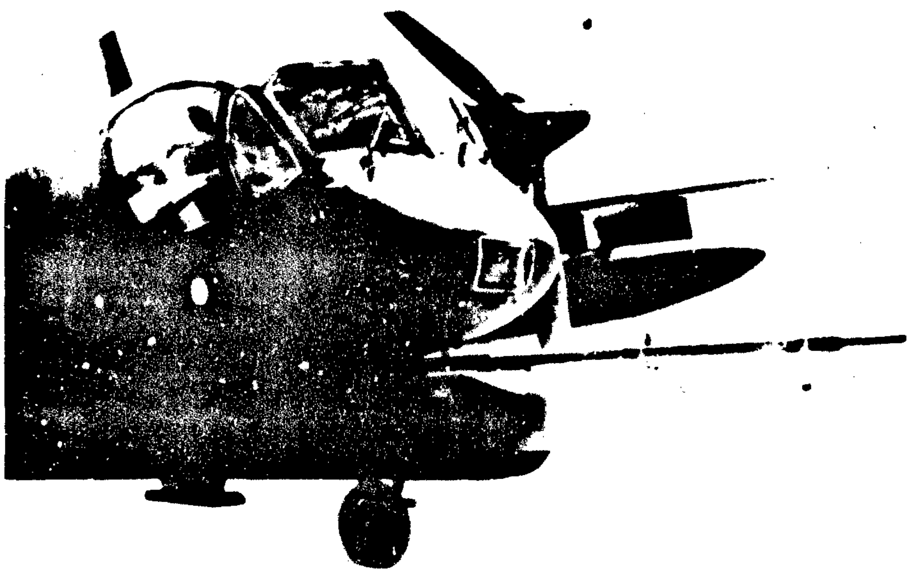


Photo 1. SLAR Mounted Airspeed Boom.

Pilot Panel

Airspeed (boom)
Altitude (boom)
Angle of sideslip
Angle of attack
Center-of-gravity normal acceleration
Elevator trim position
Aileron trim position
Rudder trim position
Left engine output shaft torque
Right engine output shaft torque

Magnetic Tape

Airspeed (boom)
Altitude (boom)
Free air temperature
Control positions:
- Longitudinal stick
- Lateral stick
- Pedal

Control forces:
- Longitudinal stick
- Lateral stick
- Pedal

Control surface positions:
- Elevator
- Left outboard aileron
- Center rudder

Aircraft attitude:
- Pitch
- Roll

Aircraft angular velocity:
- Pitch
- Roll
- Yaw

Angle of attack
Angle of sideslip
Acceleration:
- Center-of-gravity normal
- Center-of-gravity lateral

Engine gas producer speed (left and right)
Engine power turbine speed (left and right)
Engine exhaust gas temperature (left and right)
Time
Pilot event

6. Calibration of the boom-mounted pitot-static system was accomplished by use of the National Aeronautics and Space Administration's radar space positioning equipment. The airspeed system position error is presented in figures 1 and 2.

FIGURE No 1
AIRSPEED CALIBRATION
OV-1D USA S/N69-17000
STORE CONFIGURATION E WITH HOTBRICK III

SLAR MOUNTED BOOM SYSTEM
RADAR METHOD

SYMBOL	GROSS WEIGHT ~ LB	CG ~% MAC	FAT ~°C	PRESSURE ALTITUDE ~ FT	CONFIGURATION
□	16900	27.4	9.5	10260	CRUISE

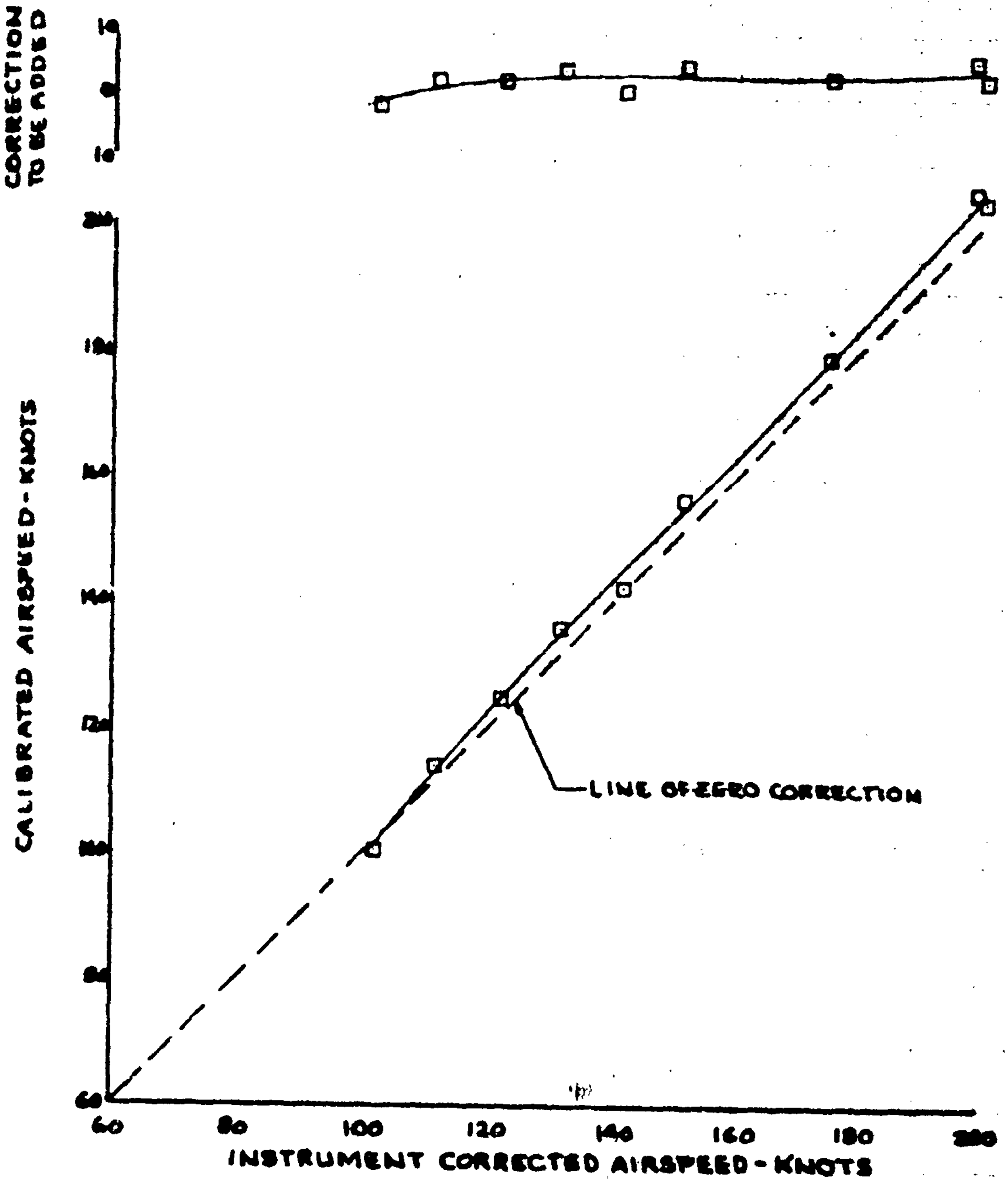
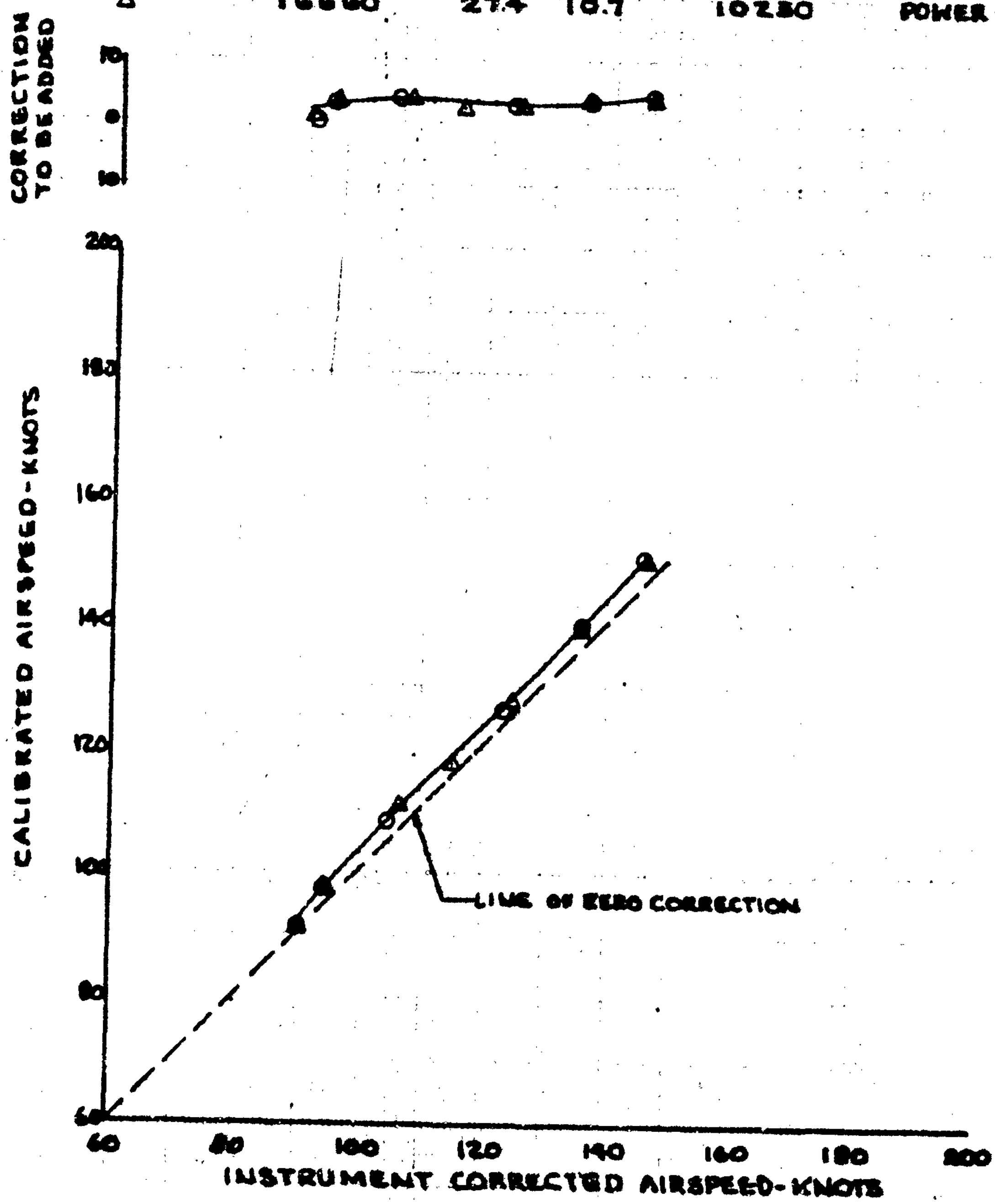


FIGURE NO 2
AIRSPEED CALIBRATION
OV-1D USA S/N 69-17000
STORE CONFIGURATION E WITH HOTBRICK III

SLAR MOUNTED BOOM SYSTEM
RADAR METHOD

SYMBOL	GROSS WEIGHT ~ LB	C.G. ~ % MAC	FAT ~ °C	PRESSURE ALTITUDE ~ FT	CONFIGURATION
○	16560	27.4	10.4	10560	TAKE OFF
△	16660	27.4	10.7	10230	POWER APPROACH



APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

TEST TECHNIQUES

Takeoff Performance

1. Takeoff performance tests were conducted from a concrete runway. Distances were estimated by aligning the airplane opposite a runway-remaining marker and observing the closest marker at liftoff or at 50 feet on the airplane radar altimeter. These markers were spaced at 1000-foot intervals along the runway and distances were estimated to the nearest 500 feet. During the takeoff roll, altitude and ambient temperature were recorded from the aircraft's standard service indicators. The pilot technique and procedure used for takeoff and climb-out were those presented in chapters 3 and 14 of the operator's manual.

Control Margins

2. Control margins were evaluated with asymmetric loads of full fuel in both drop tanks: the left drop tank half full, right drop tank full; left drop tank one-quarter full, right drop tank full; and left drop tank empty (except for trapped fuel), right drop tank full. In the CR configuration, airspeeds of approximately 115 to 185 KCAS were evaluated. In the PA configuration, airspeeds of approximately 95 to 150 KCAS were evaluated.

3. The aircraft was trimmed at the desired conditions in level unaccelerated flight or maximum-power descending flight, starting at the maximum airspeed for each test and decreasing in approximately 10-knot increments. The airspeed at which full aileron trim was required was noted.

Static Lateral-Directional Stability

4. Static lateral-directional stability tests were conducted by trimming the aircraft at the desired airspeed in zero sideslip. Power, airspeed, trim settings, and aircraft ground track were held fixed. Sideslips were increased incrementally, both left and right, up to the flight envelope limits.

Stalls

5. Stall characteristics tests were conducted by trimming the aircraft at approximately $1.2V_S$ (determined from the operator's manual) in level flight for the desired condition. The stall was approached at an airspeed reduction of less than 1 knot per second. After the stall occurred, the back pressure on the stick was reduced and for dual engines the aircraft was allowed to fly out of the stall. For single-engine stalls, the power on the operating engine was also reduced, recovery made, and power on both engines increased.

Single-Engine Control Margins

6. The single-engine control margin tests were conducted with either engine at idle and the propeller feathered. The aircraft was stabilized at incremental airspeeds between approximately 150 and 120 KCAS. At each stabilized airspeed, all control

forces were trimmed to zero, or maximum trim used, while maintaining steady-heading flight. The airspeed at which full trim was required was noted. These tests were accomplished for wings-level and for 5 degrees of bank toward the operating engine.

Single-Engine Minimum Control Airspeed

7. The single-engine minimum control airspeed tests were conducted by stabilizing the airplane at the desired conditions using military power and then reducing power on the desired engine to idle and feathering the propeller. The airspeed was decreased at a maximum rate of 1 knot per second while maintaining constant heading and wings-level until a single-engine stall occurred. The critical engine was determined by conducting tests with either the left or right propeller feathered.

Flight Flutter

8. Flight flutter tests were conducted by stabilizing the airplane at the desired conditions and attempting to excite the flutter mode, using a lateral stick pulse. Data were recorded for several seconds to enable an analysis to be made.

DATA ANALYSIS METHODS

Takeoff Performance

9. The estimated takeoff performance was compared with data obtained from figure 14-11 of the operator's manual at the altitude, ambient temperature, gross weight, and height above the runway encountered during each test. The power available was assumed to be equal to or in excess of the minimum power available as contained in the engine model specification. This assumption was substantiated by the method explained in the Power Available section.

Power Available

10. Power available from the engines installed in the test aircraft was evaluated to determine if the aircraft was a suitable sample for this test. Shaft horsepower was obtained from the aircraft torquemeters at a variety of test conditions using the torquemeter calibration from the engine test run after overhaul.

11. The gas producer speed and the shp were referred to sea-level, standard-day static conditions using the following expressions:

$$\frac{N_1}{\sqrt{\theta_t}} \quad \text{and} \quad \frac{SHP}{\delta_t\sqrt{\theta_t}} = \frac{SHP_t - \Delta SHP}{\delta_t\sqrt{\theta_t}} \qquad (1)$$

Where:

N_1 = Gas producer speed

SHP = SHP corrected for ram

ΔSHP = Ram correction

= SHP available at test true airspeed

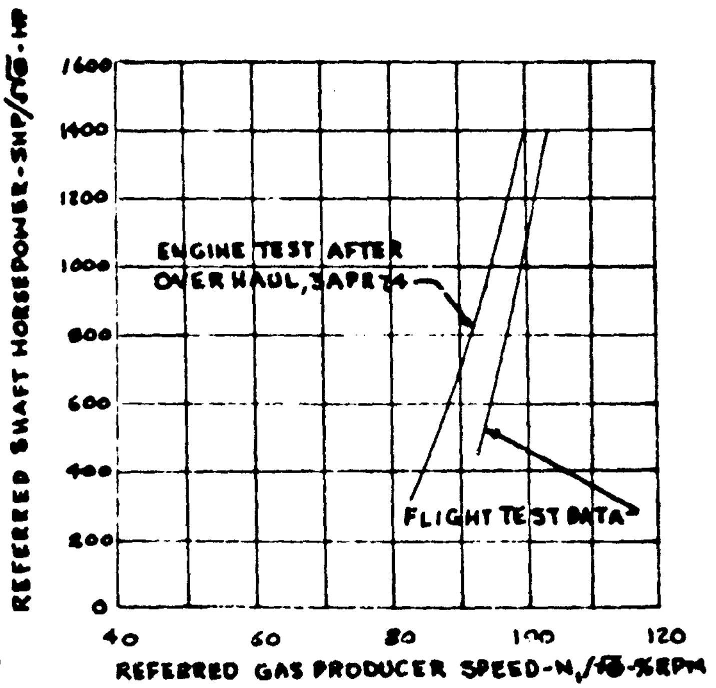
− SHP available at zero airspeed (based on power available versus true airspeed obtained from the OV-1D APE II report (USAASTA Project No. 70-03, April 1972)

δ_t = Pressure at test altitude/sea-level pressure

θ_t = Absolute temperature at test altitude/absolute sea-level, standard-day temperature

The referred values for each engine were plotted and a curve faired through the respective data. These curves were compared with curves obtained from the engine test stand run after overhaul for the respective engine. This comparison for the No. 2 engine is presented in figure 1.

FIGURE NO 1
ENGINE CHARACTERISTICS
OV-1D USA S/N 69-17000
T53-701A S/N 30036



12. This figure shows that the engine was apparently developing 300 to 400 shp less than during the test stand run. To verify this, a lift-drag polar was calculated from the data obtained during the airspeed position error calibration in the cruise configuration, using the following equations:

$$C_L = \frac{L}{1/2\ \rho\ V_T^2\ S} \qquad (2)$$

and

$$C_D = \frac{D}{1/2\ \rho\ V_T^2\ S} \qquad (3)$$

Where:

C_L = Lift coefficient

C_D = Drag coefficient

L = Lift (assumed equal to gross weight (lb))

D = Drag (lb)

ρ = Air density (lb-sec²/ft⁴)

V_T = True airspeed (ft/sec)

S = Wing area (ft²)

$$D = T = \frac{THP\ 550}{V_T} \qquad (4)$$

Where:

T = Thrust (lb)

THP = Thrust horsepower

$$THP = \eta\ SHP_t \qquad (5)$$

Where:

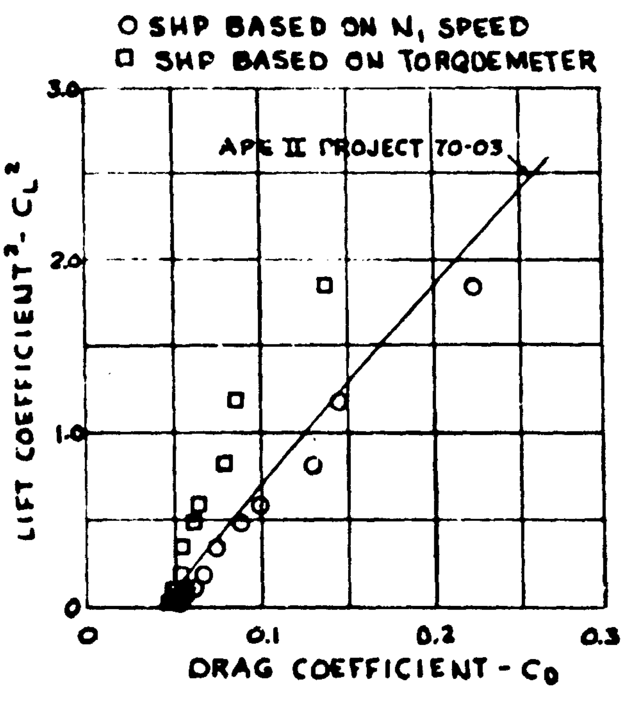
η = Propeller efficiency

The propeller efficiency was obtained from the propeller efficiency chart for the 53C51/7125-6 propeller including the blocking effect of a T-53 engine but not including compressibility corrections for high tip speed conditions.

13. A comparison of the calculated lift-drag polar based on engine torquemeter readings was made with a lift-drag polar contained in the APE II performance report for the same conditions, except without the HOT BRICK III device. This comparison is presented in figure 2.

FIGURE NO. 2

DUAL ENGINE LEVEL FLIGHT PERFORMANCE
OV-1D USA S/N 69-17000
STORE CONFIGURATION E WITH HOTBRICK III
CRUISE CONFIGURATION



14. Figure 2 shows that a considerable increase in performance (*ie*, less power required for a given gross weight and airspeed) is indicated when basing power on the engine torquemeter. Also shown on figure 2 is a lift-drag polar calculated from the data obtained during the airspeed position error calibration in the cruise configuration, using power based on the engine test stand run after overhaul and gas producer speed. This power was obtained in the following manner. The gas producer speed recorded in flight was referred to sea-level, standard-day conditions. This referred gas producer speed was used to enter a plot of referred gas producer speed versus referred shp derived from the engine test stand run after overhaul to obtain referred shp. Shaft horsepower at the test conditions was determined from referred shp using the following equation:

$$SHP_t = \left(\frac{SHP}{\delta\sqrt{\theta}}\right)\left(\delta_t\sqrt{\theta_t}\right) + \Delta SHP \qquad (6)$$

This shp was then used to calculate the drag coefficient using equations 3 through 5 as before.

15. The comparison of the calculated lift-drag polar based on gas producer speed and the engine test stand run with the APE II performance data showed a slight increase in power required for the test aircraft. When considering the increased drag of the HOT BRICK III device and the decrease in power available with the engines installed in the aircraft, the comparison seemed reasonable. It was therefore assumed that the engines in the test aircraft were developing the appropriate power and should be representative.

Flight Flutter

16. The oscillations at each flutter instrument location, resulting from the lateral stick pulse, were reduced to damping ratio using the ratio-of-maximums method. The first 0.4 second following the stick pulse apparently contained effects of aileron movement and was not used in determining damping ratio.

APPENDIX E. TEST DATA

INDEX

FIGURE NO 1

MINIMUM TRIM AIRSPEED WITH ASYMMETRIC LOAD

OV-1D USA S/N 69-17000

STORE CONFIGURATION E WITH HOT BRICK III

SYMBOL	GROSS WEIGHT ~ LB	CG ~ % MAC	CONFIGURATION
□	17500	29.0	CRUISE
Δ	17500	29.0	POWER APPROACH

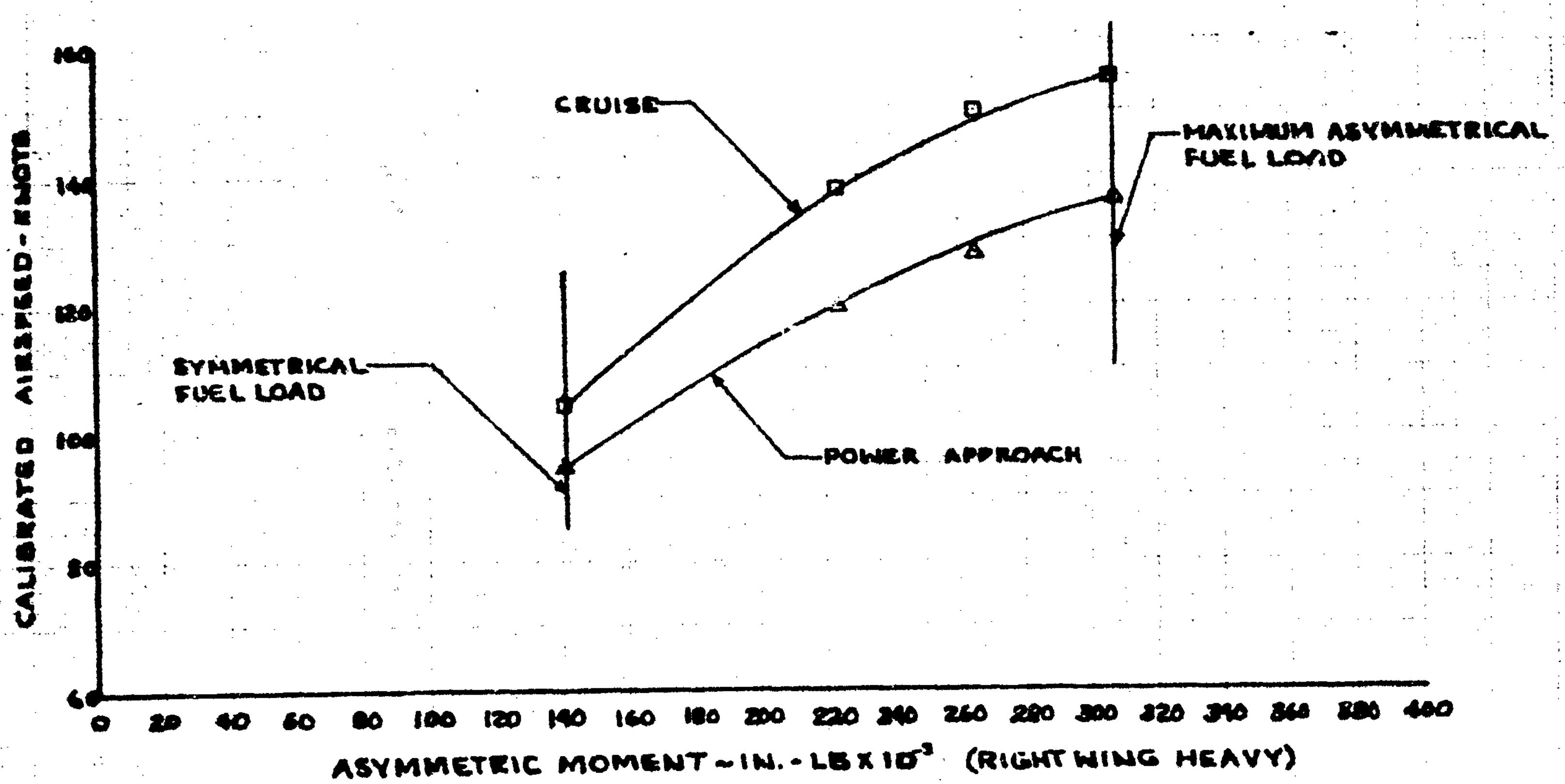


FIGURE NO. 2

CONTROL MARGINS

OV-1D USA S/N 69-17000
STORE CONFIGURATION E WITH HOT BRICK III

SYMMETRICAL FUEL LOAD

CRUISE CONFIGURATION
GROSS WEIGHT 17720 LB
CG 28.1 PERCENT MAC

PRESSURE ALTITUDE 7580 FT
FREE AIR TEMP 18.0 DEG C

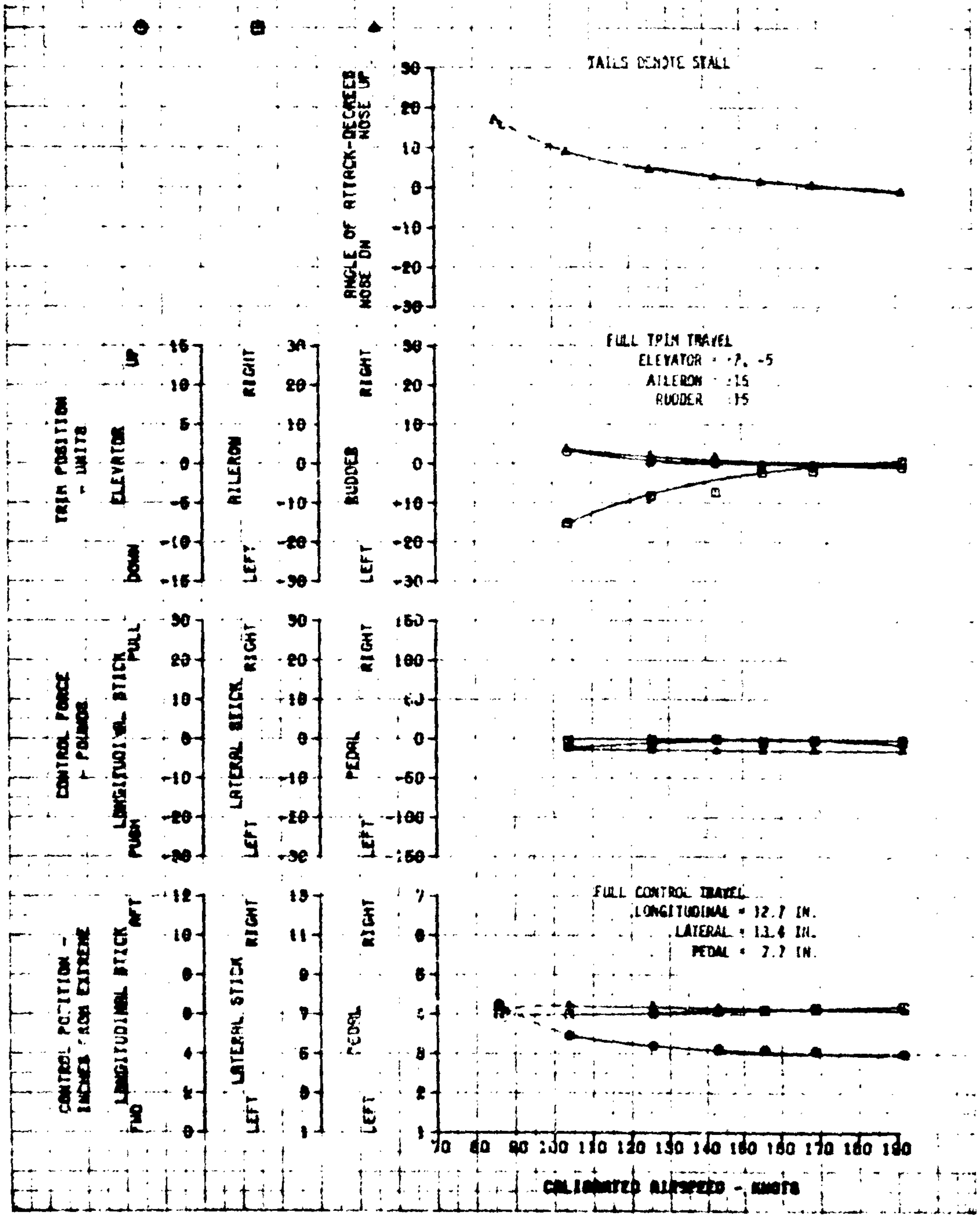


FIGURE NO. 5
CONTROL MARGINS

OV-10 USA S/N 66-17000
STORE CONFIGURATION E WITH HOT BRICK III

LEFT DROP TANK EMPTY - RIGHT DROP TANK FULL

CRUISE CONFIGURATION
GROSS WEIGHT 17300 LB
CG 28.0 PERCENT MAC

PRESSURE ALTITUDE 2840 FT
FREE AIR TEMP 17.5 DEG C

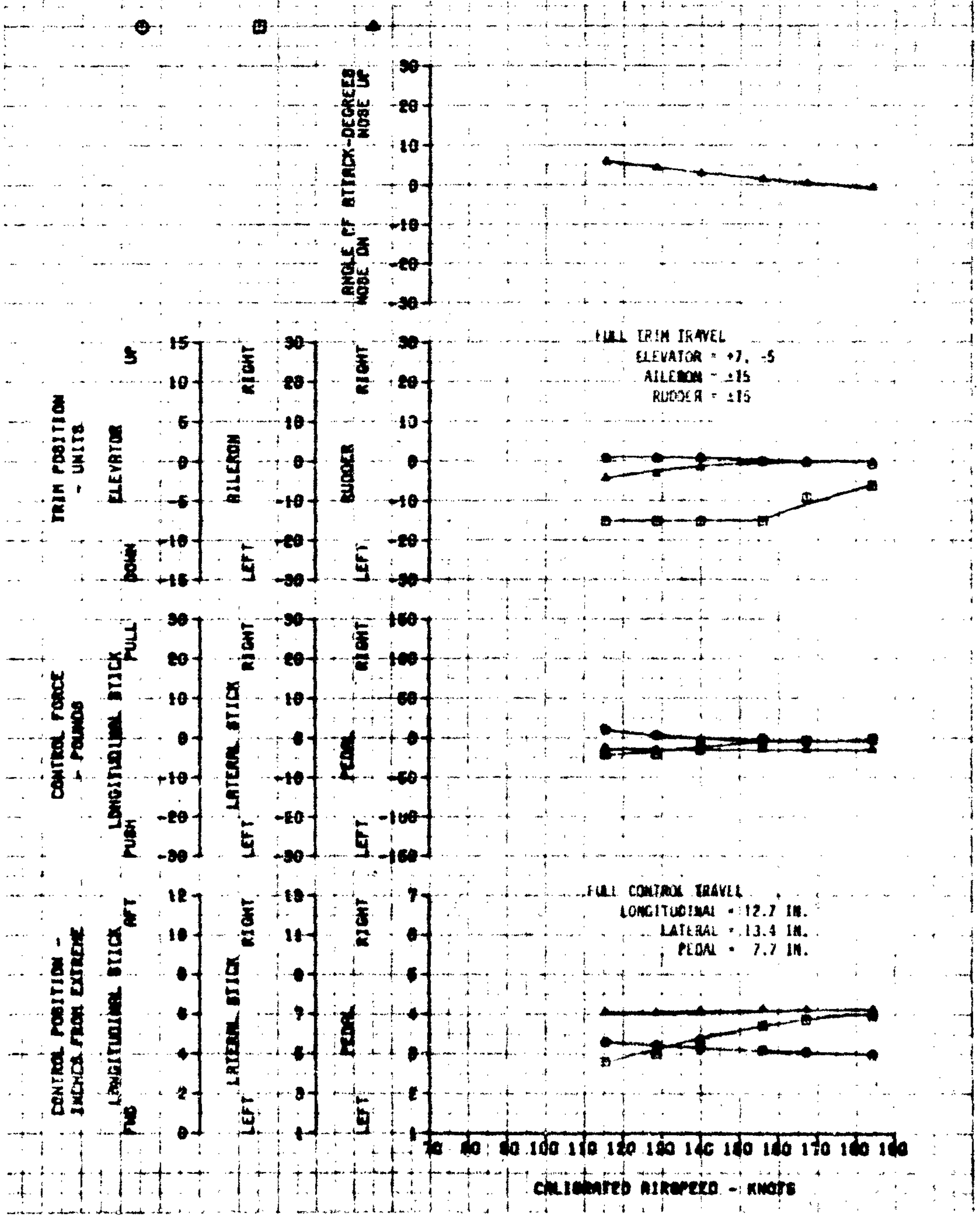


FIGURE NO. 4

CONTROL MARGINS

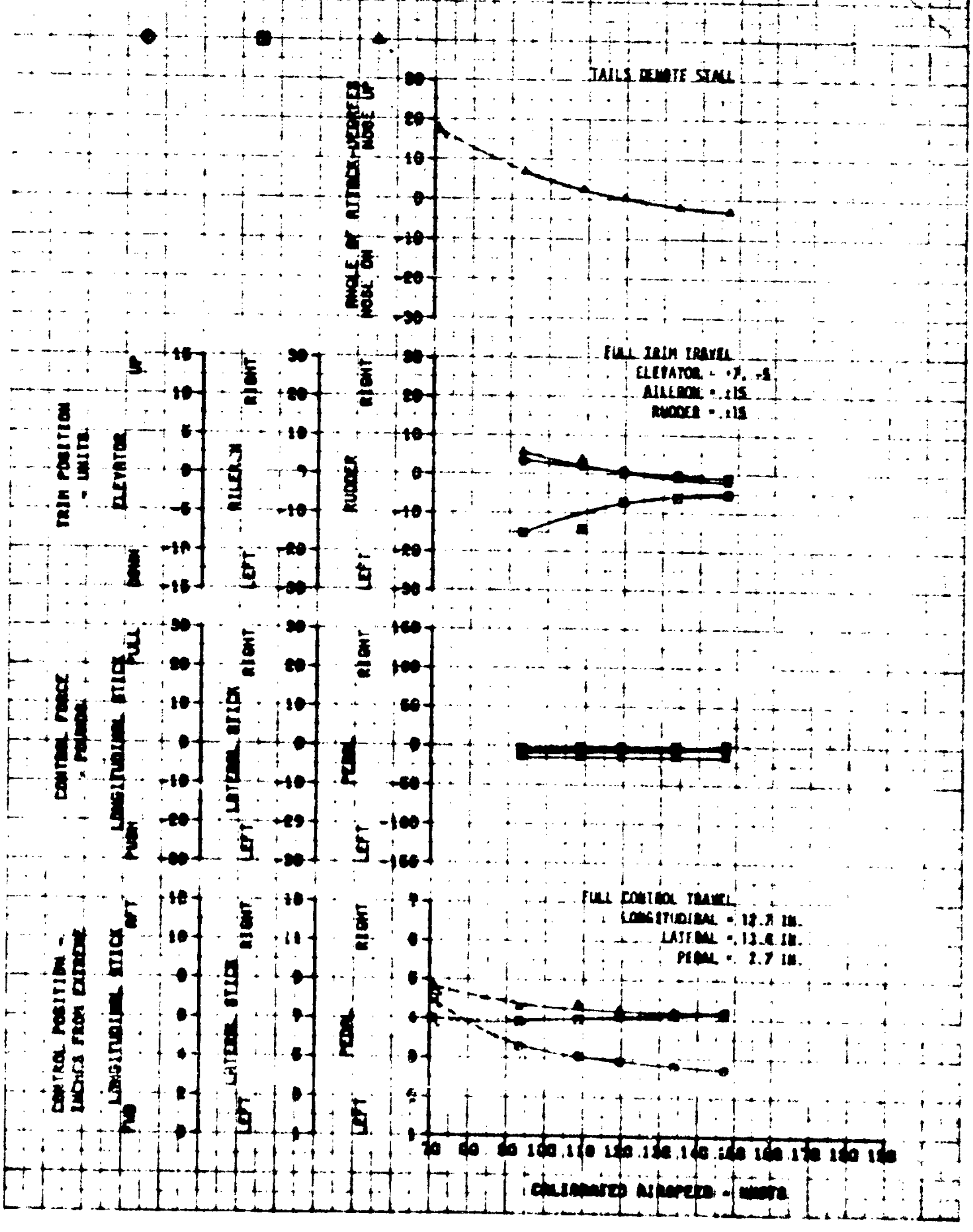
OV-10 USA S/N 68-17000

STORE CONFIGURATION E WITH MXU BRICK 111

SYMMETRICAL FUEL LOAD

POWER APPROACH CONFIGURATION
GROSS WEIGHT 17440 LB
CG 28.0 PERCENT MAC

PRESSURE ALTITUDE 7200 FT
FREE AIR TEMP 18.5 DEG C



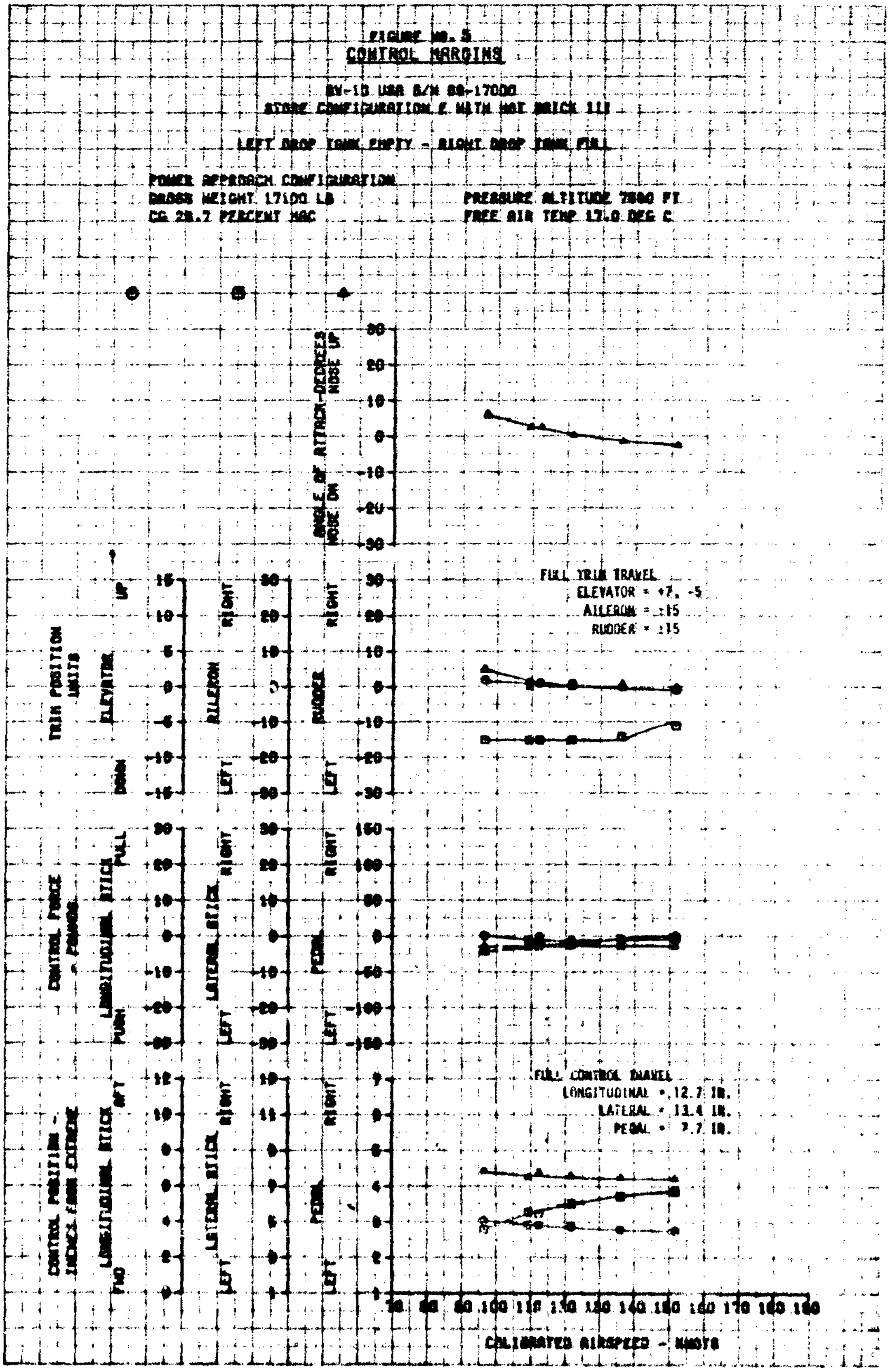
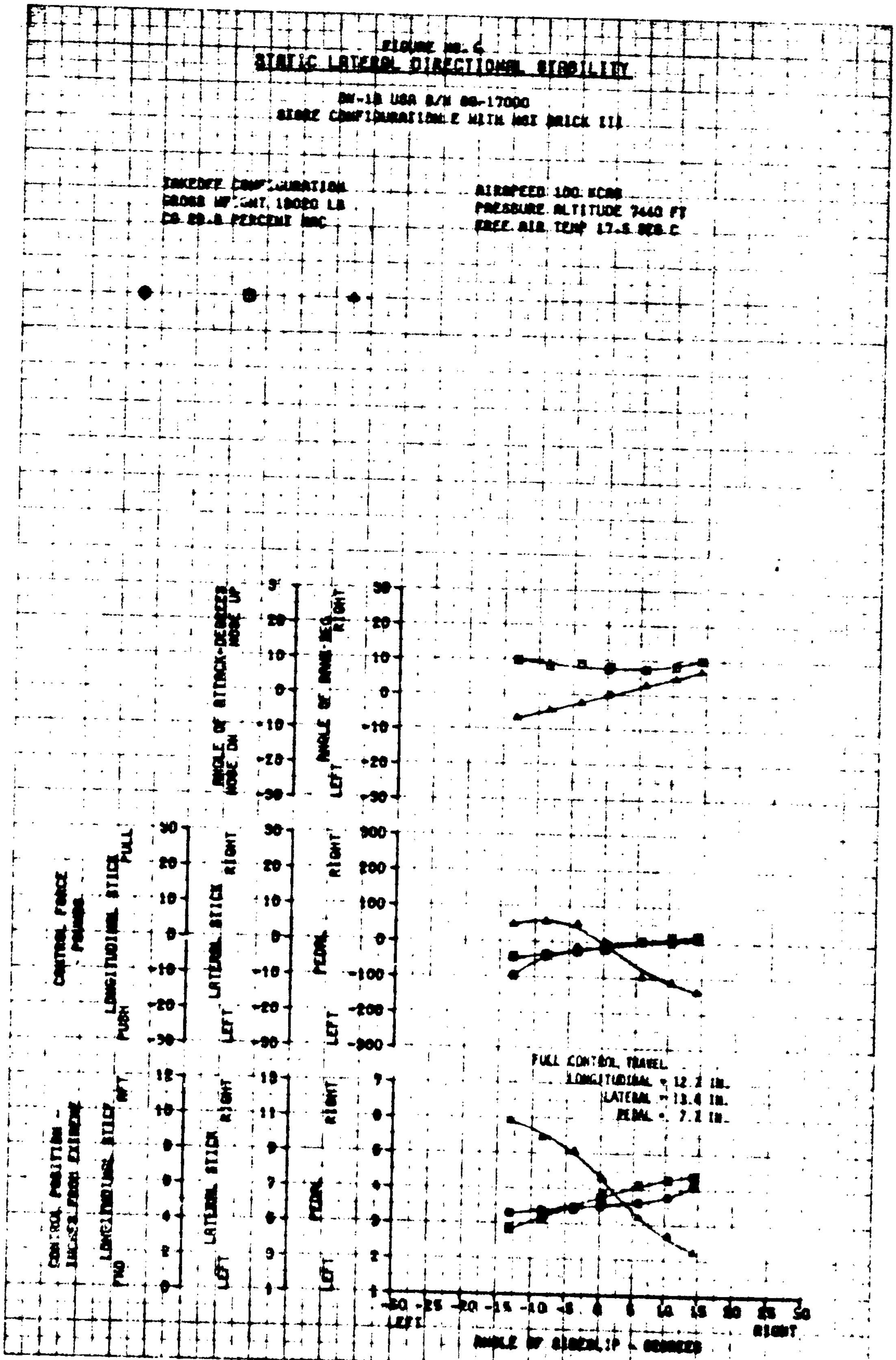


FIGURE NO. 5
CONTROL MARGINS
LEFT DROP TANK EMPTY - RIGHT DROP TANK FULL
POWER APPROACH CONFIGURATION
GROSS WEIGHT 17100 LB
CG 28.7 PERCENT MAC
FREE AIR TEMP 17.0 DEG C
ANGLE OF ATTACK-DEGREES
NOSE UP
NOSE DN
TRIM POSITION
UNITS
ELEVATOR
AILERON
RUDDER
FULL TRIM TRAVEL
ELEVATOR = +7, -5
AILERON = ±15
RUDDER = ±15
CONTROL FORCE
- POUNDS
LONGITUDINAL STICK
LATERAL STICK
PEDAL
PUSH
PULL
LEFT
RIGHT
CONTROL POSITION -
INCHES FROM EXTREME
FWD
AFT
FULL CONTROL TRAVEL
LONGITUDINAL = 12.7 IN.
LATERAL = 13.4 IN.
PEDAL = 7.7 IN.
CALIBRATED AIRSPEED - KNOTS



STATIC LATERAL DIRECTIONAL STABILITY
TAKEOFF CONFIGURATION
AIRSPEED 100 KCAS
PRESSURE ALTITUDE 7440 FT
CONTROL FORCE POUNDS
LONGITUDINAL STICK
PUSH
PULL
LATERAL STICK
PEDAL
LEFT
RIGHT
CONTROL POSITION
FULL CONTROL TRAVEL
LONGITUDINAL
LATERAL
PEDAL
ANGLE OF SIDESLIP

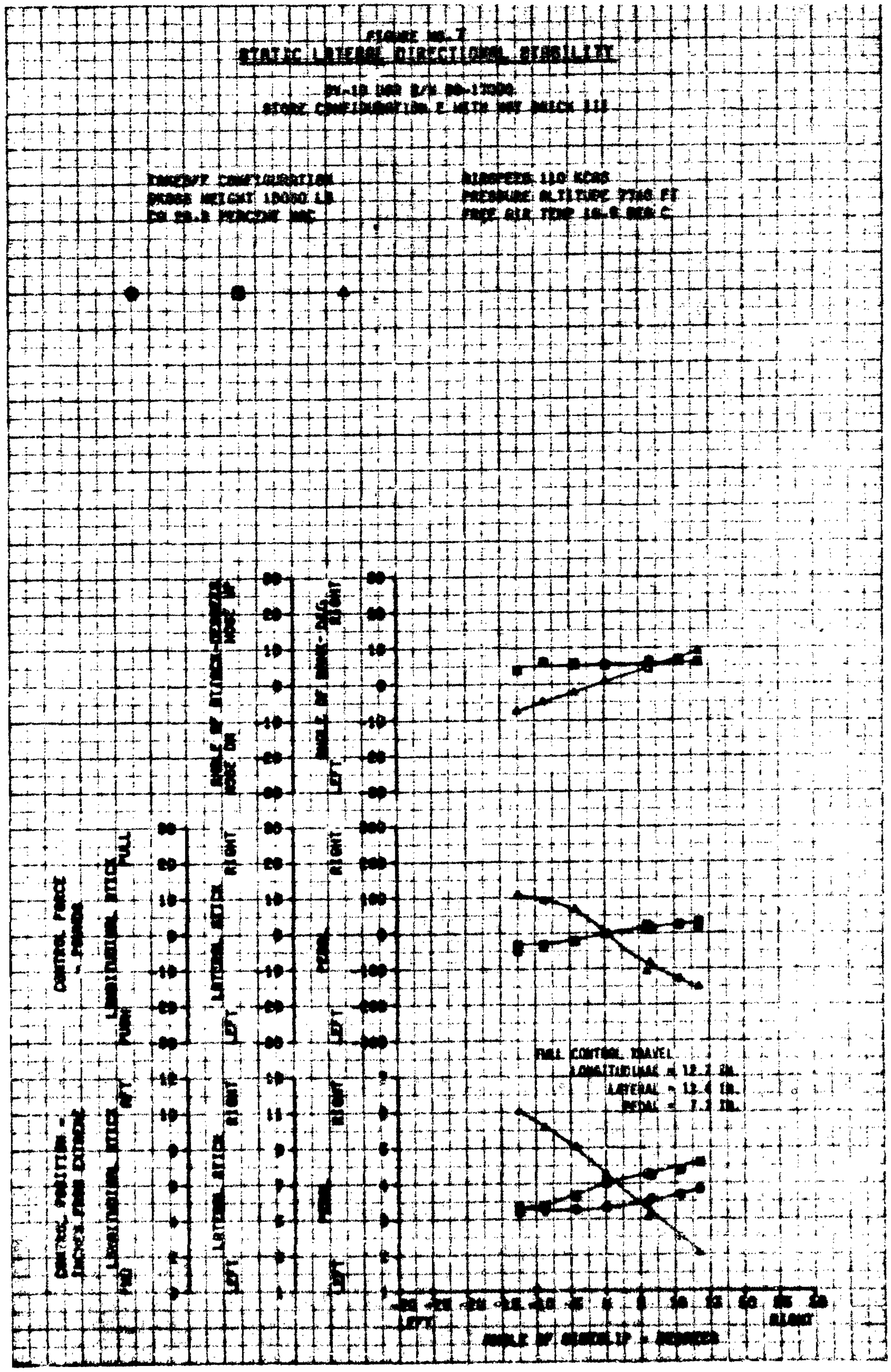
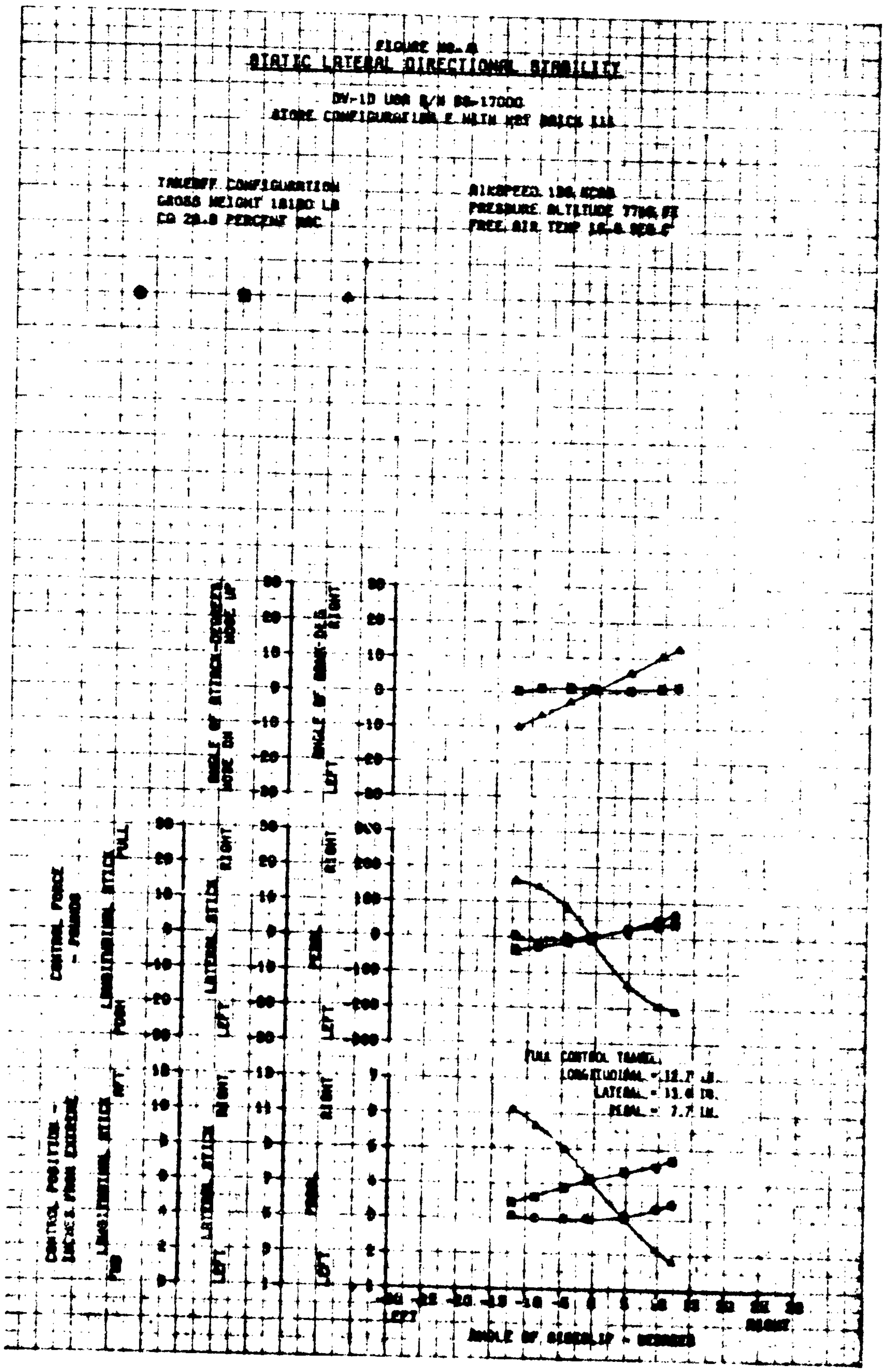


FIGURE NO. 7
STATIC LATERAL DIRECTIONAL STABILITY
TAKEOFF CONFIGURATION
GROSS WEIGHT 18080 LB
AIRSPEED 110 KCAS
FULL CONTROL TRAVEL
LEFT
RIGHT
ANGLE OF SIDESLIP ~ DEGREES


STATIC LATERAL DIRECTIONAL STABILITY
TAKEOFF CONFIGURATION
GROSS WEIGHT 18180 LB
CG 28.8 PERCENT MAC
ANGLE OF ATTACK - DEGREES
NOSE UP
NOSE DN
ANGLE OF BANK - DEG
LEFT
RIGHT
CONTROL FORCE - POUNDS
LONGITUDINAL STICK
PULL
PUSH
LATERAL STICK
PEDAL
CONTROL POSITION - INCHES FROM EXTREME
AFT
FWD
FULL CONTROL TRAVEL
LONGITUDINAL
LATERAL
PEDAL
ANGLE OF SIDESLIP - DEGREES

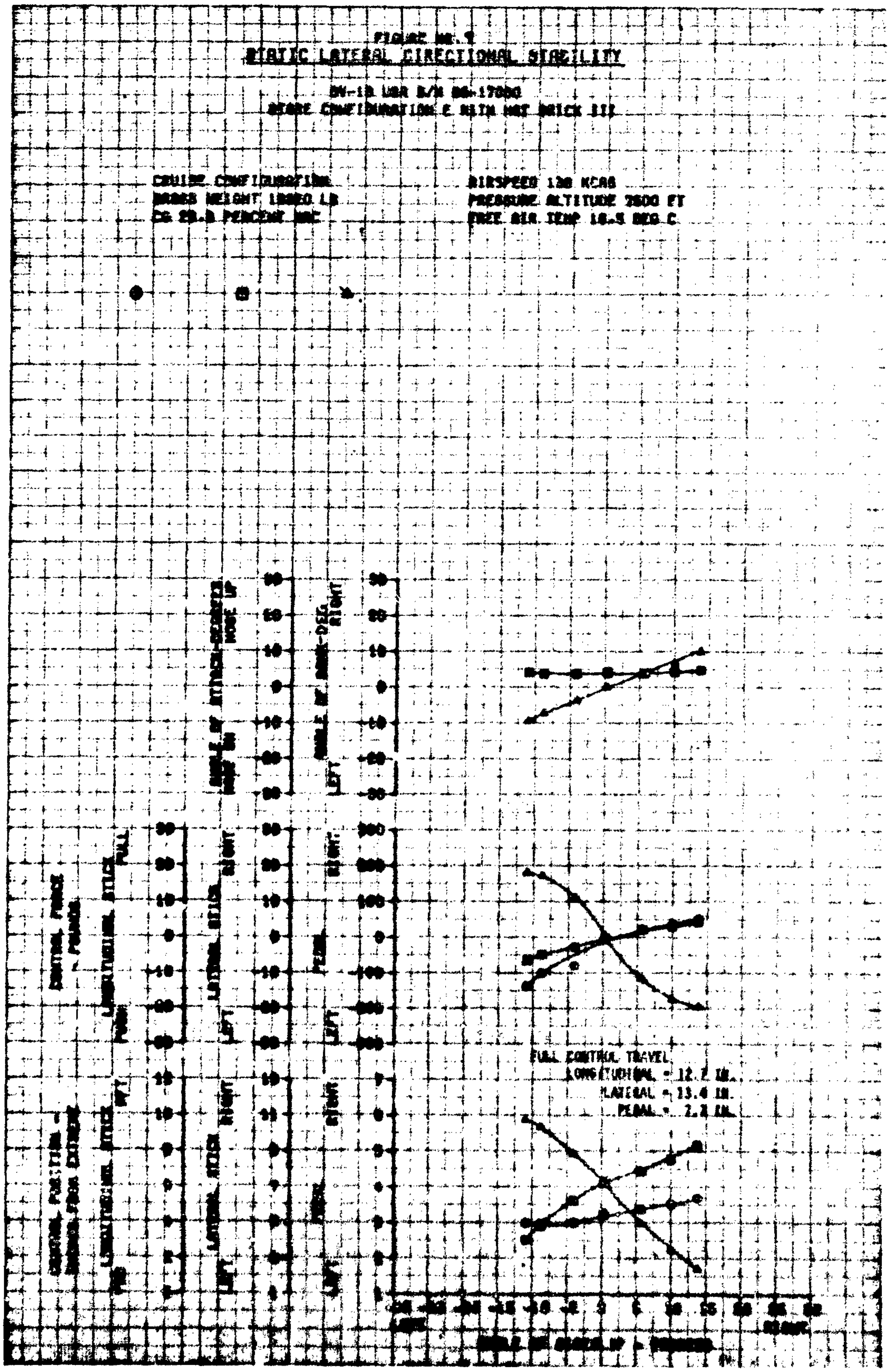

STATIC LATERAL DIRECTIONAL STABILITY
CRUISE CONFIGURATION
FULL CONTROL TRAVEL

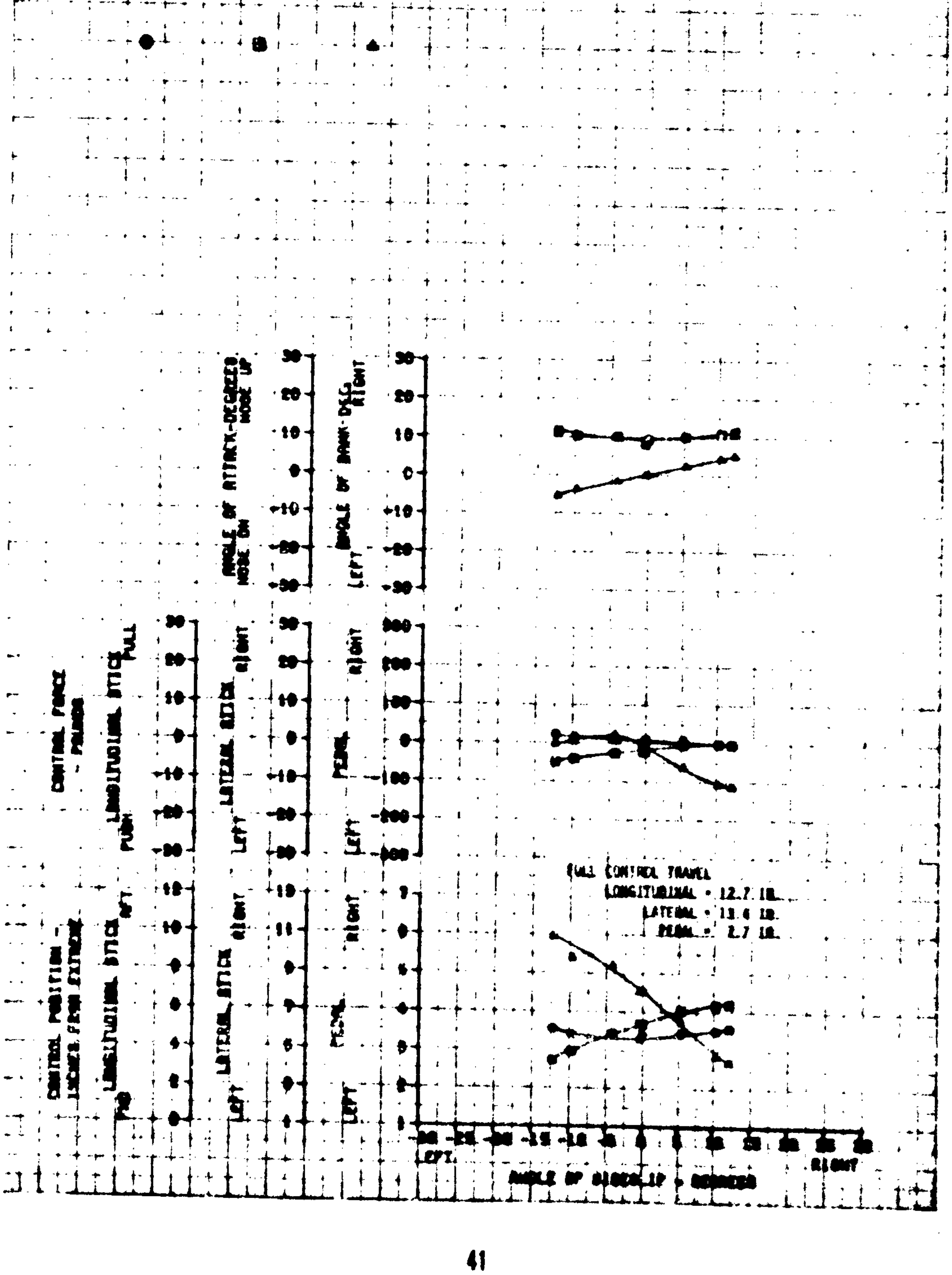
FIGURE NO. 1D

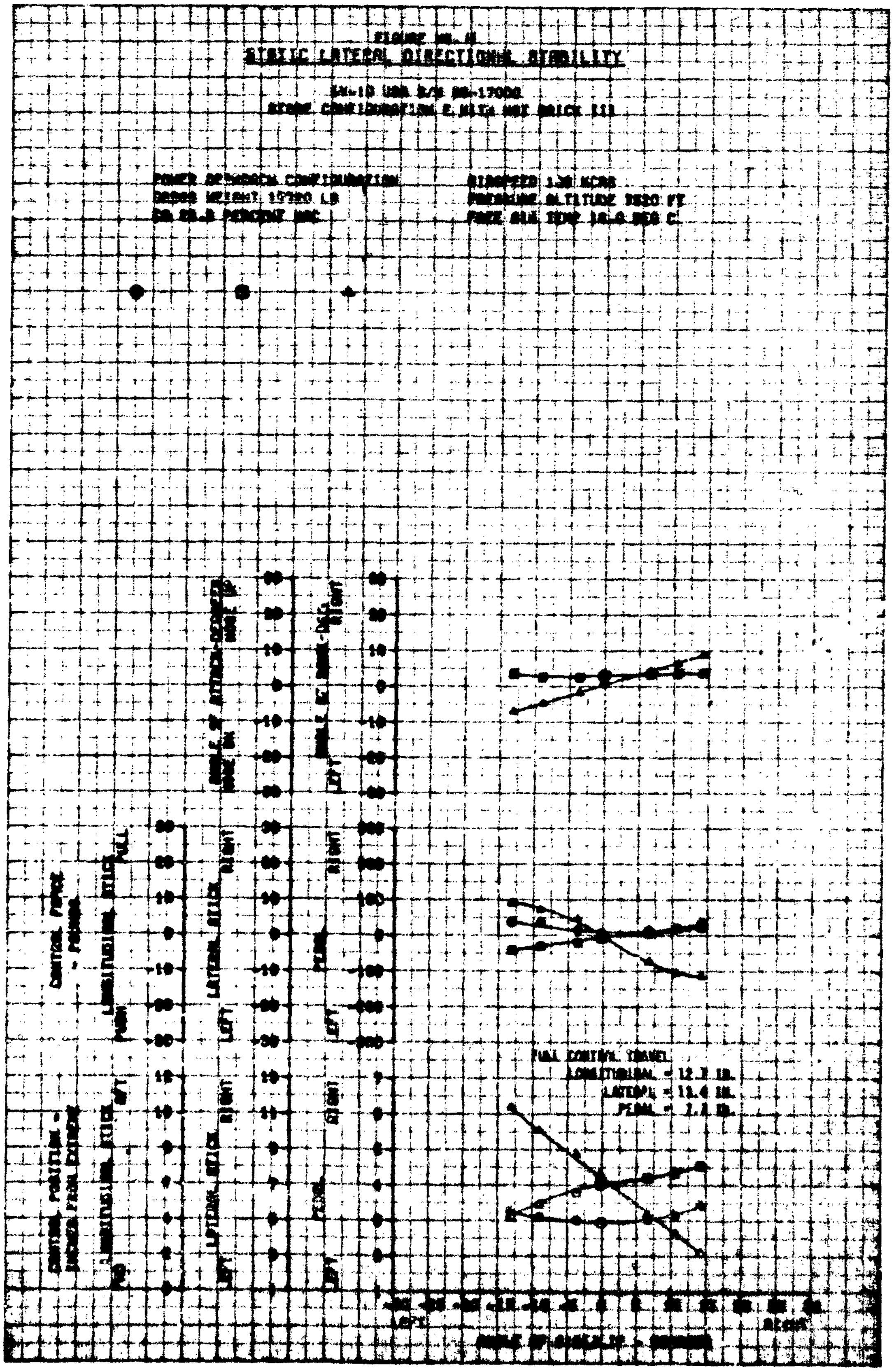
STATIC LATERAL DIRECTIONAL STABILITY

OV-1D USA S/N 68-17000
STORE CONFIGURATION E WITH NOI BRICK III

POWER APPROACH CONFIGURATION
GROSS WEIGHT 17880 LB
CG 28.8 PERCENT MAC

AIRSPEED 88 KCAS
PRESSURE ALTITUDE 7840 FT
FREE AIR TEMP 18.0 DEG C




STATIC LATERAL DIRECTIONAL STABILITY
FULL CONTROL TRAVEL
LEFT
RIGHT

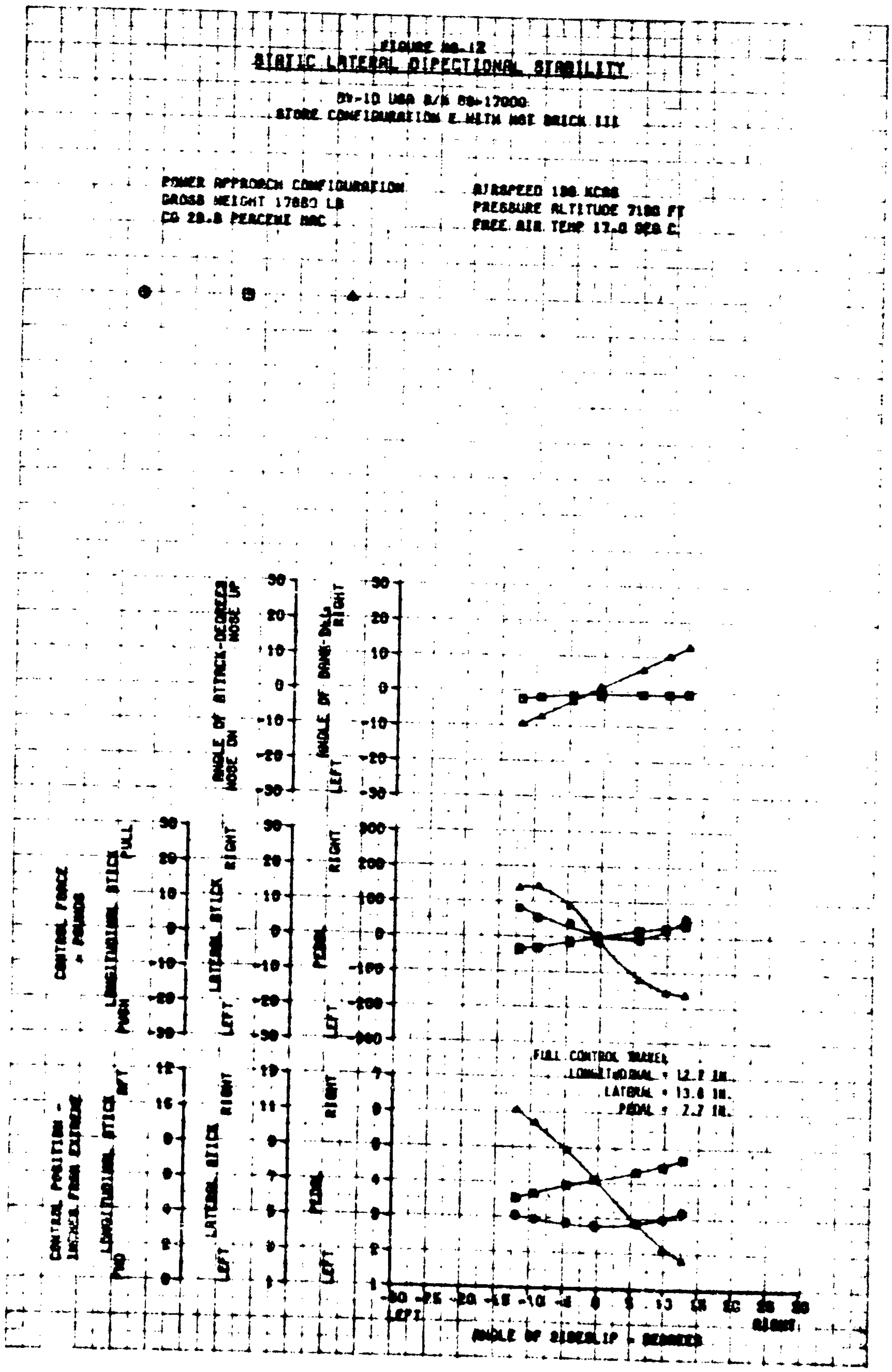


FIGURE NO. 12
STATIC LATERAL DIRECTIONAL STABILITY
POWER APPROACH CONFIGURATION
GROSS WEIGHT 17880 LB
PRESSURE ALTITUDE
FREE AIR TEMP
CONTROL FORCE - POUNDS
LONGITUDINAL STICK
PUSH
PULL
LATERAL STICK
LEFT
RIGHT
PEDAL
CONTROL POSITION - INCHES FROM EXTREME
FULL CONTROL TRAVEL
LONGITUDINAL
LATERAL
PEDAL
ANGLE OF ATTACK - DEGREES
NOSE DN
NOSE UP
ANGLE OF SIDESLIP - DEGREES

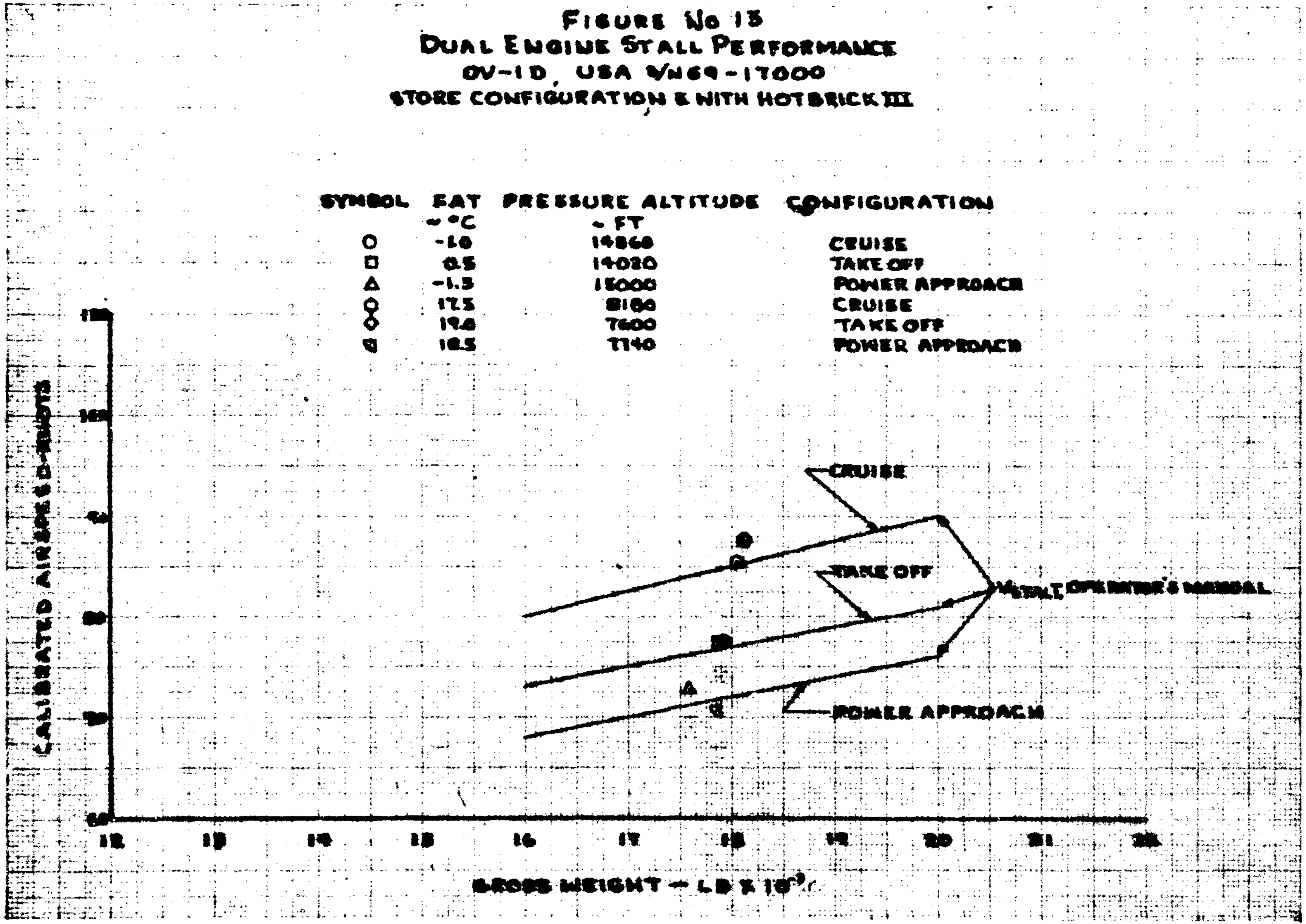


FIGURE No 13
DUAL ENGINE STALL PERFORMANCE
OV-1D, USA S/N69-17000
STORE CONFIGURATION E WITH HOTBRICK III
SYMBOL
FAT ~ °C
PRESSURE ALTITUDE ~ FT
CONFIGURATION
-1.0
0.5
-1.5
17.5
19.6
18.5
14860
14020
15000
8180
7600
7140
CRUISE
TAKE OFF
POWER APPROACH
CRUISE
TAKE OFF
POWER APPROACH
CRUISE
TAKE OFF
POWER APPROACH
V_{STALL} OPERATOR'S MANUAL
CALIBRATED AIRSPEED-KNOTS
GROSS WEIGHT ~ LB X 10^3
12
13
14
15
16
17
18
19
20
21
22

FIGURE NO. 14
DUAL ENGINE STALL

OV-10 USA S/N 69-17000
STORE CONFIGURATION E WITH HOT BRICK III

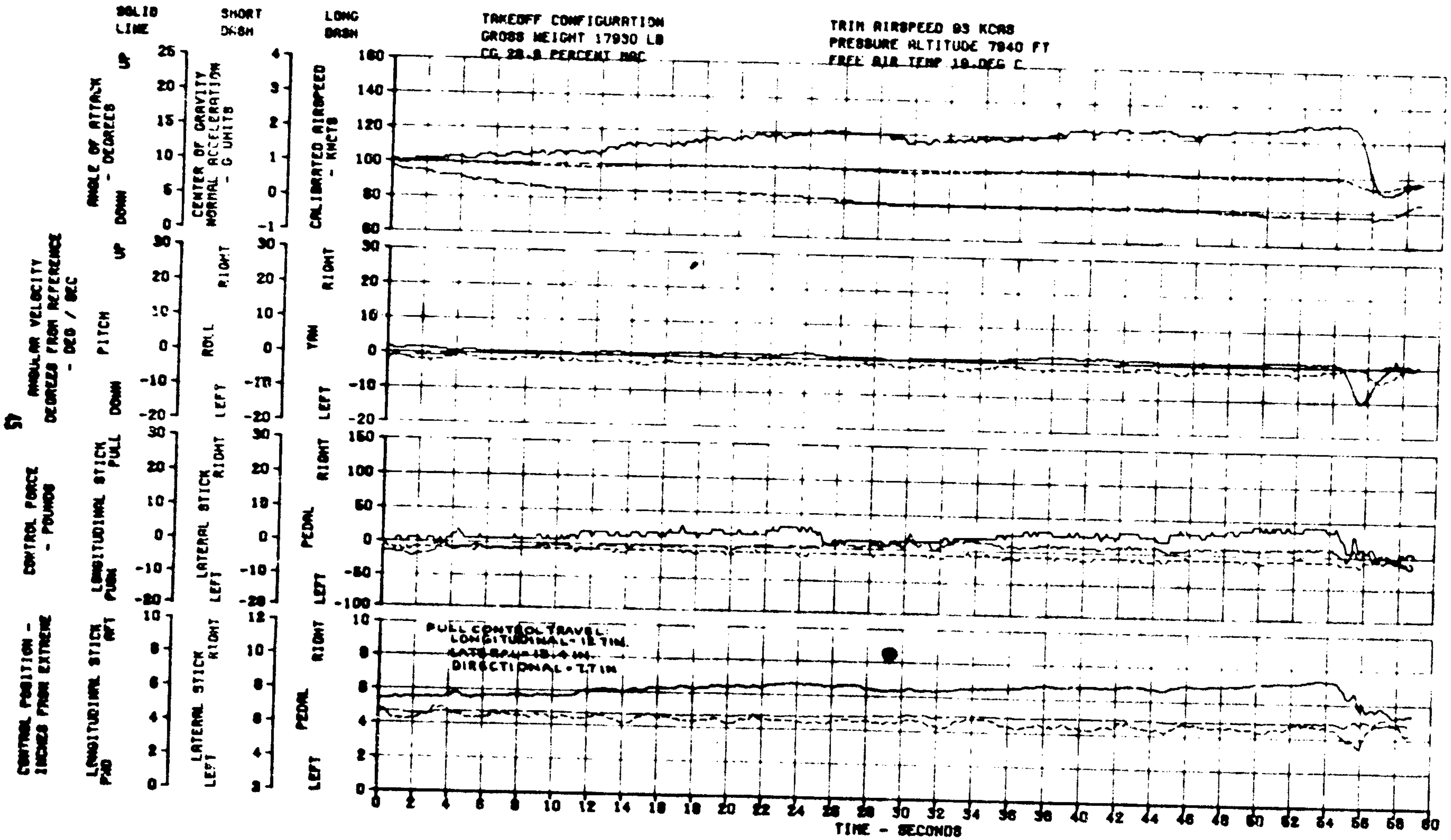


FIGURE NO. 15

DUAL ENGINE STALL

OV-1D USA S/N 69-17000
STORE CONFIGURATION E WITH HOT BRICK III

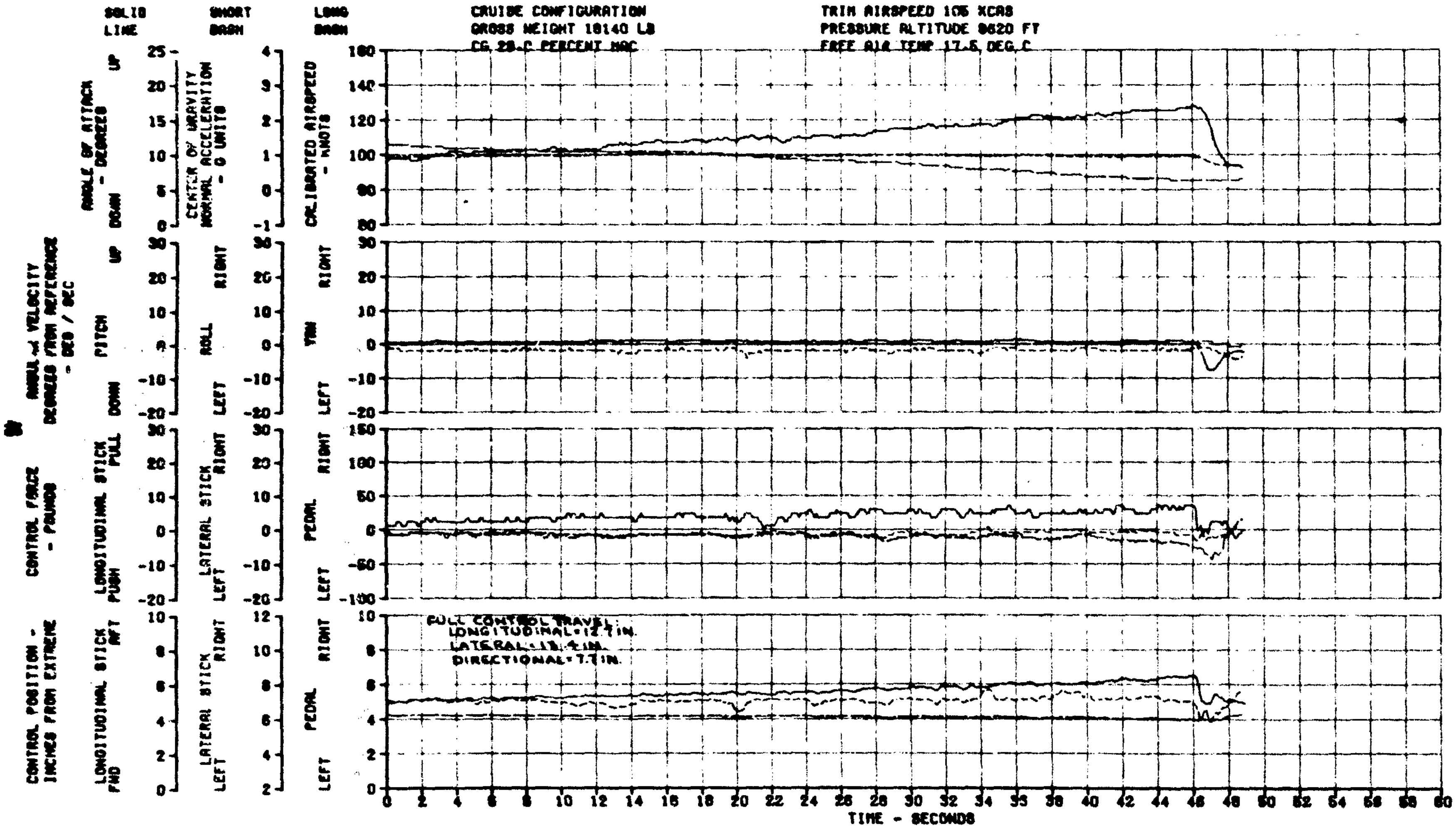


FIGURE NO. 16

DUAL ENGINE STALL

OV-1D USA S/N 69-17000

STORE CONFIGURATION E WITH HOT BRICK III

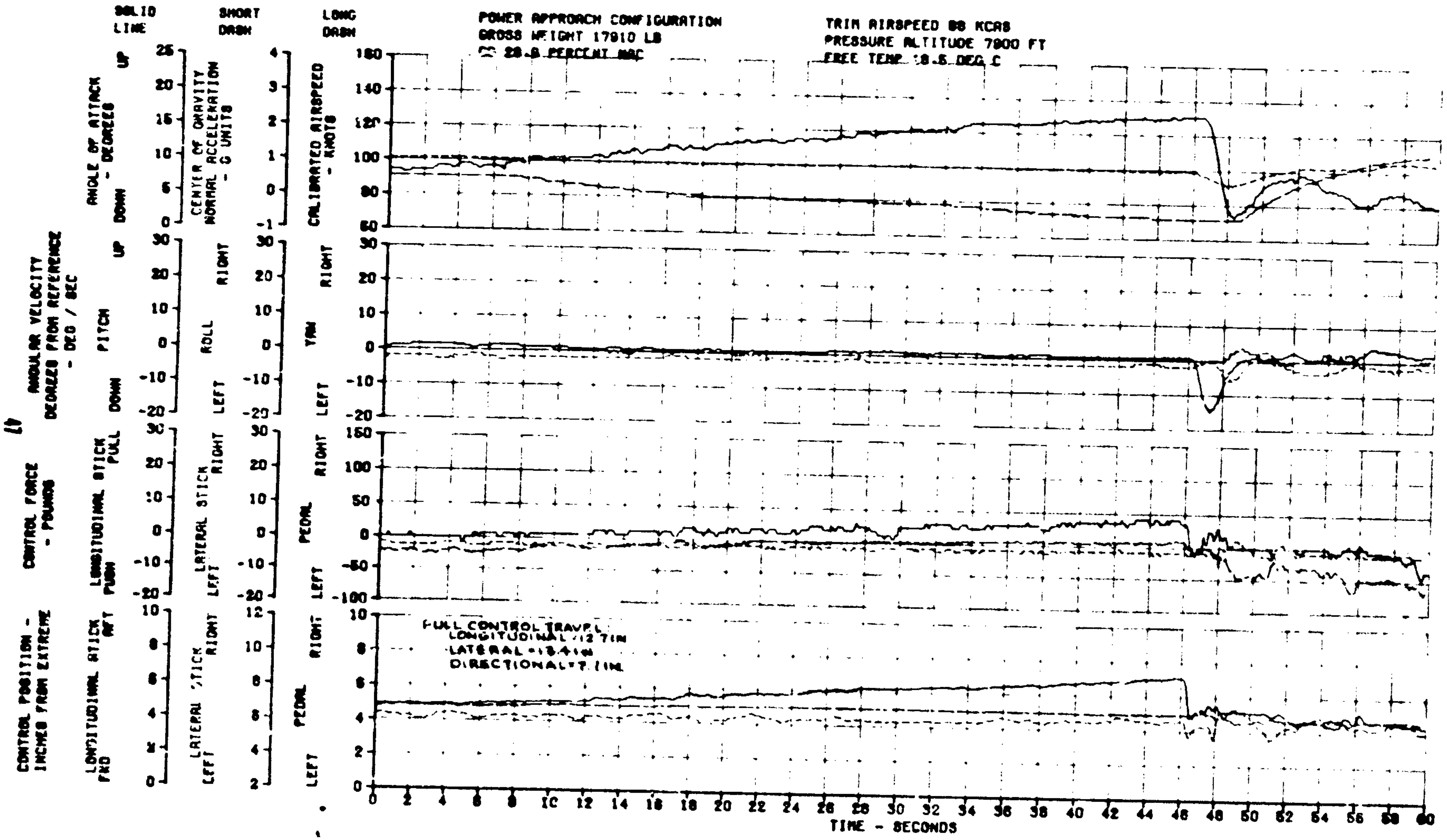


FIGURE NO. 17

SINGLE ENGINE CONTROL MARGINS

OV-1D USA S/N 68-17000

STORE CONFIGURATION E WITH HOT BRICK III

LEFT PROPELLER FEATHERED - 5 DEGREES RIGHT BANK

TAKEOFF CONFIGURATION
GROSS WEIGHT 18000 LB
CG 28.8 PERCENT MAC

PRESSURE ALTITUDE 2140 FT
FREE AIR TEMP 17.5 DEG C

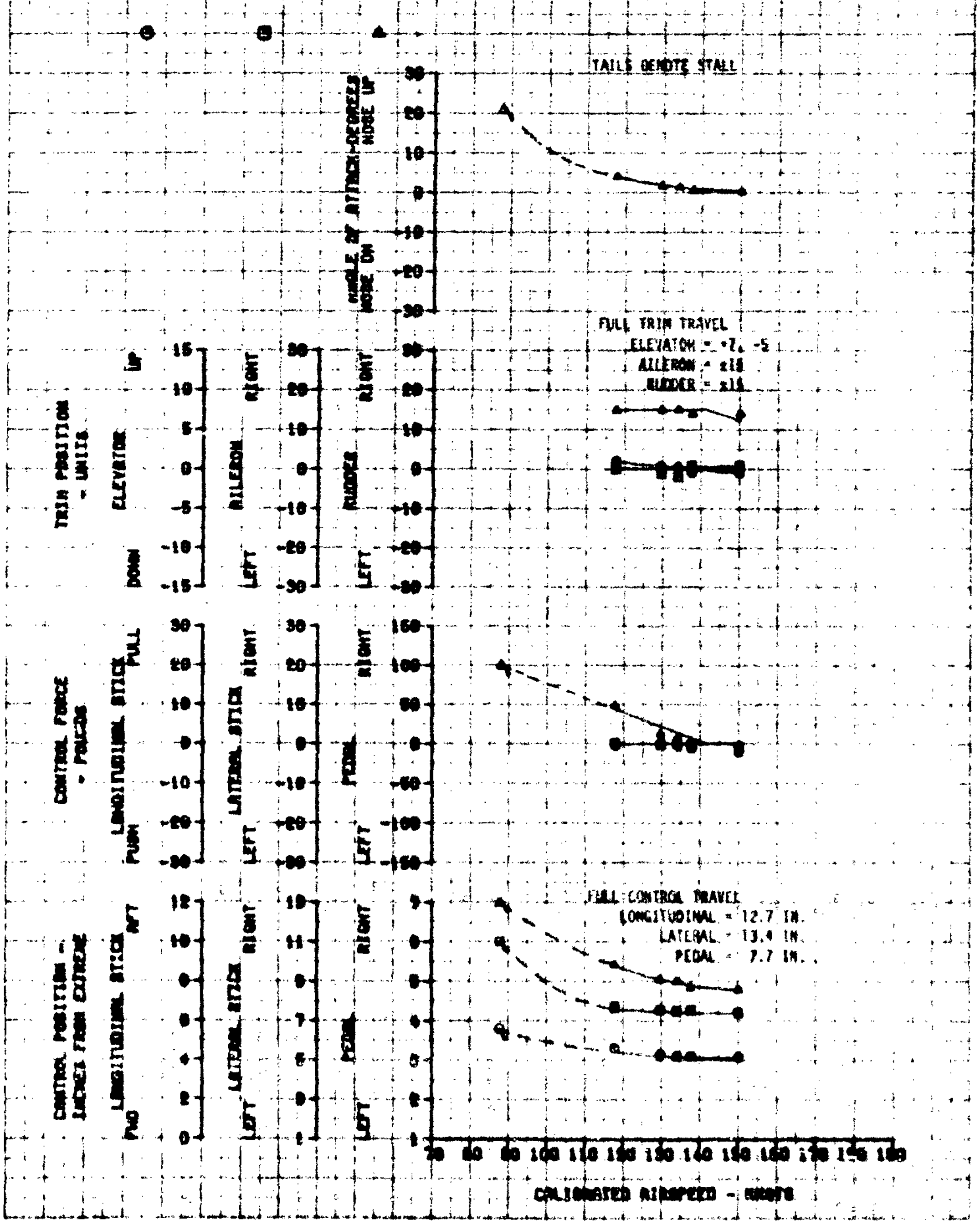


FIGURE NO. 18

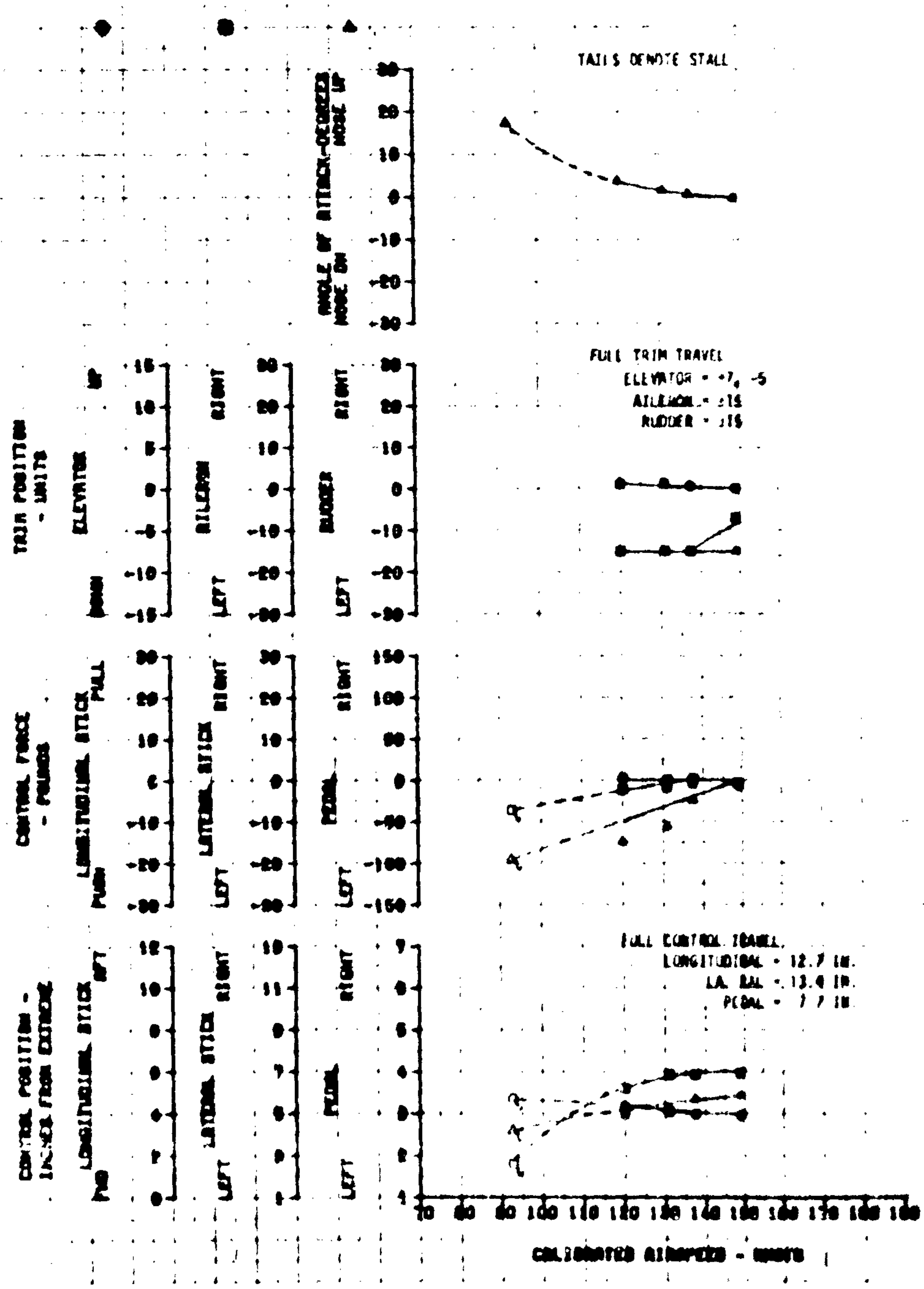
SINGLE ENGINE CONTROL MARGINS

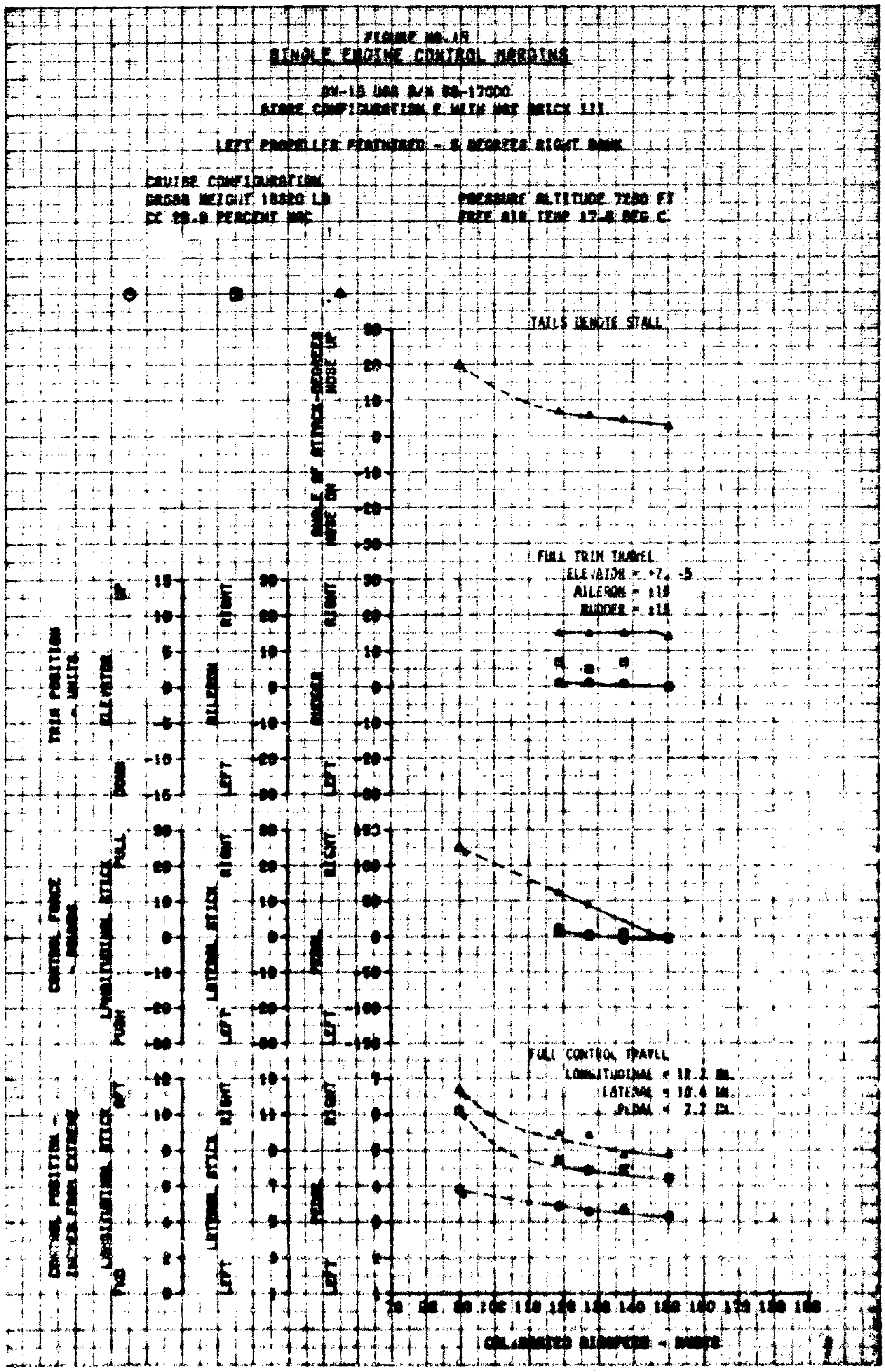
OV-1D USA S/N 68-17000
STORE CONFIGURATION E WITH HOT BRICK III

RIGHT PROPELLER FEATHERED - 5 DEGREES LEFT BANK

TAKEOFF CONFIGURATION
GROSS WEIGHT 17900 LB
CG 28.8 PERCENT MAC

PRESSURE ALTITUDE 7280 FT
FREE AIR TEMP 18.5 DEG C




SINGLE ENGINE CONTROL MARGINS
CRUISE CONFIGURATION
TAILS DENOTE STALL
FULL TRIM TRAVEL
ELEVATOR = +7, -5
AILERON = ±15
RUDDER = ±15
FULL CONTROL TRAVEL
LONGITUDINAL = 12.2 IN.
LATERAL = 10.4 IN.
PEDAL = 7.2 IN.

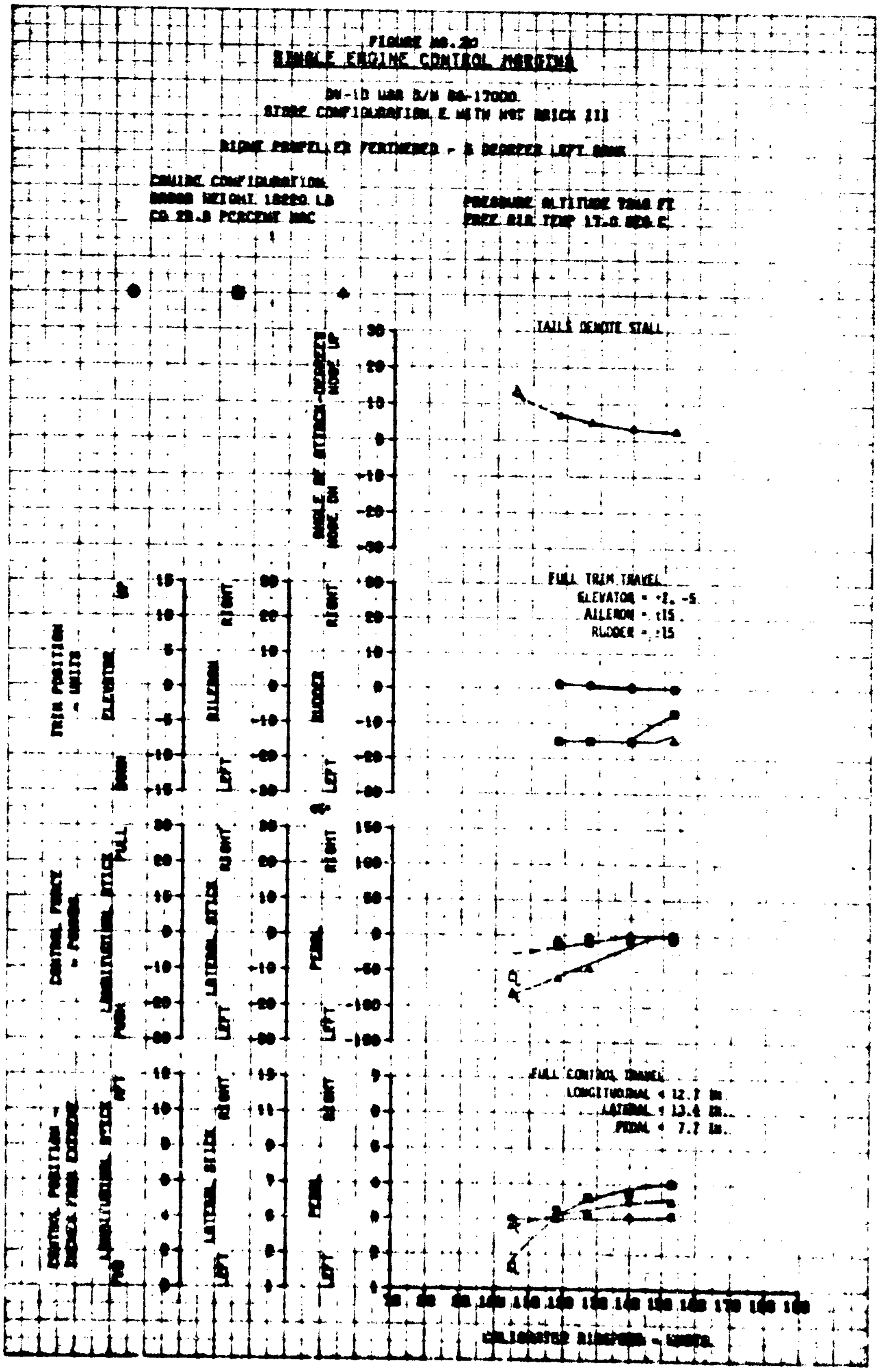

SINGLE ENGINE CONTROL MARGINS
TAILS DENOTE STALL
FULL TRIM TRAVEL
ELEVATOR = +2, -5
AILERON = ±15
RUDDER = ±15
FULL CONTROL TRAVEL
PEDAL ± 7.7 IN.
LATERAL STICK
PEDAL
LEFT
RIGHT

FIGURE NO. 21

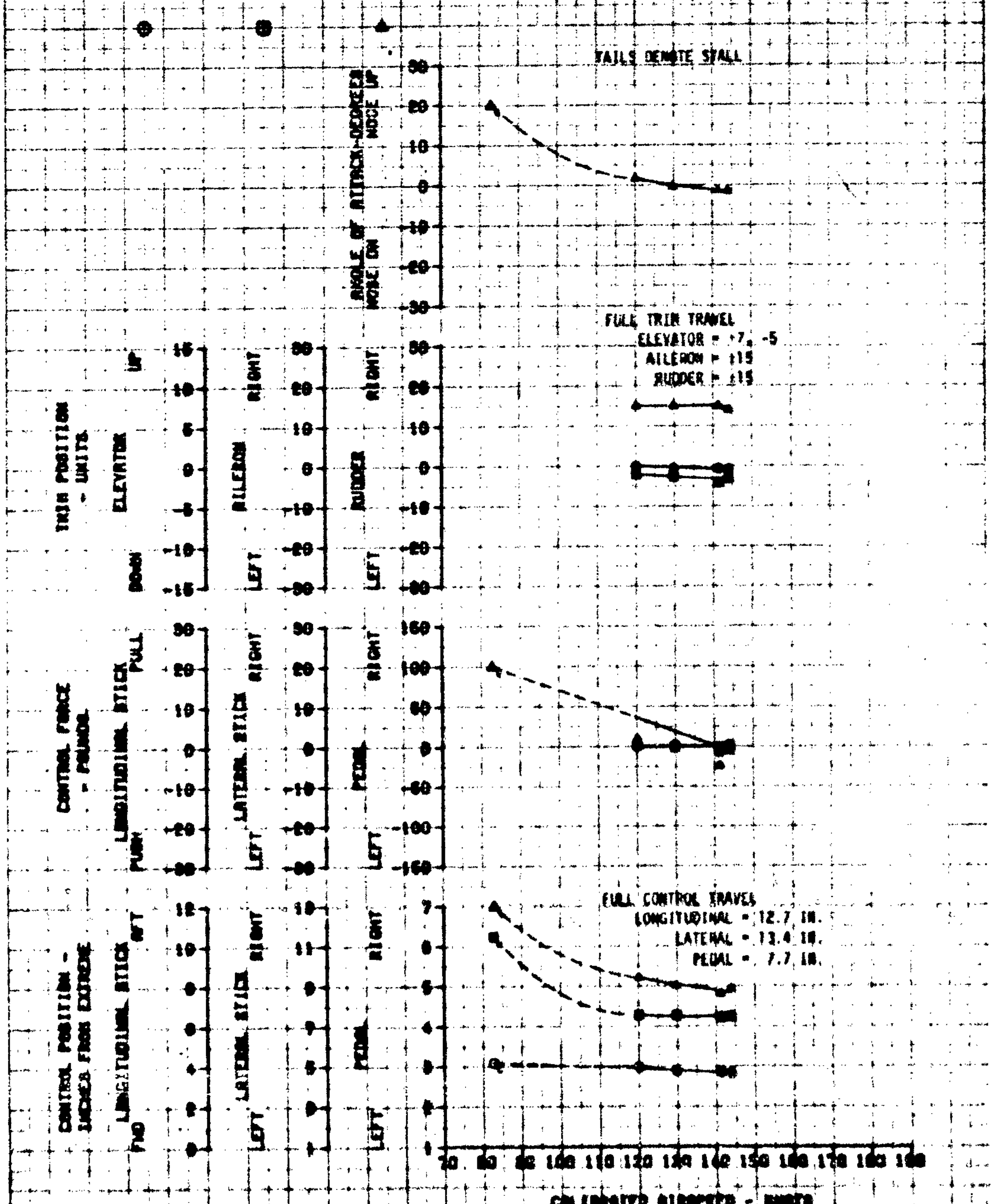
SINGLE ENGINE CONTROL MARGINS

OV-1D USA S/N 69-17000
STORE CONFIGURATION E WITH HOT BRICK III

LEFT PROPELLER FEATHERED - 5 DEGREES RIGHT BANK

POWER APPROACH CONFIGURATION
GROSS WEIGHT 18280 LB
CG 20.8 PERCENT MAC

PRESSURE ALTITUDE 5000 FT
FREE AIR TEMP 17.0 DEG C



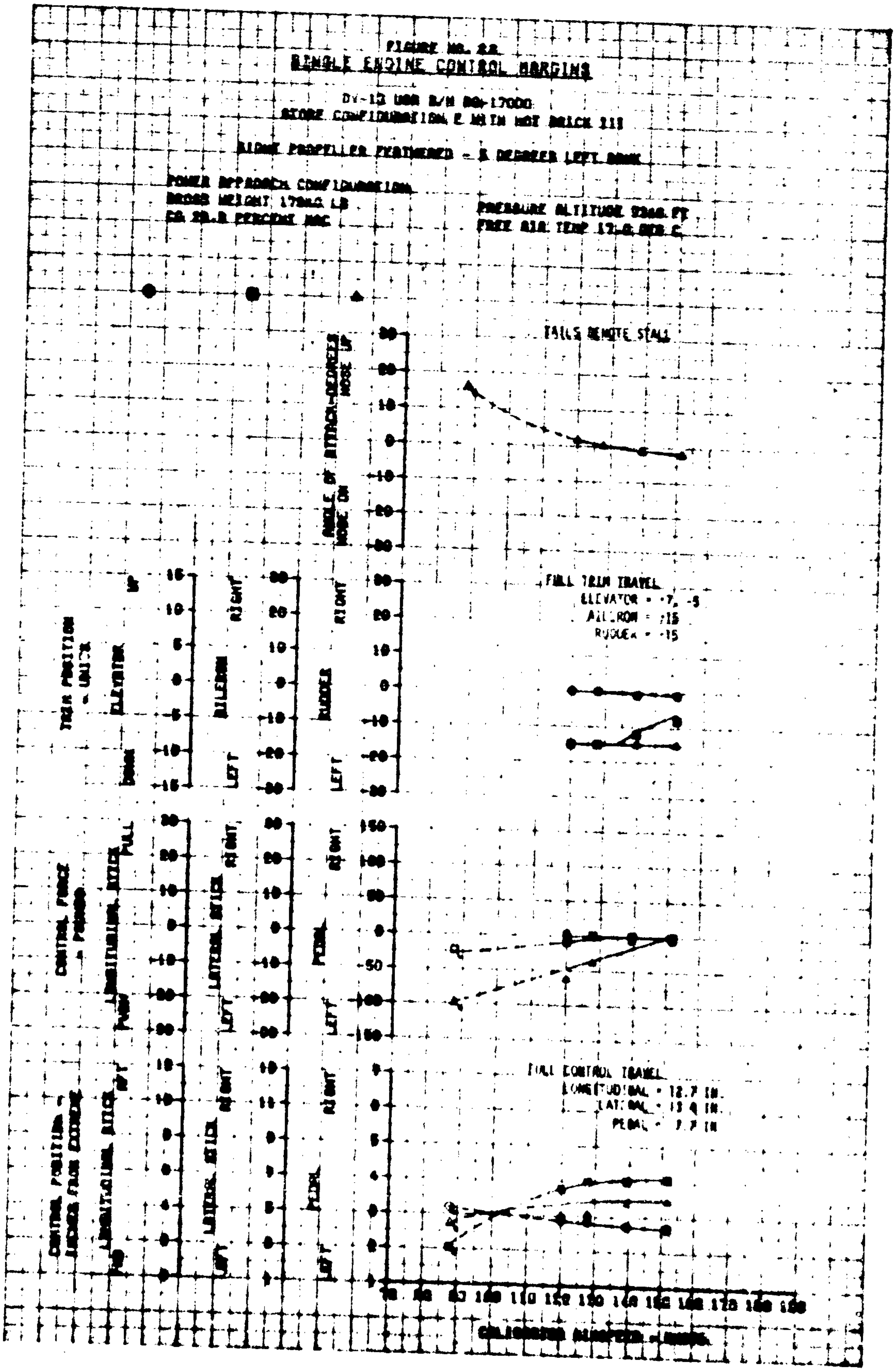


FIGURE NO. 28
SINGLE ENGINE CONTROL MARGINS
POWER APPROACH CONFIGURATION
PRESSURE ALTITUDE
FREE AIR TEMP
TAILS REMOTE STALL
FULL TRIM TRAVEL
ELEVATOR
AILERON = ±15
RUDDER
TRIM POSITION
ELEVATOR
AILERON
RUDDER
LEFT
RIGHT
CONTROL FORCE
PULL
PUSH
LATERAL STICK
PEDAL
FULL CONTROL TRAVEL
LONGITUDINAL = 12.7 IN.
LATERAL = 13.4 IN.
PEDAL = 7.7 IN
CONTROL POSITION
LONGITUDINAL STICK
LATERAL STICK
PEDAL
CALIBRATED AIRSPEED

FIGURE NO 23
SINGLE ENGINE MINIMUM CONTROL AIRSPEED
OV-1D USA S/N 69-17000
STORE CONFIGURATION E WITH HOTBRICK III
TAKE OFF CONFIGURATION

SYMBOL	FAT ~°C	PRESSURE ALTITUDE ~FT	FLIGHT CONDITION
□	0.5	14640	RIGHT PROPELLER FEATHERED
○	3.5	13580	LEFT PROPELLER FEATHERED
◇	13.5	7820	RIGHT PROPELLER FEATHERED
○	16.5	8120	LEFT PROPELLER FEATHERED

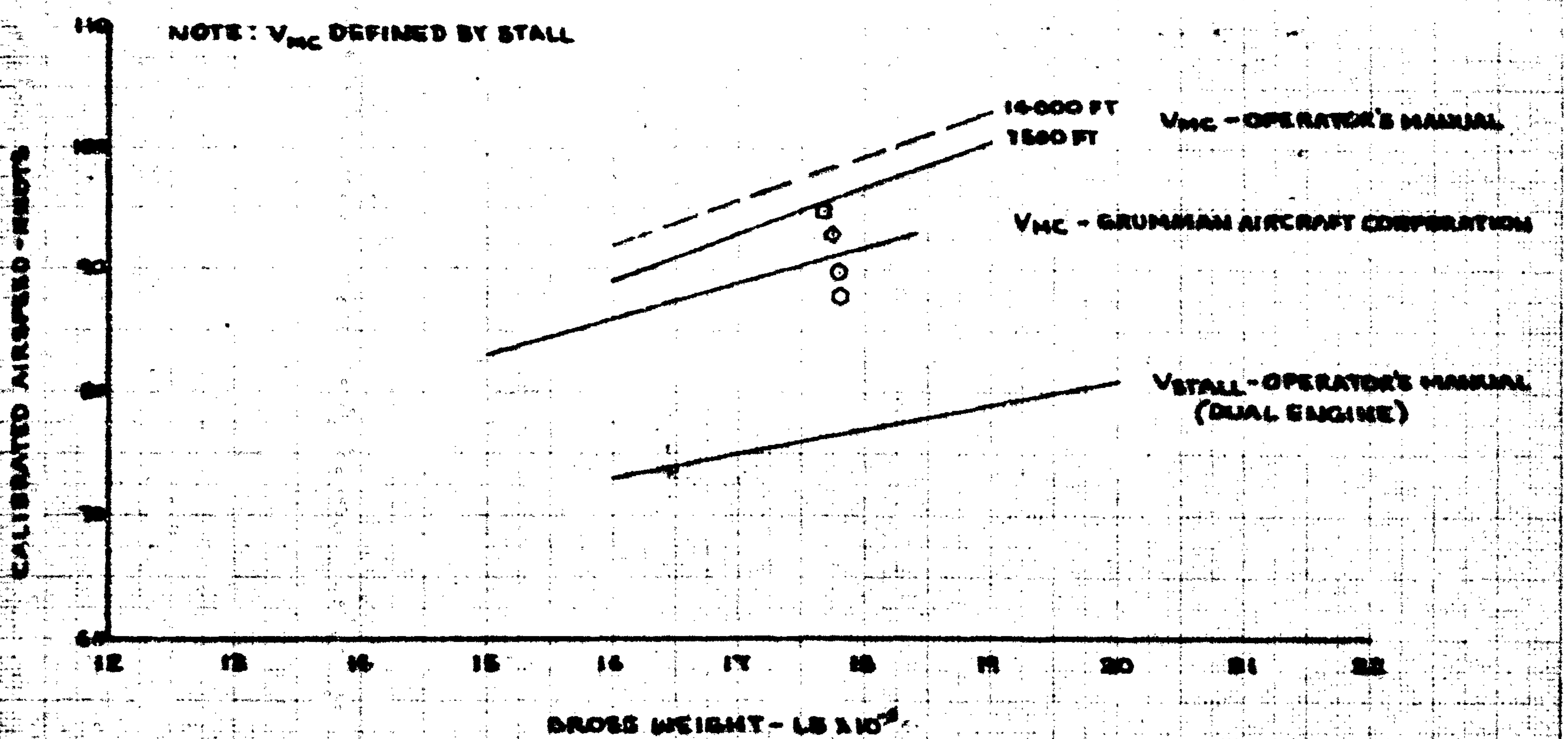


FIGURE NO 24
SINGLE ENGINE MINIMUM CONTROL AIRSPEED
OV-1D USA S/N 68-17000
STORE CONFIGURATION E WITH HOT BRICK III
CRUISE CONFIGURATION

SYMBOL	FAT ~°C	PRESSURE ALTITUDE ~FT	FLIGHT CONDITION
□	3.0	13780	RIGHT PROPELLER FEATHERED
⊙	-1.5	15400	LEFT PROPELLER FEATHERED
⊙	16.0	6900	LEFT PROPELLER FEATHERED

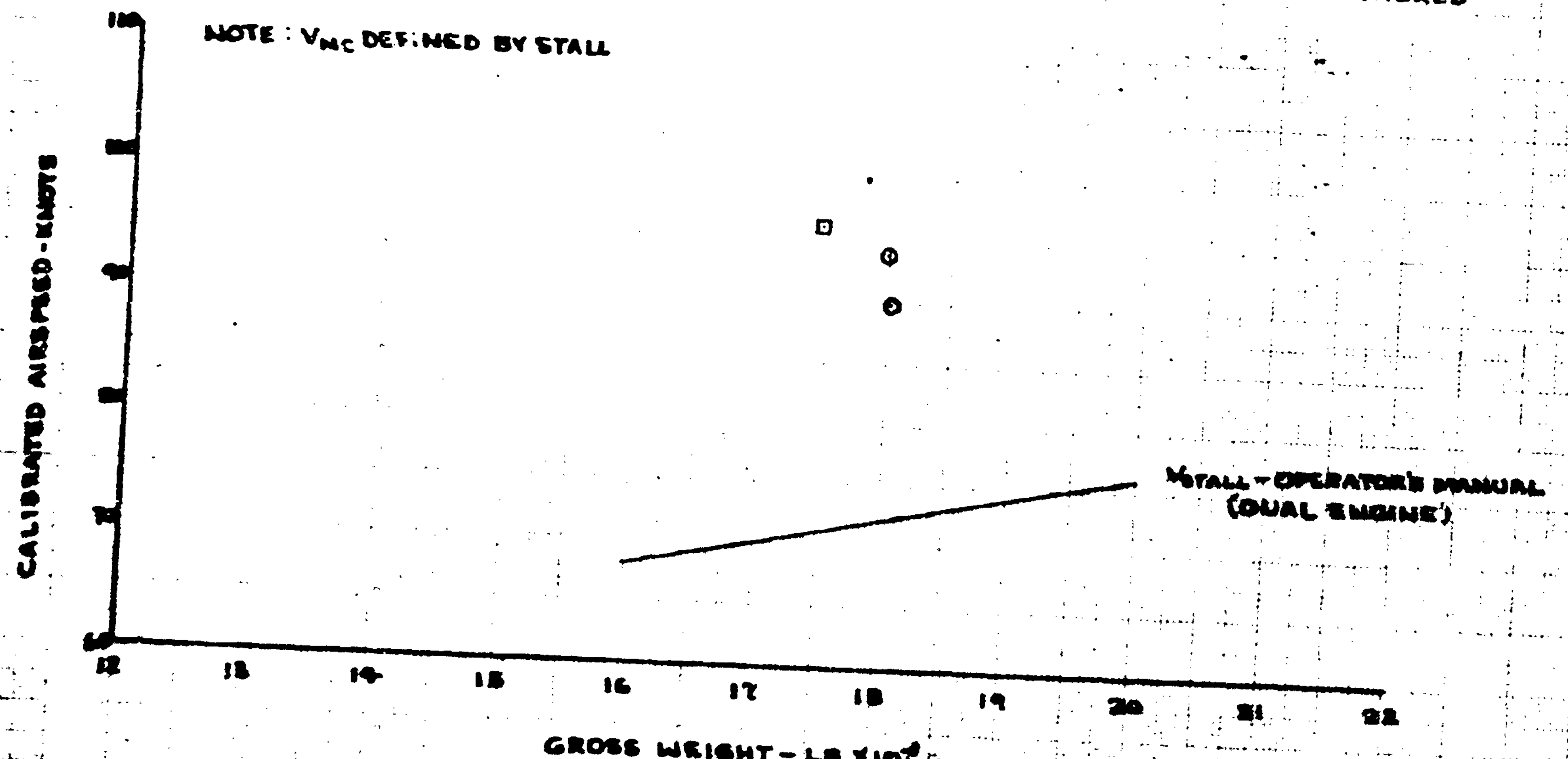


Figure No 25

Single Engine Minimum Control Airspeed

OV-1D USA 5/N 69-17000

Store Configuration E with Hot Brick III

Power Approach Configuration

Symbol	FAT ~°C	Pressure Altitude ~ FT	Flight Condition
□	0.0	14160	Right Propeller Feathered
○	3.5	13500	Left Propeller Feathered
◇	15.5	7960	Right Propeller Feathered
○	17.5	6860	Left Propeller Feathered

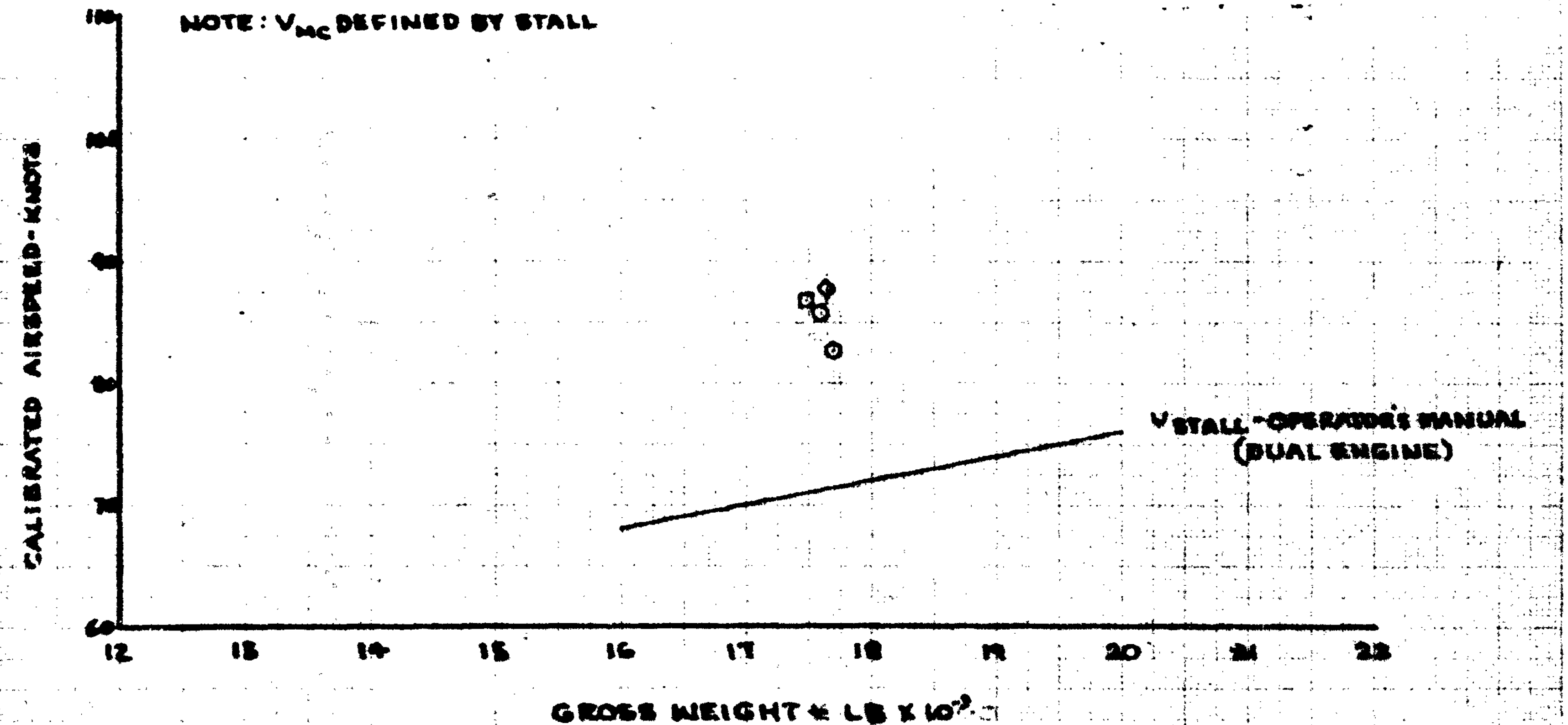


FIGURE NO. 24
SINGLE ENGINE STALL

OV-10 USA S/N 68-17000
STORE CONFIGURATION E WITH HOT BRICK III

LEFT PROPELLER FEATHERED

SOLID LINE   SHORT DASH   LONG DASH

TAKEOFF CONFIGURATION
GROSS WEIGHT 17900 LB
CG 28.8 PERCENT MAC

TRIM AIRSPEED 102 KCAS
FREE AIR TEMP 18.6 DEG C

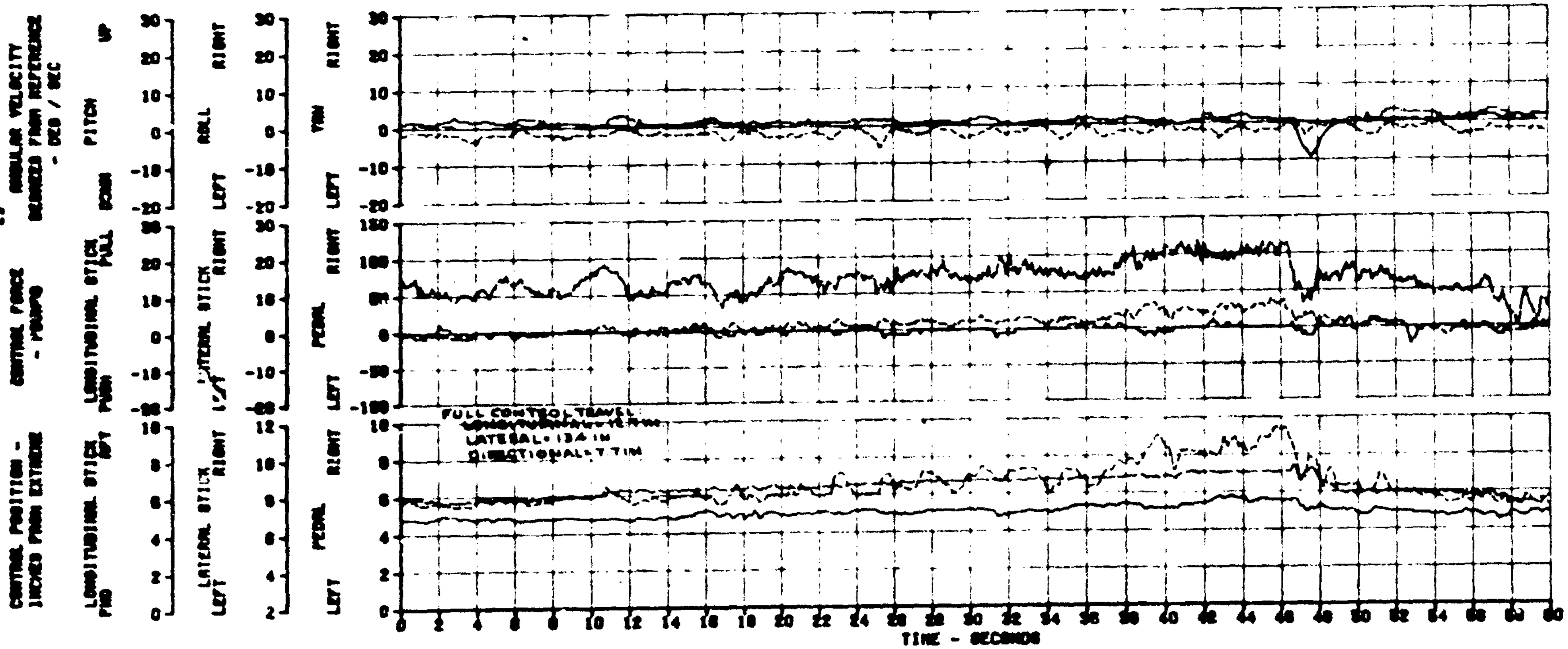


FIGURE NO. 26 CONTINUED

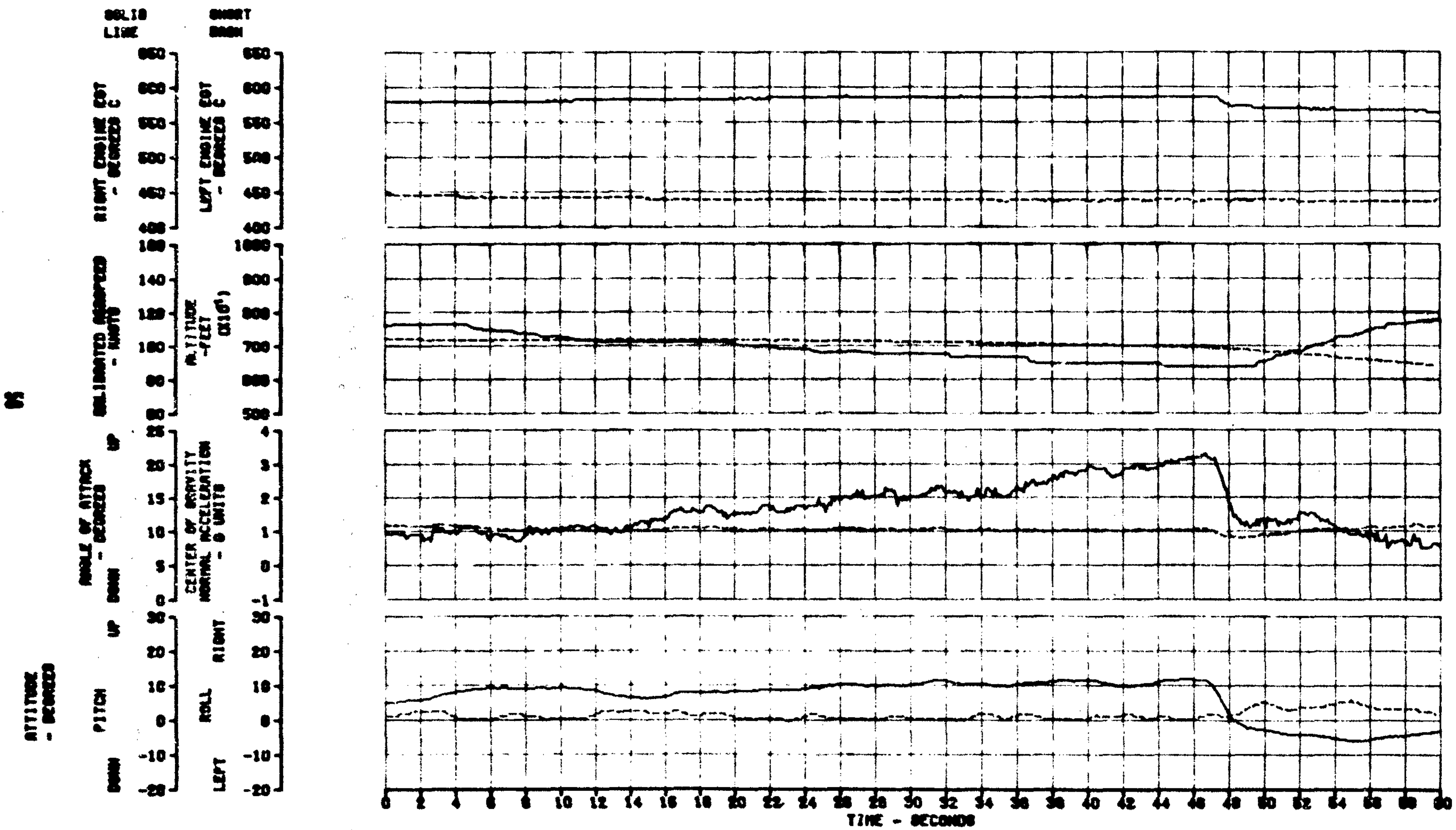


FIGURE NO.27

SINGLE ENGINE STALL

OV-10 USA S/N 00-17000
STORE CONFIGURATION E WITH HOT BRICK III

RIGHT PROPELLER FEATHERED

TAKEOFF CONFIGURATION
GROSS WEIGHT 17700 LB
CG 30.8 PERCENT MAC

TRIM AIRSPEED 102 KCAS
FREE AIR TEMP 15.5 DEG C

SOLID LINE | SHORT DASH | LONG DASH

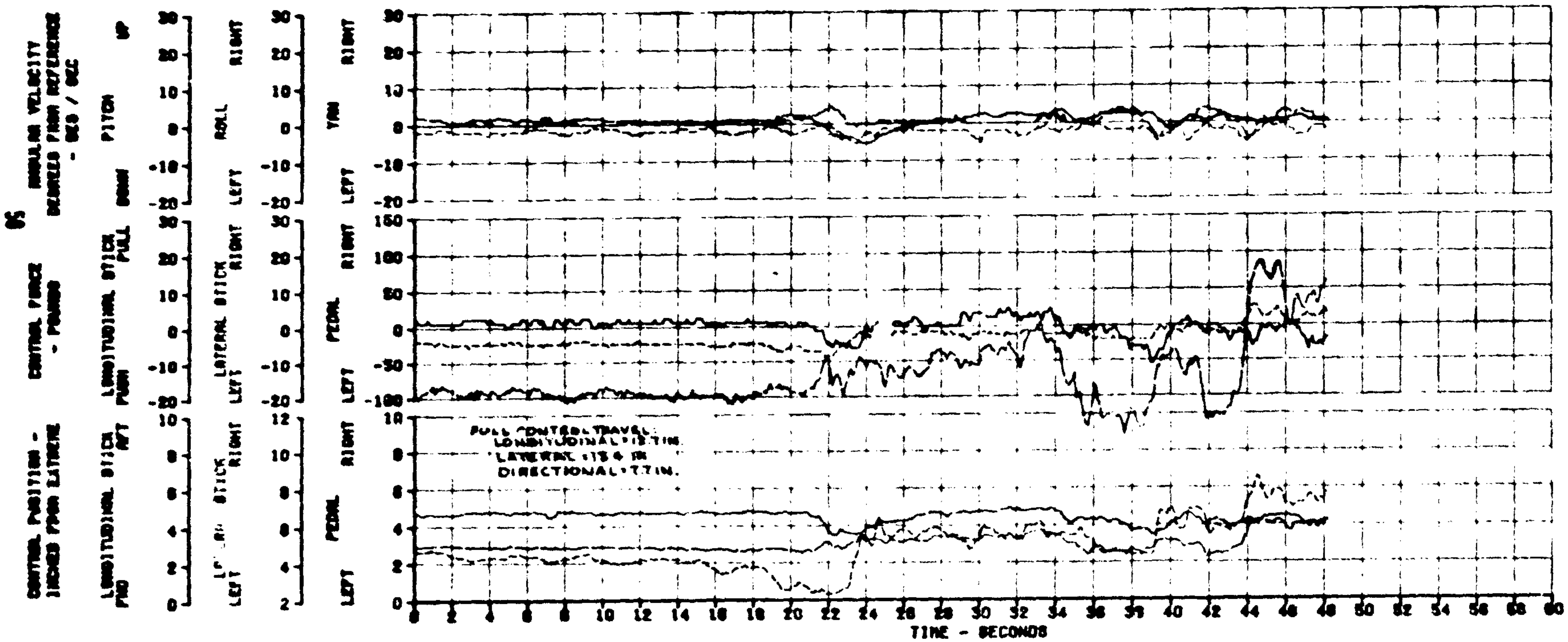


FIGURE NO. 27 CONTINUED

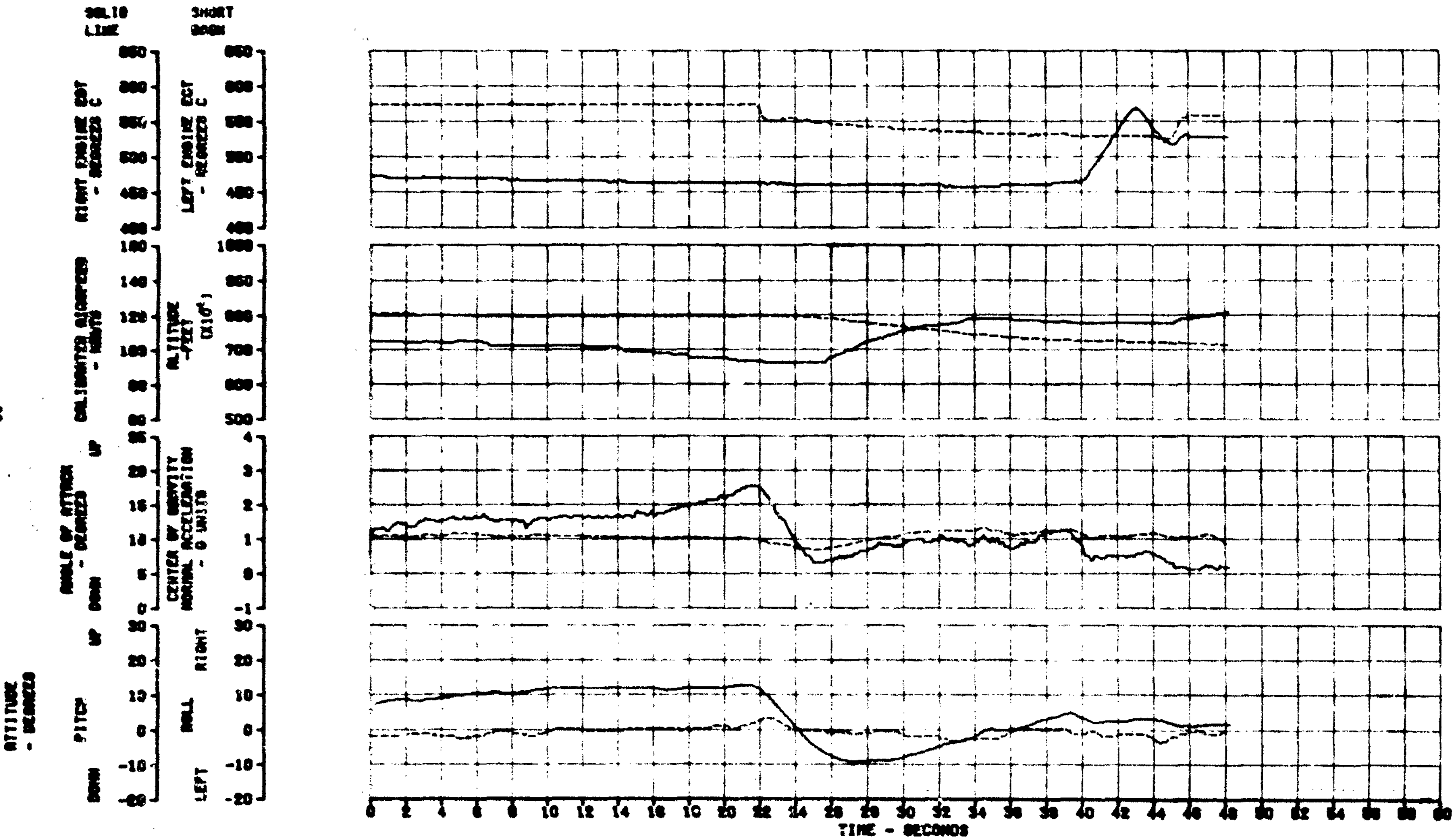


FIGURE NO. 28

SINGLE ENGINE STALL

OV-10 USA S/N 69-17000
STORE CONFIGURATION E WITH HOT BRICK III

SOLID LINE | SHORT DASH | LONG DASH

LEFT PROPELLER FEATHERED

CRUISE CONFIGURATION
GROSS WEIGHT 10020 LB
CG 29.1 PERCENT MAC

TRIM AIRSPEED 144 KCAS
FREE AIR TEMP 16.0 DEG C

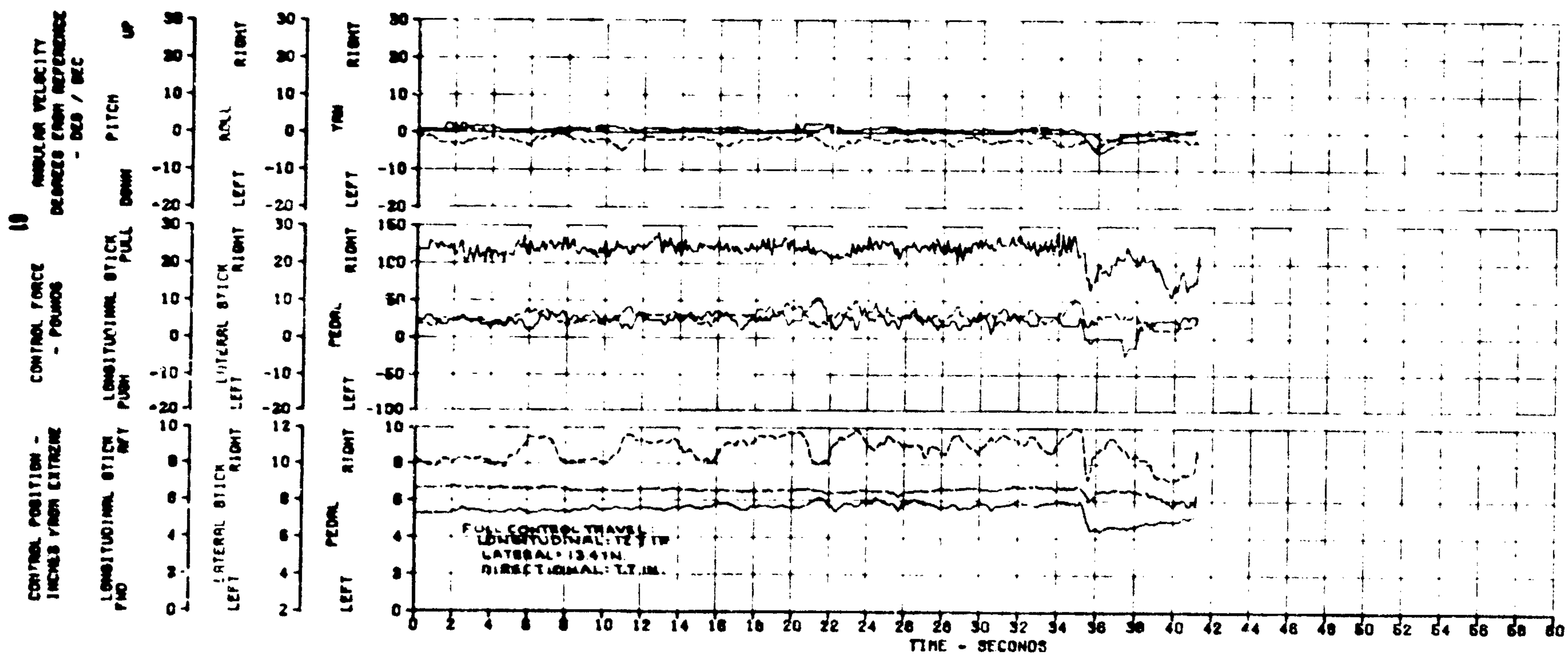


FIGURE NO.28 CONTINUED

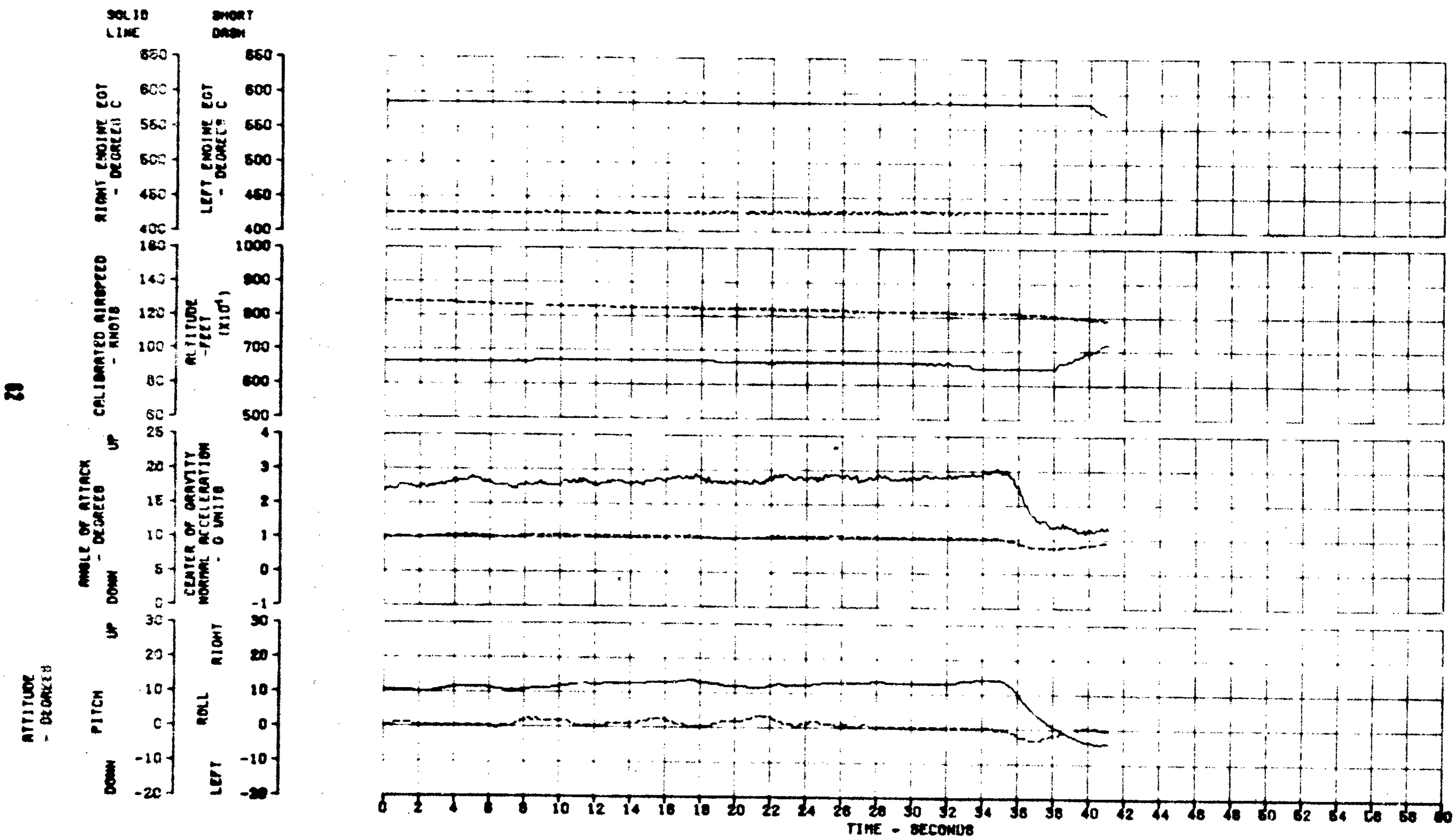


FIGURE NO. 29

SINGLE ENGINE STALL

OV-1D USA S/N 69-17000
STORE CONFIGURATION E WITH HOT BRICK III

SOLID LINE	SHORT DASH	LONG DASH

RIGHT PROPELLER FEATHERED

CRUISE CONFIGURATION
GROSS WEIGHT 17480 LB
CG 29.1 PERCENT MAC

TRIM AIRSPEED 144 KCAS
FREE AIR TEMP 2.5 DEG C

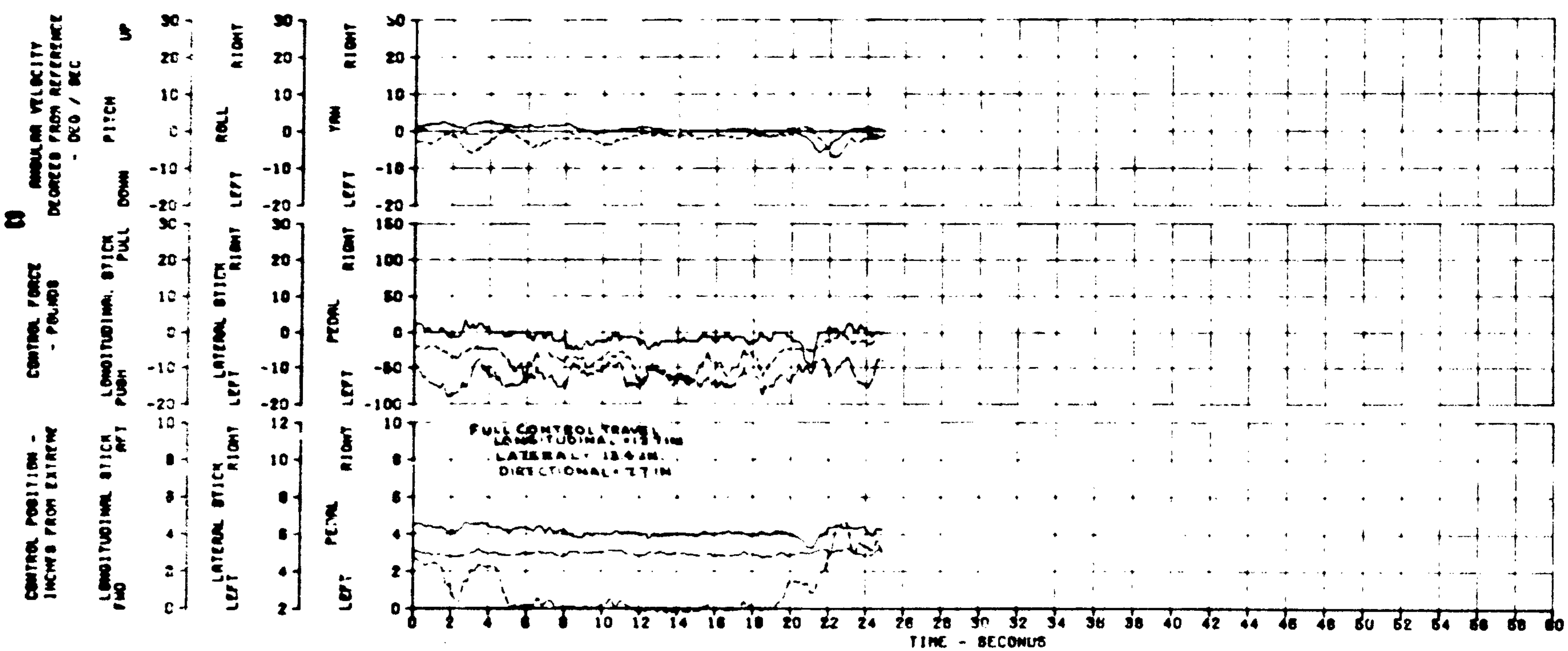


FIGURE NO. 27 CONTINUED

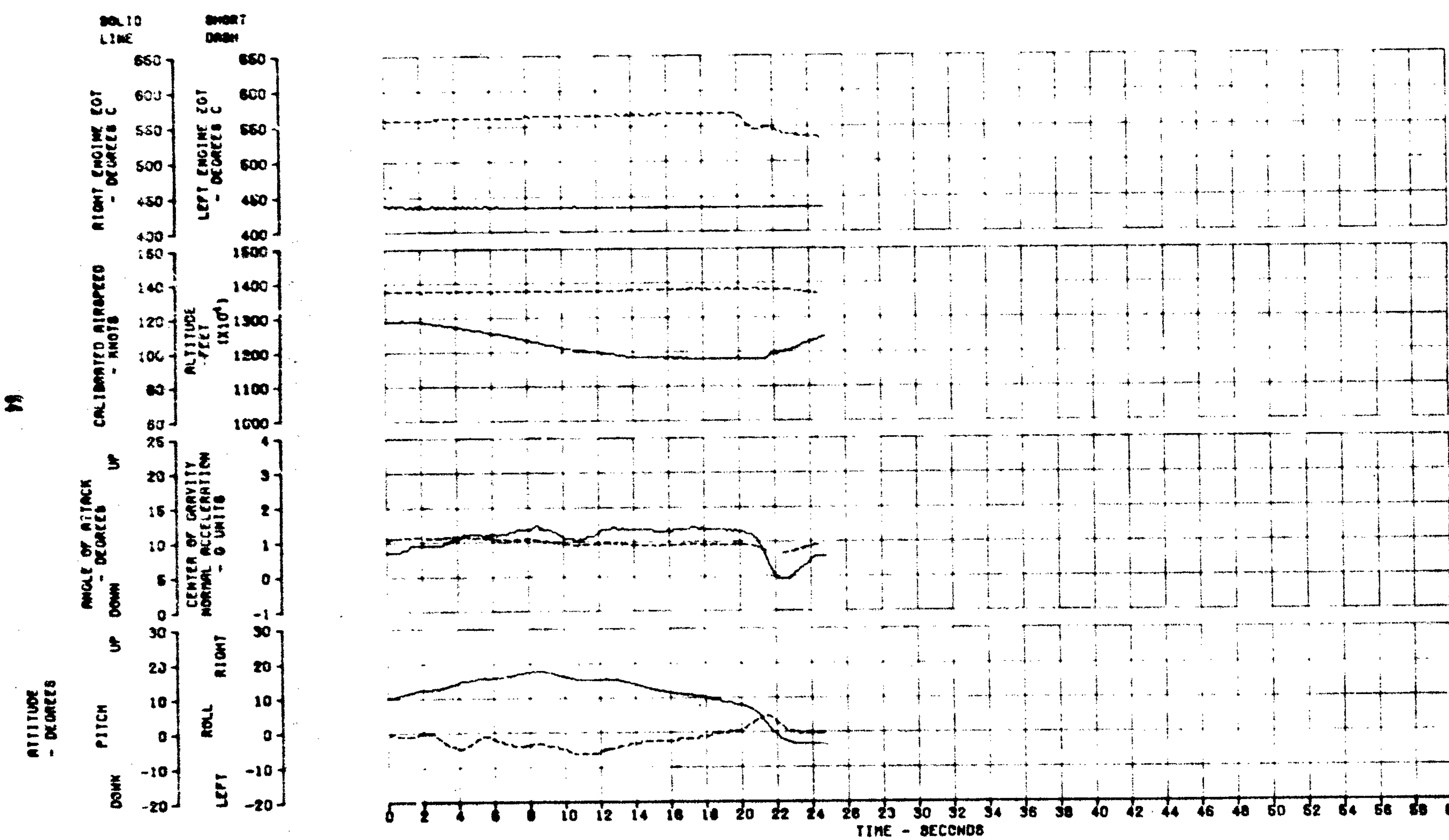


FIGURE NO. 30
<u>SINGLE ENGINE STALL</u>

OV-1D USA S/N 68-17000
STORE CONFIGURATION E WITH HOT BRICK III

LEFT PROPELLER FEATHERED

POWER APPROACH CONFIGURATION
GROSS WEIGHT 17700 LB
CG 28.8 PERCENT MAC

TRIM AIRSPEED 100 KCAS
FREE AIR TEMP 17.6 DEG C

SOLID LINE | SHORT DASH | LONG DASH

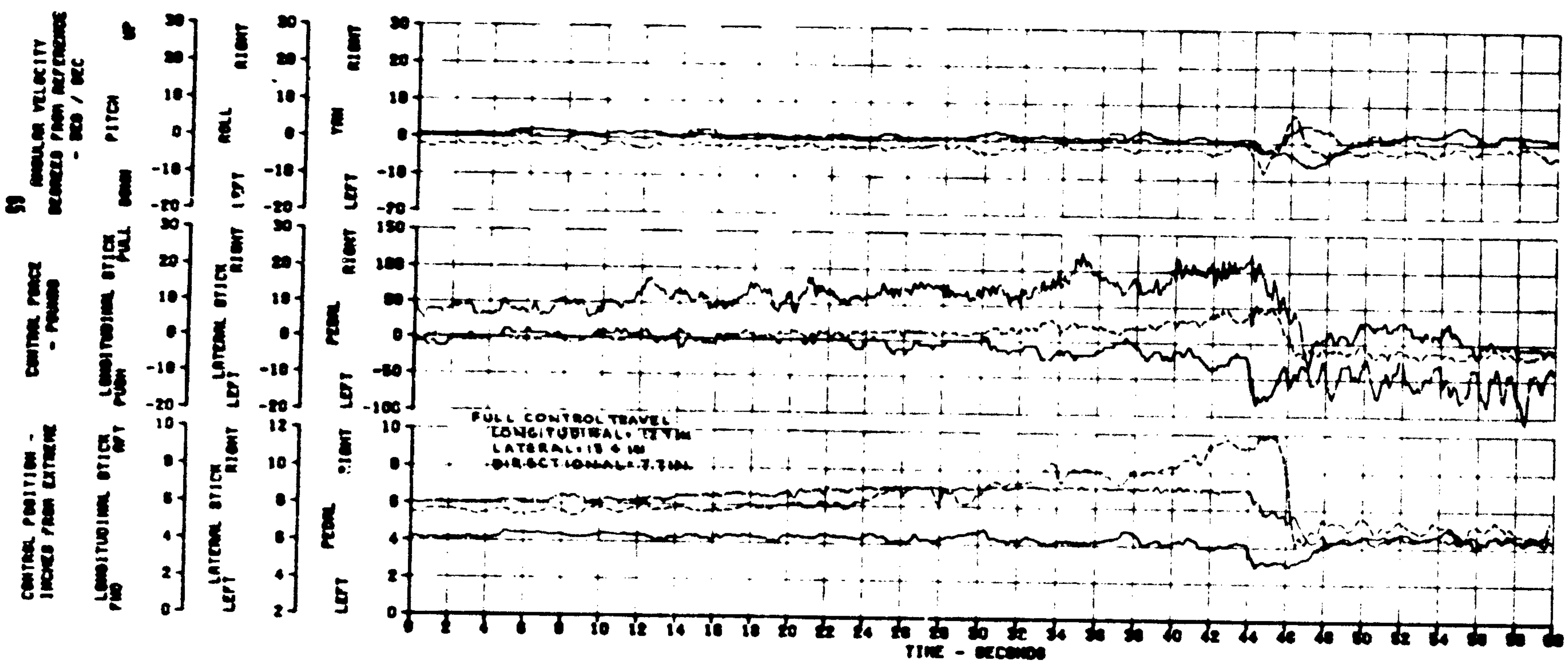


FIGURE NO. 50 CONTINUED

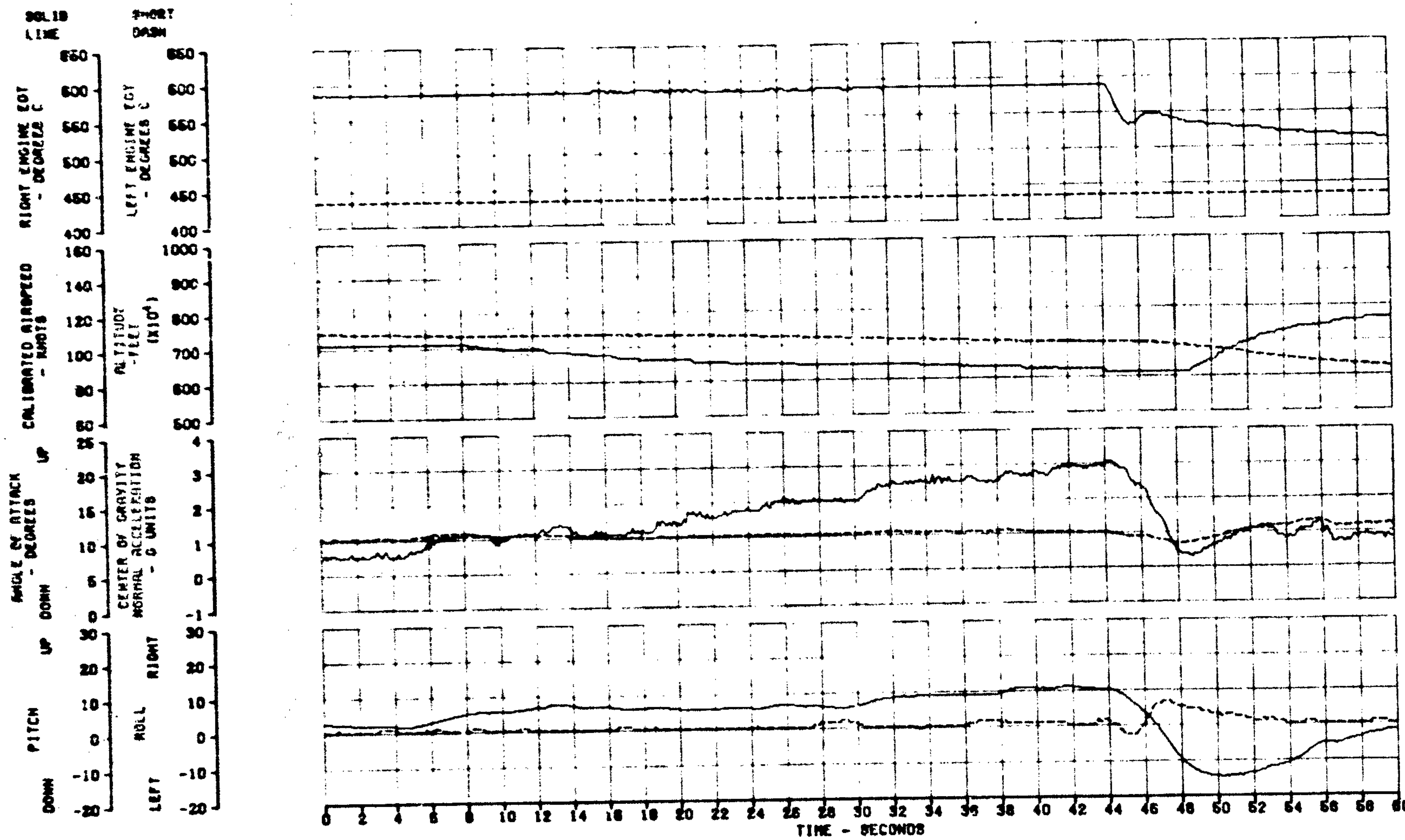


FIGURE NO. 31
SINGLE ENGINE STALL

OV-1D USA S/N 68-17000
STORE CONFIGURATION E WITH HOT BRICK III

LEFT PROPELLER FEATHERED

POWER APPROACH CONFIGURATION
GROSS WEIGHT 17600 LB
CG 28.8 PERCENT MAC

TRIM AIRSPEED 123 KCAS
FREE AIR TEMP 3.6 DEG C

SOLID LINE | SHORT DASH | LONG DASH

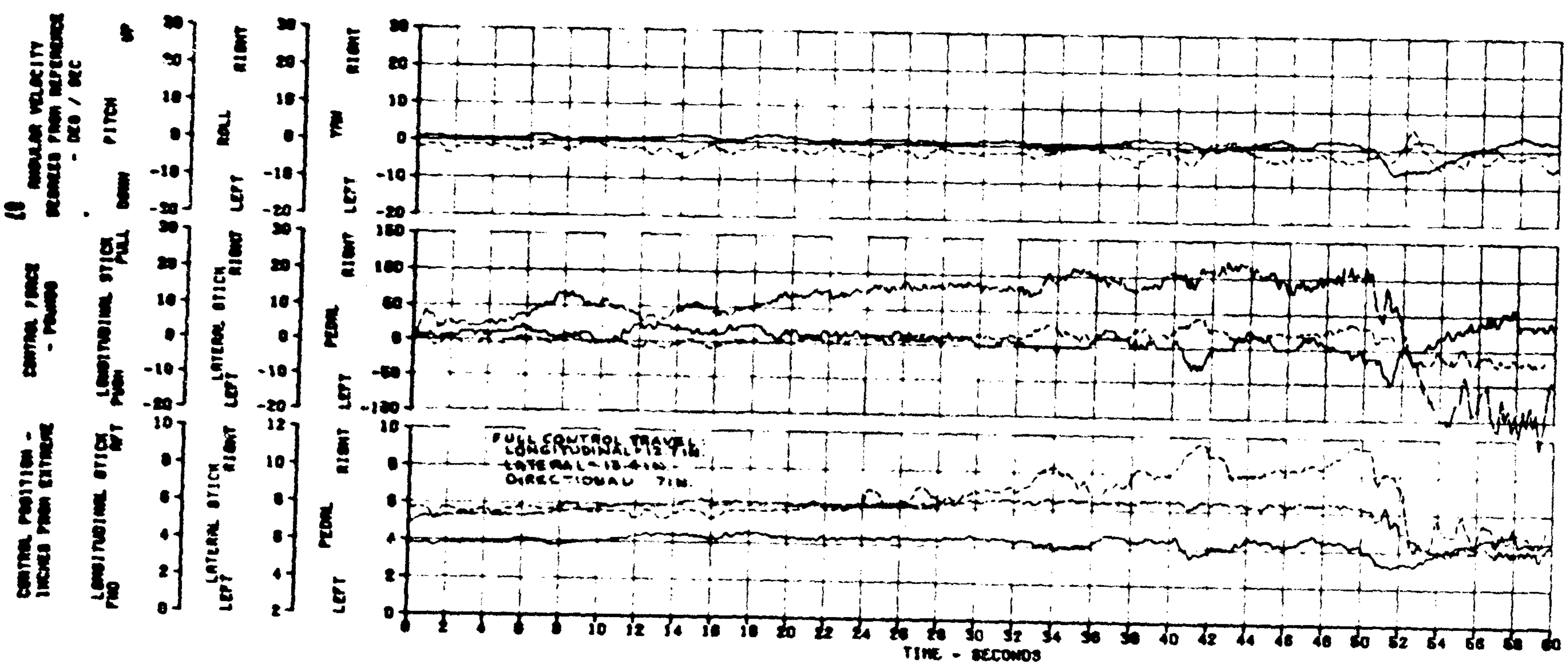


FIGURE NO. 31 CONTINUED

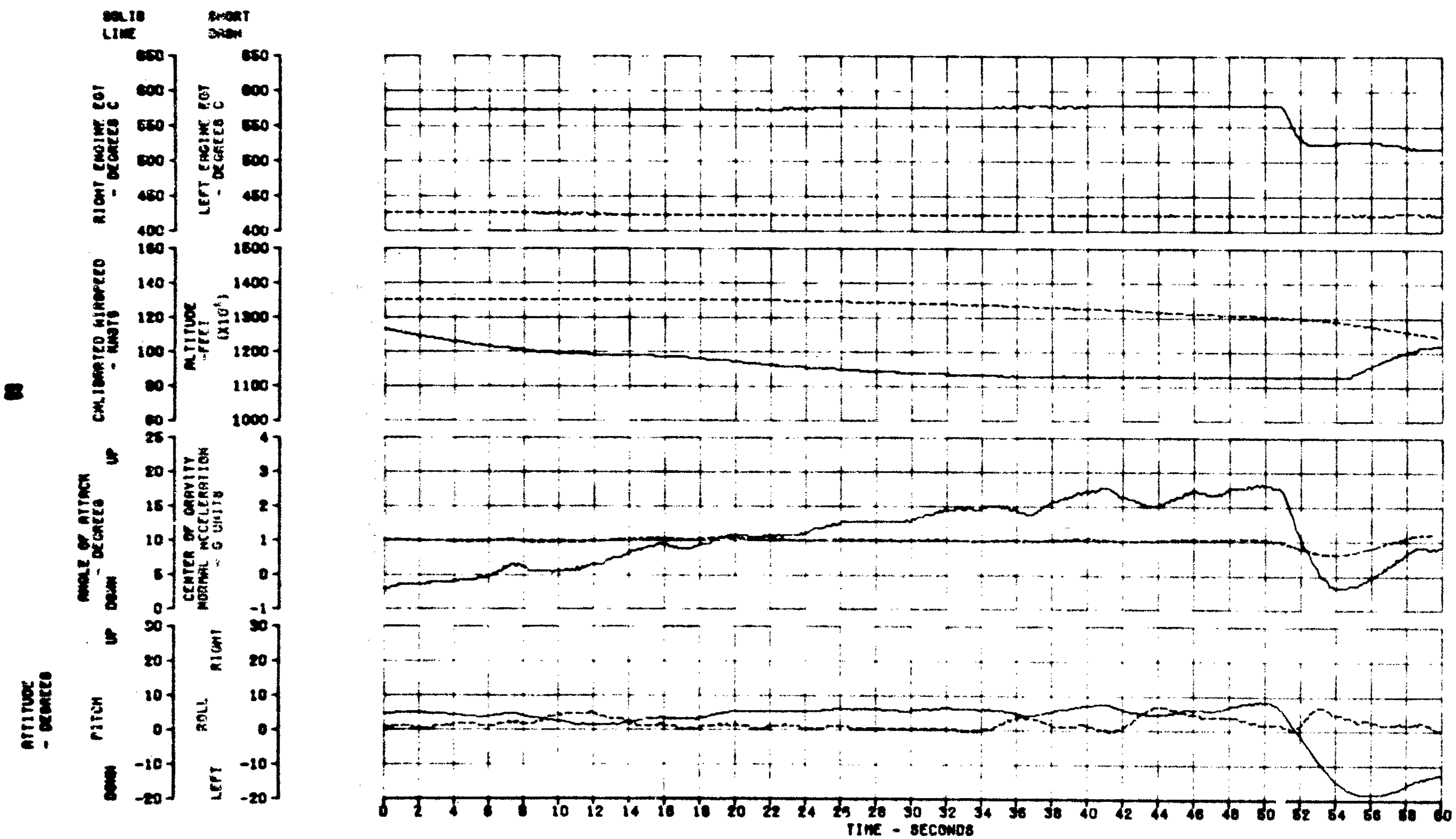


FIGURE NO. 82

SINGLE ENGINE STALL

OV-1D USA S/N 68-17000
STORE CONFIGURATION E WITH HOT BRICK III

RIGHT PROPELLER FEATHERED

POWER APPROACH CONFIGURATION
GROSS WEIGHT 17080 LB
CG 30.8 PERCENT MAC

TRIM AIRSPEED 100 KCAS
FREE AIR TEMP 15.5 DEG C

SOLID LINE — SHORT DASH — LONG DASH

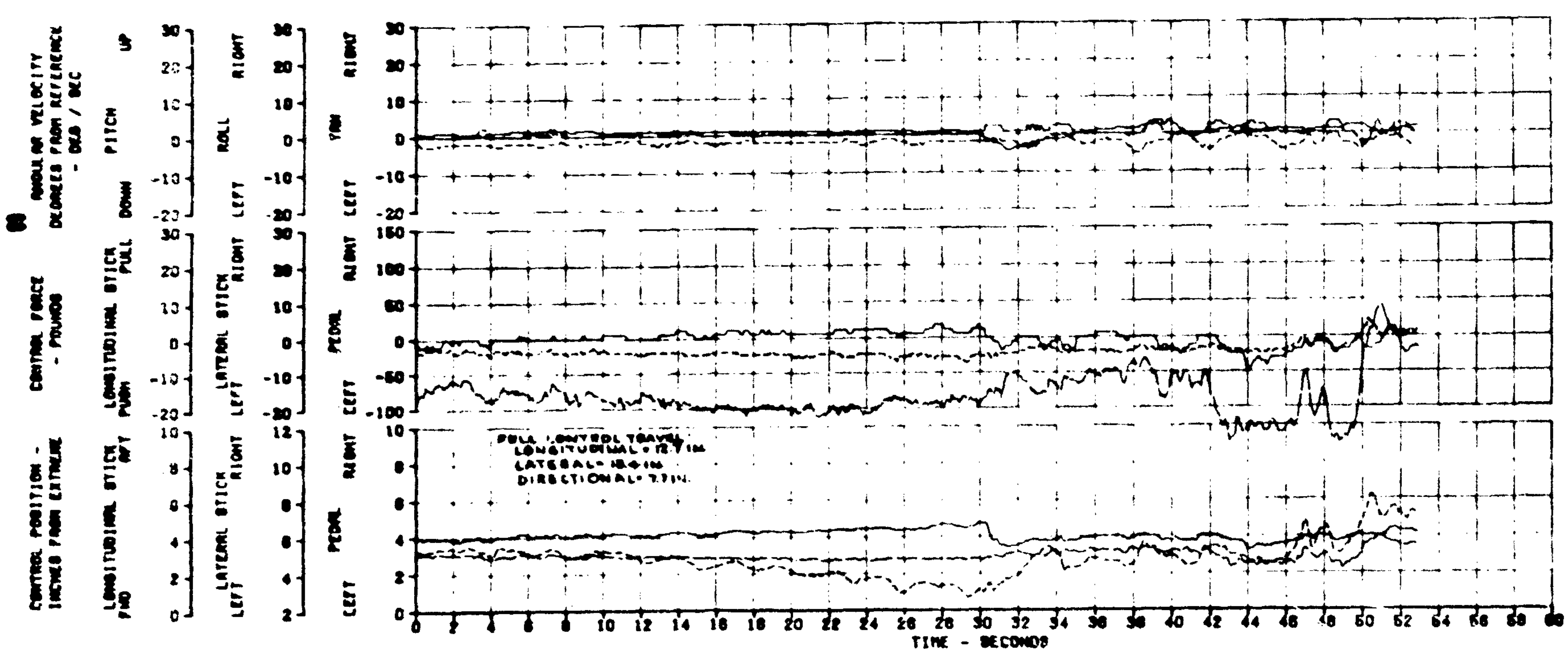


FIGURE NO. 32 CONTINUED

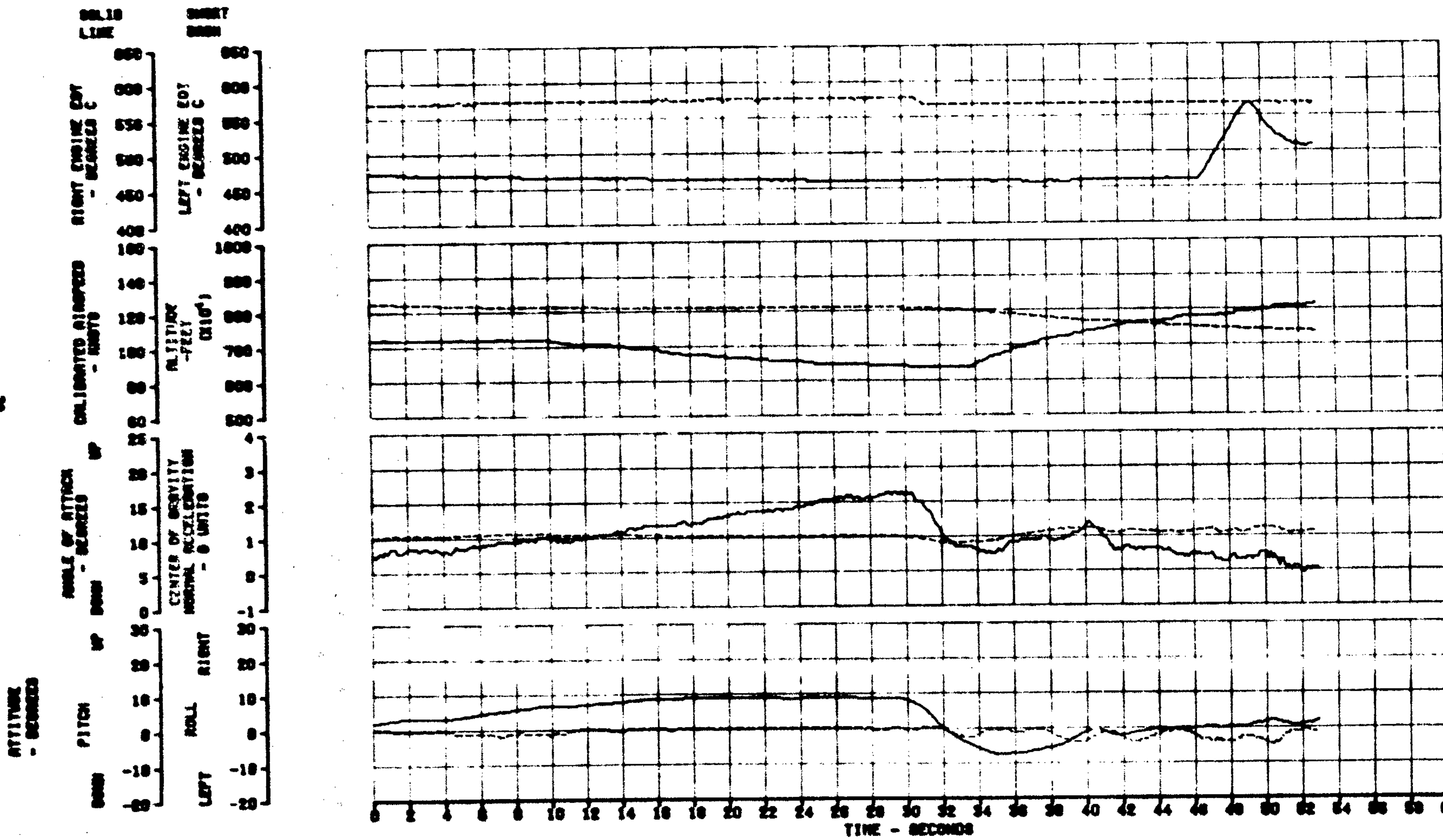


FIGURE NO 33
FLIGHT FLUTTER
OV-1D USA 1/N69-17018
STORE CONFIGURATION B

GROSS WEIGHT (LB)	CG (PERCENT MAC)	PRESSURE ALTITUDE (FT)
15500	29	5000

SENSOR LOCATION: HOT BRICK TANK FORWARD VERTICAL

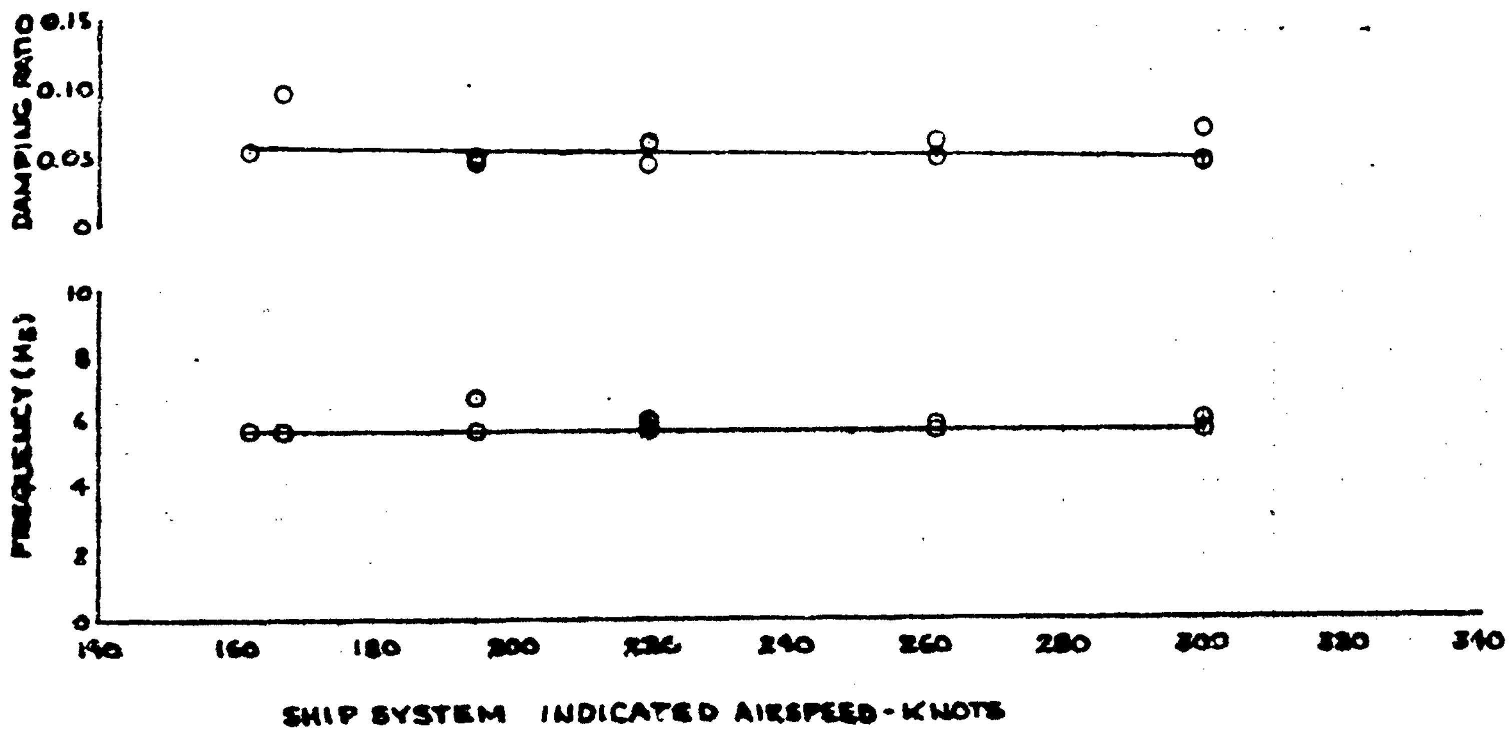


FIGURE NO 34
FLIGHT FLUTTER
OV-1D USA 4/NG9-1T018
STORE CONFIGURATION B

GROSS WEIGHT (LB)	CG (PERCENT MAC)	PRESSURE ALTITUDE (FT)
15500	29	5000

SENSOR LOCATION: HOT BRICK TANK FORWARD LATERAL

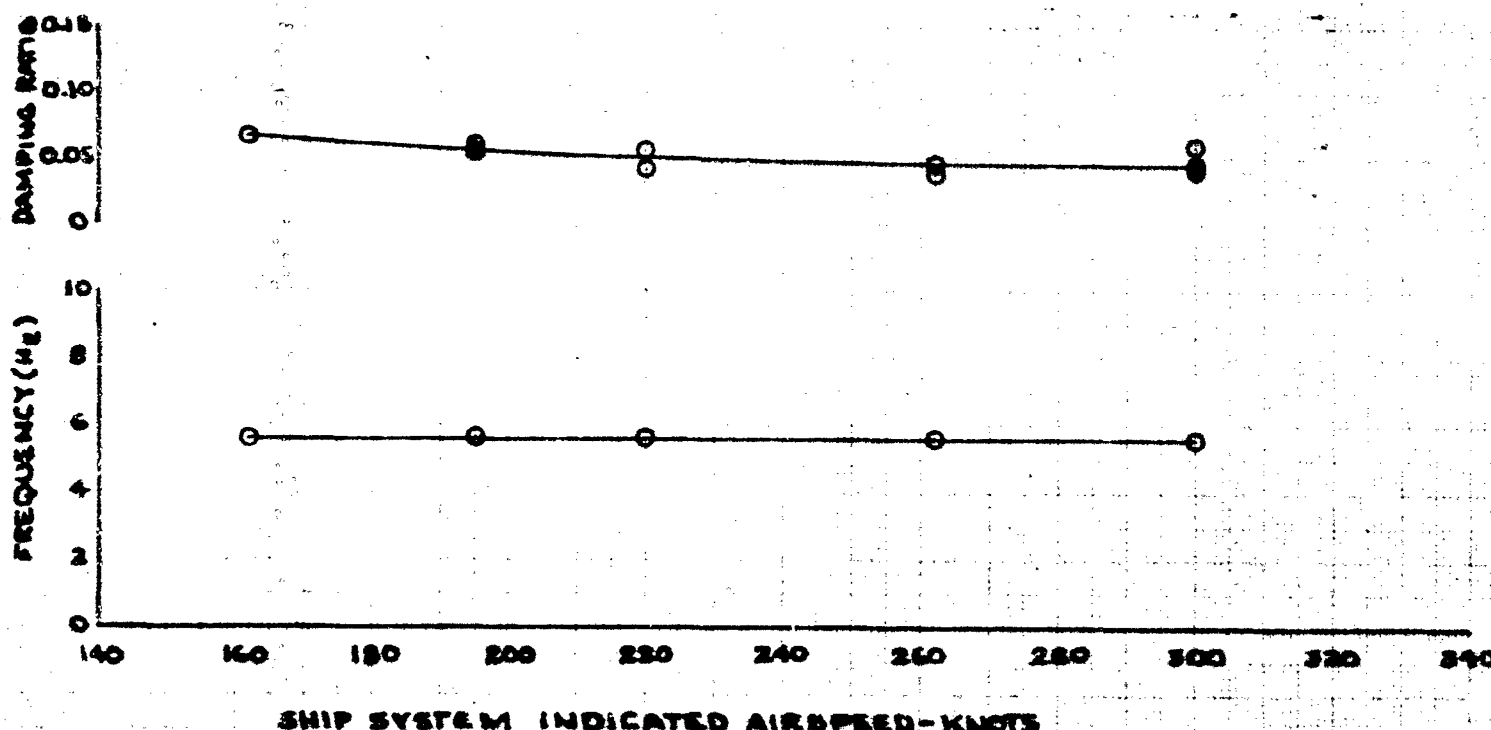


FIGURE No 35
FLIGHT FLUTTER
OV-1D USA S/N 69-17018
STORE CONFIGURATION B

GROSS WEIGHT (LB)	CG (PERCENT MAC)	PRESSURE ALTITUDE (FT)
15500	29	5000

SENSOR LOCATION: RIGHT WING AT STATION 46 AFT VERTICAL

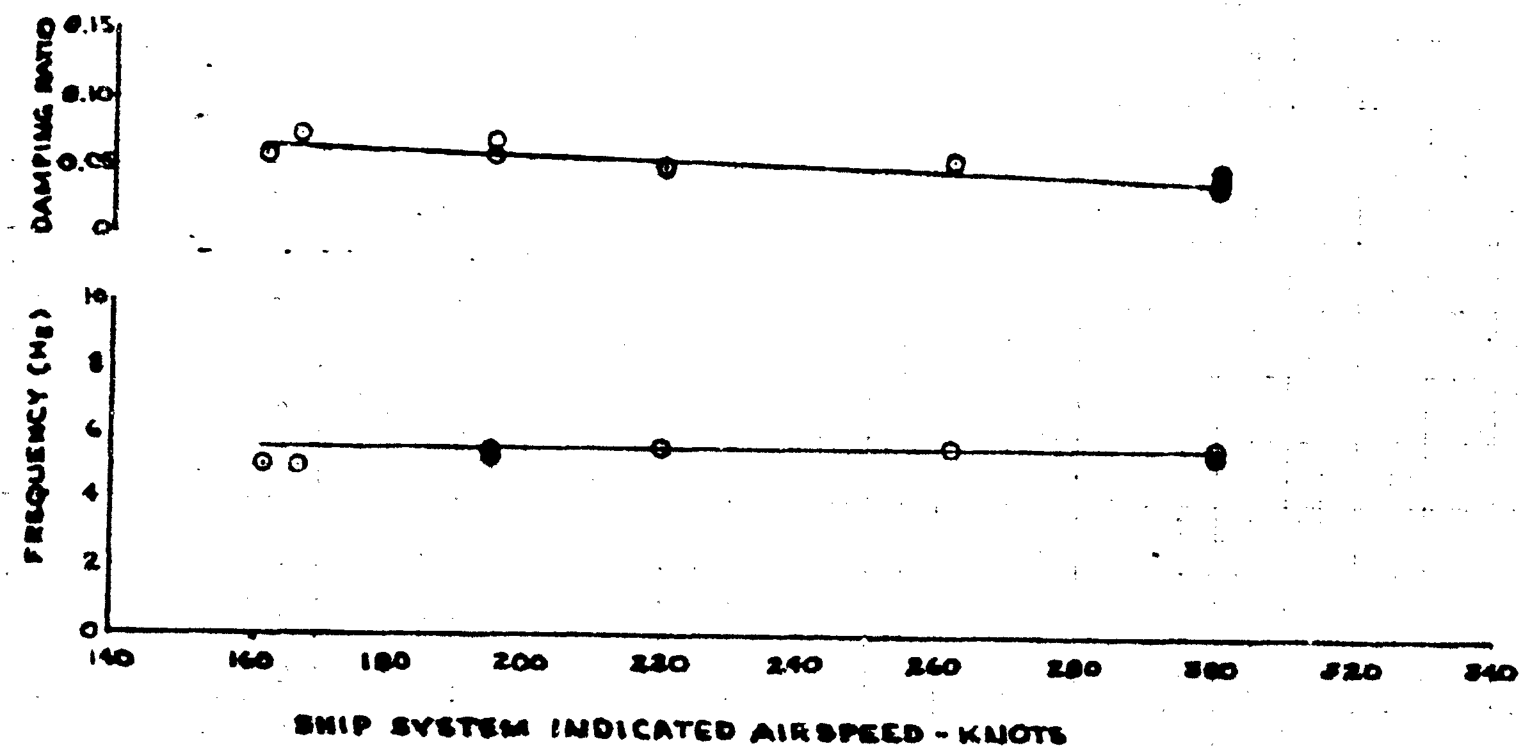


FIGURE NO 36
FLIGHT FLUTTER
OV-1D USA 9/16? -17018
STORE CONFIGURATION B

GROSS WEIGHT (LB)	CG (PERCENT MAC)	PRESSURE ALTITUDE (FT)
13500	29	5000

SENSOR LOCATION: RIGHT WING TIP FORWARD VERTICAL

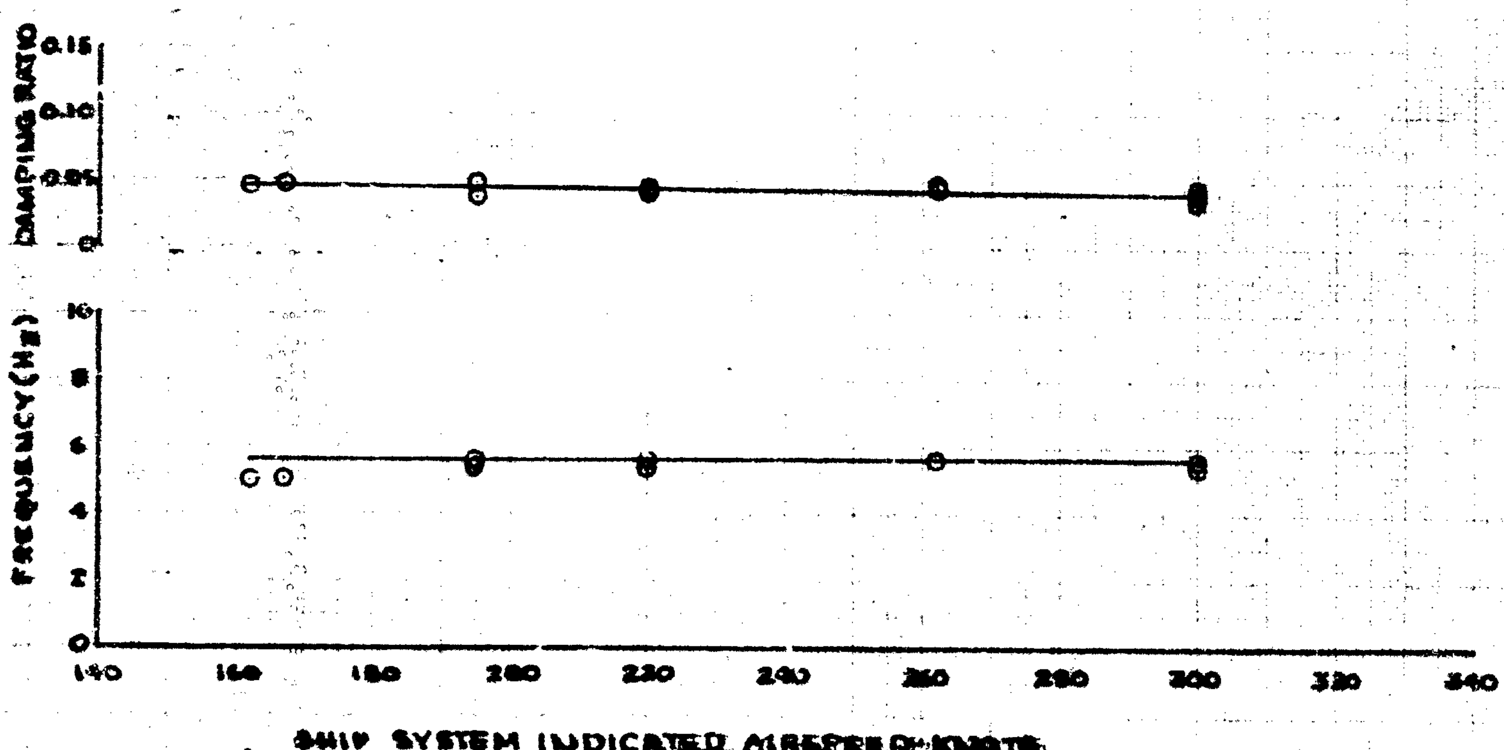


FIGURE NO 37

FLIGHT FLUTTER

OV-1D USA S/N 62-17018

STORE CONFIGURATION E WITH HOT BRICK III

GROSS WEIGHT (LB)	CG (PERCENT MAC)	PRESSURE ALTITUDE (FT)
16000	29	5000

SENSOR LOCATION: HOT BRICK TANK FORWARD VERTICAL

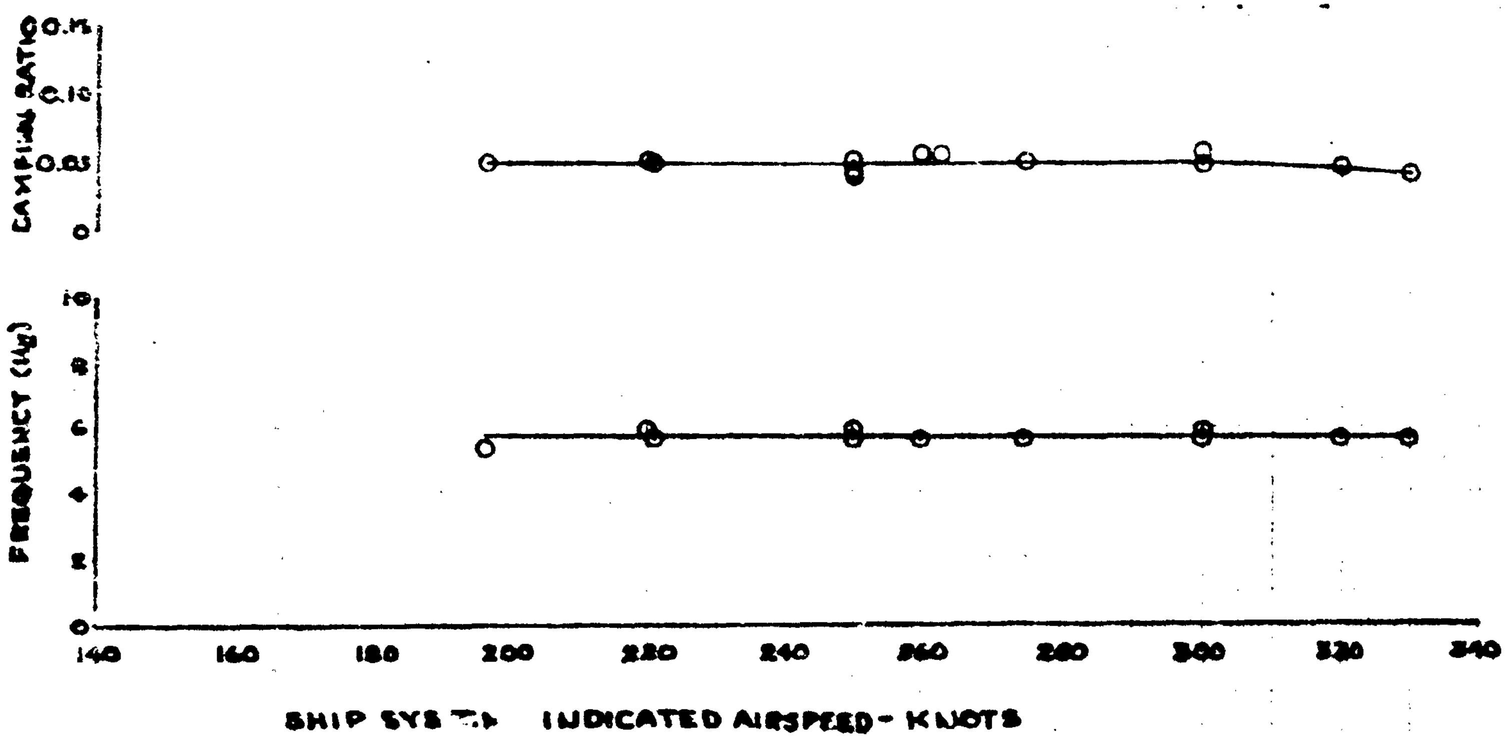


FIGURE No 38

FLIGHT FLUTTER

OV-1D USA [illegible]

STORE CONFIGURATION E WIT[illegible] HOT BRICK III

GROSS WEIGHT (LB)	CG (PERCENT MAC)	PRESSURE ALTITUDE (FT)
16000	29	5000

SENSOR LOCATION: HOT BRICK TANK FORWARD LATERAL

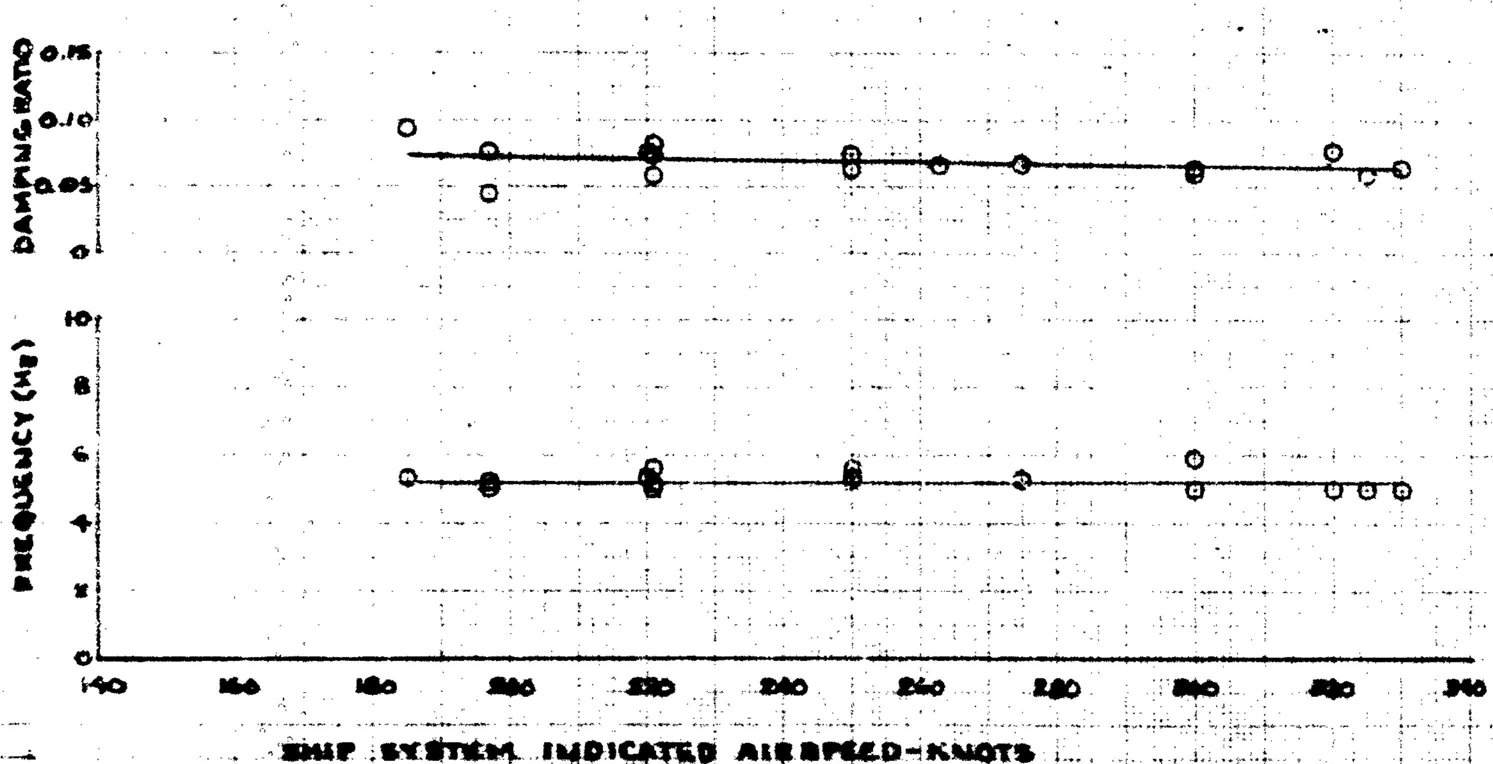


FIGURE No 39
FLIGHT FLUTTER
OV-1D USA S/N69-17018
STORE CONFIGURATION E WITH HOT BRICK III

GROSS WEIGHT (LB)	CG (PERCENT MAC)	PRESSURE ALTITUDE (FT)
16000	29	5000

SENSOR LOCATION: RIGHT WING AT STATION 4 AFT VERTICAL

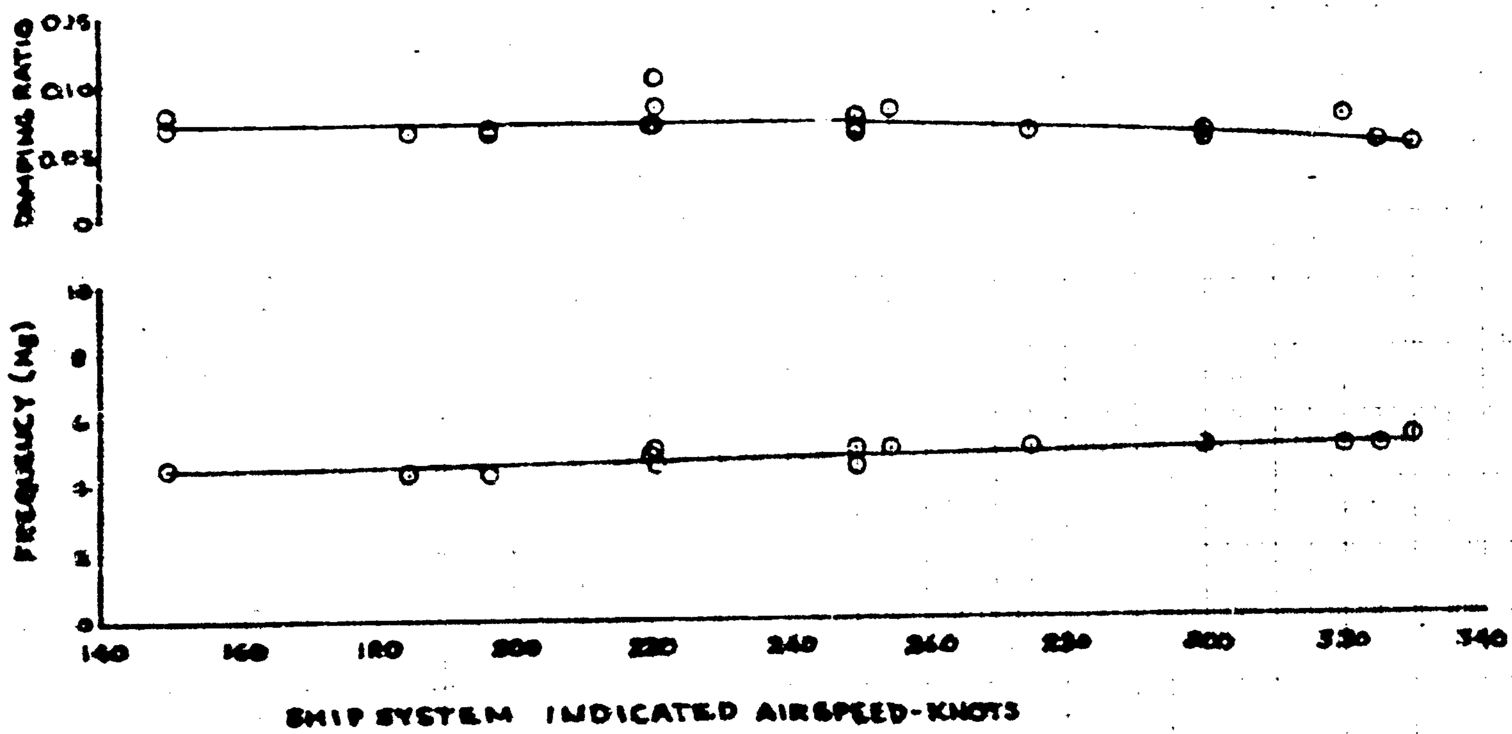
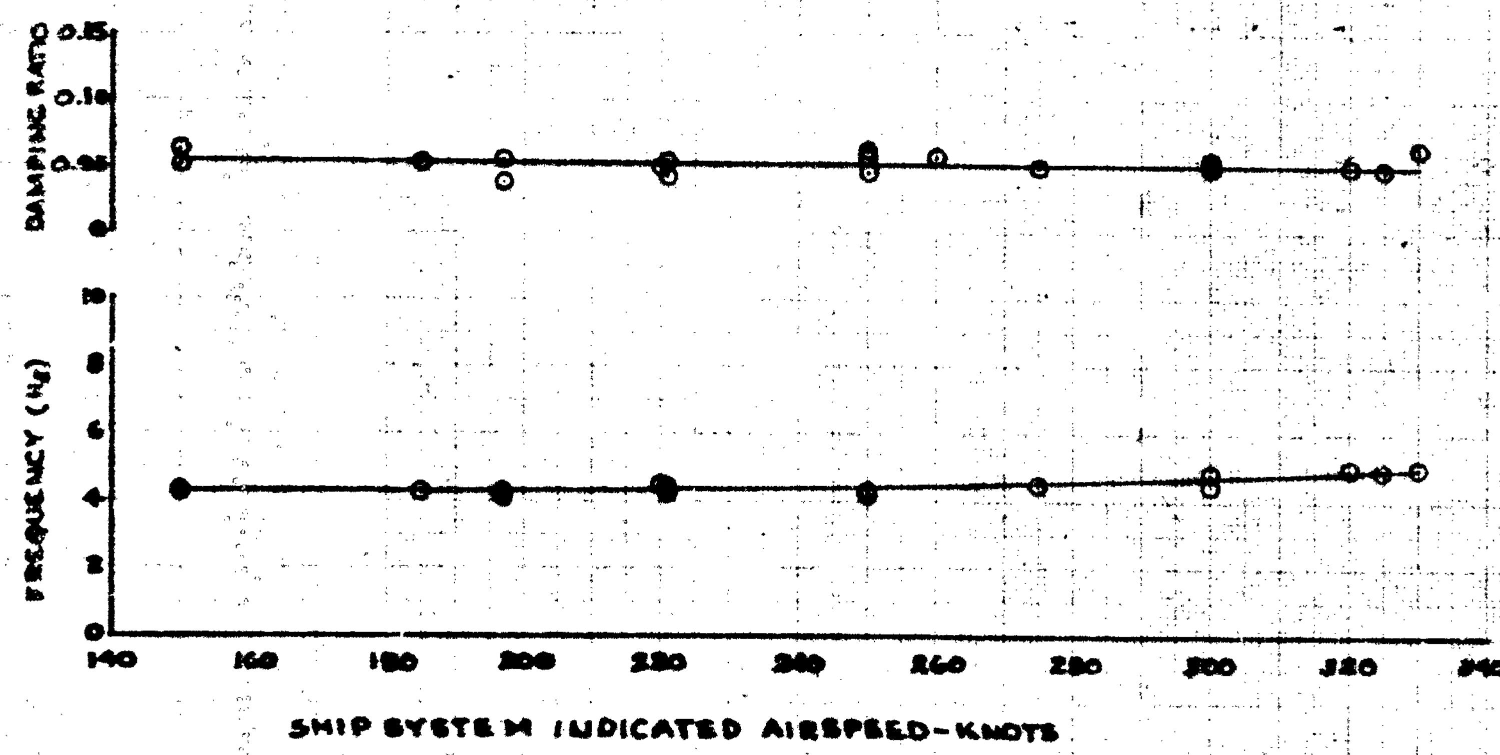


FIGURE NO 40
FLIGHT FLUTTER
OV-1D USA S/N 69-17018
STORE CONFIGURATION E WITH HOT BRICK III

GROSS WEIGHT (LB)	CG (PERCENT MAC)	PRESSURE ALTITUDE (FT)
16000	29	5000

SENSOR LOCATION: RIGHT WING TIP FORWARD VERTICAL



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