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RDTE PROJECT NO. 1X1T9191D684
USAAVSCOM PROJECT NO. 67-23
USAASTA PROJECT NO. ~~67-23~~

ENGINEERING FLIGHT TEST OF AN IR SUPPRESSION KIT INSTALLATION ON THE OV-1B AIRCRAFT

FINAL REPORT

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JULY 1969

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

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ABSTRACT

The engineering flight test of the OV-1 Hayes Infrared (IR) Suppression Kit installation was conducted at Edwards Air Force Base, California, from 23 January through 22 March 1968, by the US Army Aviation Systems Test Activity for the US Army Aviation Materiel Laboratories. The performance and flying qualities of the aircraft with the suppression kit installed was compared to that of the standard production aircraft. Additionally, the pressure loss, temperature rise, and vibration characteristics of the IR suppressor were measured. The performance and flying qualities of the OV-1 were not significantly affected by the suppression kit installation. Two deficiencies were detected during the test: exhaust gas blow-by between the engine shroud and the suppressor shroud adapter and high skin temperatures in the area where the suppression kit fairing joined the engine nacelle. The suppressor pressure, temperature and vibration data were forwarded to the US Army Aviation Material Laboratories for analysis in accordance with the US Army Aviation Systems Command's instructions.

FOREWORD

The infrared suppression kits were installed on the OV-1B by Hayes International Corporation, Birmingham, Alabama. The instrumentation used to monitor conditions in the IR suppressor was furnished, installed, calibrated and maintained by the US Army Aviation Materiel Laboratories, Fort Eustis, Virginia.

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INTRODUCTION

BACKGROUND

1. The US Army's interest in air vehicle survivability has led to funding the development of passive countermeasure equipment against infrared seekers. This equipment is being developed by Hayes International Corporation, Birmingham, Alabama, under a US Army contract and the equipment effectiveness is being tested by the US Army Aviation Materiel Laboratories (USAAVLABS). The effects of installing an actual infrared (IR) suppression kit on the performance and flying qualities of OV-1B aircraft, were evaluated by flight tests, performed by the US Army Aviation Systems Test Activity (USAASTA) for USAAVLABS.

2. Authority for the USAASTA participation in the OV-1B IR suppression kit evaluation was provided by the Test Directive issued by the US Army Aviation Systems Command (USAAVSCOM) on 26 April 1968, (ref 1, app I). The Test Plan was approved by USAAVSCOM in April 1968 (ref 2).

TEST OBJECTIVES

3. The primary objectives of these tests were to provide USAAVSCOM quantitative and qualitative information on both performance and stability, and control characteristics of the OV-1B aircraft with the IR suppression kit installation. A secondary objective was to measure pressure, temperature, and vibration in the infrared suppressor and furnish USAAVLABS with a compilation of these data as directed in reference 8, appendix I.

DESCRIPTION

4. The test aircraft was a production model OV-1B Mohawk (S/N 64-14246) manufactured by Grumman Aircraft Engineering Corporation, Bethpage, New York. The engine exhaust shrouds of the aircraft were fitted with IR suppression kits manufactured by Hayes International Corporation. The OV-1B is a two-place, midwing, triple-vertical-tail, twin turboprop airplane with a side looking airborne radar (SLAR) antenna mounted on the lower right side of the fuselage and is powered by two T53-L-7 free-turbine engines rated at 1100 shaft horsepower (shp) at sea level standard conditions. The IR suppression kits were heat diffusing devices mounted to and extending aft of the modified engine exhaust shrouds. An exhaust shroud nacelle faired the IR suppression installation into the

existing engine nacelle. Details of the installation are presented in reference 3, appendix I. Design details of the suppression unit are presented in reference 4. A detailed description of the OV-1B is presented in the operator's manual (ref 5). Photographs of the test aircraft and the suppressor assembly are shown in appendix VI.

SCOPE OF TEST

5. The performance and flying qualities tests were flown in the following cruise configurations:

Suppressors ON configuration	OV-1B, 12,650 pounds standard gross weight, two T53-L-7 engines, IR suppression kit installed, gear and flaps up. External-stores pylons installed (wing station 185), nose mounted pitot static boom with angle-of-sideslip and angle-of-attack vanes installed.
Suppressors OFF configuration	Same as suppressors ON configuration except IR suppression kit removed and production exhaust shroud installed.

6. Seventeen productive flights were conducted, accumulating a total of 17.6 productive flight hours. Performance and stability and control data obtained in the suppressors ON configuration were compared to similar data obtained in the suppressors OFF configuration. Performance data were also compared with handbook predicted data. The aircraft was tested under the following conditions:

Airspeed	100 to 255 KTAS
Engine Start GRWT	13,446 to 13,661 pounds
Engine Start CG	160.1 to 160.5 inches
Propeller Speed	1150 to 1675 rpm
Propeller Synchronizer	ON
Auto Pilot	Engaged (Altitude Hold, OFF)
Pressure Altitude	5000 feet and 10,000 feet
Outside Air Temperature	+17°F to +52°F
Fuel	JP-4
Heater	OFF

7. During all testing in the suppressors ON configuration, measurements of pressure losses, temperature rises and vibrations of the suppression kit were recorded on an oscillograph.

METHODS OF TEST

8. The level flight performance and flying qualities tests were conducted using the techniques outlined in references 6 and 7, appendix I. Aided by a photopanel and an oscillograph, data were recorded manually.

9. The test-day engine shaft horsepower was computed using engine-torquemeter and propeller-rpm test-day data. Test-day torquemeter readings were determined using Lycoming engine calibration data. Power was set using the manufacturer's recommended optimum gas producer/propeller speed schedule (fig 10, app II). The test-day shp was then corrected for weight and altitude effects to obtain a generalized power parameter (SHP_{ew}) as follows:

$$SHP_{ew} = SHP_t \sqrt{\sigma}\left(\frac{W_s}{W_t}\right)^{3/2}$$

10. The airspeed data were obtained from a sensitive airspeed indicator connected to the ship's system. This pitot-static system was calibrated by the pacer method. Airspeed calibration data are presented in figure 1, appendix II. The test-day true airspeed was corrected for weight and altitude to obtain a generalized airspeed parameter (V_{ew}) as follows:

$$V_{ew} = V_t \sqrt{\sigma}\left(\frac{W_s}{W_t}\right)^{1/2}$$

11. A Pilot Rating Scale was used to augment qualitative comments on flying qualities. This scale is shown in appendix VII.

12. The test instrumentation used on the OV-1B and the special instrumentation used in the IR suppressor are contained in appendix III. A glossary of terms used in this report is presented in appendix IV.

CHRONOLOGY

13. The chronology of testing is as follows:

a.	Test aircraft received	1 December 1967
b.	Test directive received	29 April 1968
c.	Test started	23 January 1968
d.	Test completed	22 March 1968

RESULTS & DISCUSSION

GENERAL

14. The engineering flight test of the OV-1B IR suppression kit installation was conducted to determine the degradation in level-flight performance and changes in flying qualities caused by the kit installation. The aircraft performance, with the suppression kit installed, was compared to that of the standard production aircraft. The performance and flying qualities of the aircraft were not significantly affected by the suppression kit installation. Within the scope of the test, the installation resulted in a performance degradation which varied from 3.3 percent of power at 100-knots true airspeed (KTAS) to 1.5 percent of power at 250 KTAS, and caused no appreciable change in the flying qualities of the OV-1B. These results did not substantiate the increasing percentage of power losses with increasing airspeed predicted in reference 4, appendix I. The performance of the test aircraft exceeded that calculated from the operator's manual at all airspeeds flown in both configurations.

LEVEL FLIGHT PERFORMANCE

15. Level flight performance data were obtained at 5000- and 10,000-foot pressure altitudes with IR suppression kits installed over a modified engine shroud and in the standard production shroud configuration. The results of these tests are presented in figures 3 and 4, appendix II. Data for both figures were taken with the same instrumentation installed; therefore, the data accuracy for each figure is similar. A comparison of generalized speed power polars developed from these figures is presented in figure 2, appendix II. A summary of the performance degradation is presented in table 1. The results did not substantiate the shaft horsepower losses predicted by Hayes, as the percentage of horsepower loss decreased with increasing airspeed rather than increased. In general, the results substantiate the shaft horsepower losses predicted by Hayes, and the IR suppressor kits do not significantly affect the level flight performance capabilities of the OV-1B aircraft.

Table 1. Performance Summary.
Gross Weight - 12,650 pounds
Sea Level Standard Day

Airspeed KTAS	Predicted Horsepower Clean Configuration	Horsepower Required Suppr ON	Horsepower Required Suppr OFF	Percent Increase[1]
225	[2]1815	1704	1679	1.5
220	[2]1762	1608	1583	1.6
166	[2]838	826	810	2.0
100	[2]501	465	450	3.3

[1]Suppressors ON configuration compared to suppressors OFF configuration.

[2]Calculated from data in operator's manual.

STATIC STABILITY

16. Because of the limited scope of this evaluation, the static stability tests were conducted at one trim airspeed. The trim airspeed used was the velocity for maximum range as specified in the operator's manual. Data were obtained for both suppressors ON configuration and suppressors OFF configuration. The results of the static stability tests are presented in figures 5 and 6, appendix II. The results show that, within the scope of the test, the IR suppression kit installation has a negligible affect on the static stability of the OV-1B aircraft (PRS A-2). Longitudinal, static stick-fixed and stick-free stability was positive (elevator trailing edge down and push force required to increase airspeed). During lateral-directional static stability testing, the aircraft required a constant increase of rudder force, opposite to sideslip, as the sideslip angle was increased.

DYNAMIC STABILITY

17. Dynamic stability was qualitatively analyzed by trimming the aircraft in balanced, level flight and observing the aircraft's reaction to pulse-type, control inputs in the lateral, longitudinal and yaw axes. The results of these tests indicated that there was no discernible difference between the dynamic stability of the aircraft in the suppressors ON configuration or in the suppressors

OFF configuration. In both cases, the aircraft motions were heavily damped and were not bothersome to the pilot (PRS A-2).

IR SUPPRESSION KIT INSTALLATION

18. The IR suppressor assembly is a series of concentric, steel-mesh, hollow rings. The rings are interconnected by three steel tubes which furnish outside ram air to the hollow rings. The assembly is welded to a shroud extension which is then fitted over a modified production exhaust shroud. The poor fit resulted in a gap between the shroud and suppressor-shroud extension through which back pressure exhaust gases escaped. Evidence of this deficiency was noted when carbon deposits were found on the nacelle flush-ram-air inlet (see photo 5, app VI). Correction of the deficiency is mandatory for satisfactory Army use. In addition to the exhaust gas blow-by problem, a nacelle overheating problem was experienced which caused blistering of the paint in the area where the engine nacelle joins the IR suppression kit coupling. Temperature-sensitive paint was used to estimate nacelle skin temperature. Results showed that temperatures in excess of 300 degrees Fahrenheit occurred on the nacelle skin (see photos 6 through 9). These two problems were most pronounced during ground operations with the propeller feathered and are probably interrelated. Extended operation with high nacelle skin temperatures could result in permanent, nacelle structural damage and correction of this condition is mandatory for satisfactory Army use. It is recommended that further testing be performed to ascertain proper design of a suppression kit.

19. The pressure, temperature and vibration data obtained on the IR suppression kit installation (app V) have been forwarded to USA-AVLABS (ATTN: SAVFE-SS) for reduction and analysis, in accordance with the instructions contained in reference 8, appendix I. A diagram of the IR suppression kit pressure and temperature pickup locations is shown in figure A, appendix V.

ENGINE CHARACTERISTICS

20. Engine performance data for both suppressors ON and suppressors OFF configurations are presented in figures 7, 8 and 9, appendix II. These data indicate that there was a slight increase in exhaust gas temperature with the IR suppression kits installed. This difference was noticeable at both pressure altitudes when comparing one configuration with the other. This means that to develop a given horsepower a higher exhaust gas temperature will result with IR suppression kits installed. It should be pointed out that this difference is small.

CONCLUSIONS

21. The IR suppression kit installation did not adversely affect the performance and flying qualities of the OV-1B airplane.

22. Correction of the following deficiencies is mandatory prior to release of the aircraft for operational use with the IR suppression kits.

a. Exhaust gas blow-by between the suppressor adaptor and the exhaust shroud (para 18).

b. Overheating of the nacelle skin in the vicinity of the suppression kit fairing attachment (para 18).

RECOMMENDATIONS

23. The deficiencies should be corrected prior to release of the aircraft for operational use with the IR suppression kits installed (para 22).

24. Further testing should be performed to ascertain proper suppression kit design (para 18).

APPENDIX I. REFERENCES

1. Message, USAAVSCOM, AMSAV-ER-4-1399, Unclas, subject: Test Directive, USAASTA Project No. 67-23, OV-1B IR Suppression Performance Tests, 26 April 1968.

2. Preliminary Test Plan, USAASTA Project No. 67-23, *Engineering Flight Test of an IR Suppression Kit Installation on the OV-1B Aircraft*, January 1968.

3. DA Modification Work Order, Installation of Infrared Suppression Unit (OV-1 Aircraft), number unassigned.

4. Contract DAAJ02-67-0012, Hayes International Corporation, *Design of an Infrared Suppression for the OV-1 Aircraft, (Phase II Report)*, revised 15 November 1967.

5. Technical Manual, TM 55-1510-204-10, *OV-1 Aircraft*, October 1965.

6. Handbook, US Naval Test Pilot School, CDR M. W. Townsend, USN, *Performance Testing Manual*, August 1966.

7. Handbook, G. B. Doyle, LTC, USMC, *Pilot Techniques for Stability and Control Testing*, revised by F. S. Peterson, LCDR, USN, US Naval Test Pilot School, Summer, 1958.

8. Message, USAAVSCOM, AMSAV-R-FT, subject: USAAVNTA Project No. 67-23, Engineering Test of an IR Suppression Kit Installation on the OV-1 Aircraft, January 1969, (U) 19 April 1969.

APPENDIX II. TEST DATA

FIGURE 1

AIRSPEED CALIBRATION

OV-1B USA S/N 64-14246

SHIP'S SYSTEM PACER METHOD

AVERAGE GROSS WEIGHT: 13070 LB GEAR : UP

AVERAGE C.G. : 160.1 IN FLAPS: 0 DEG

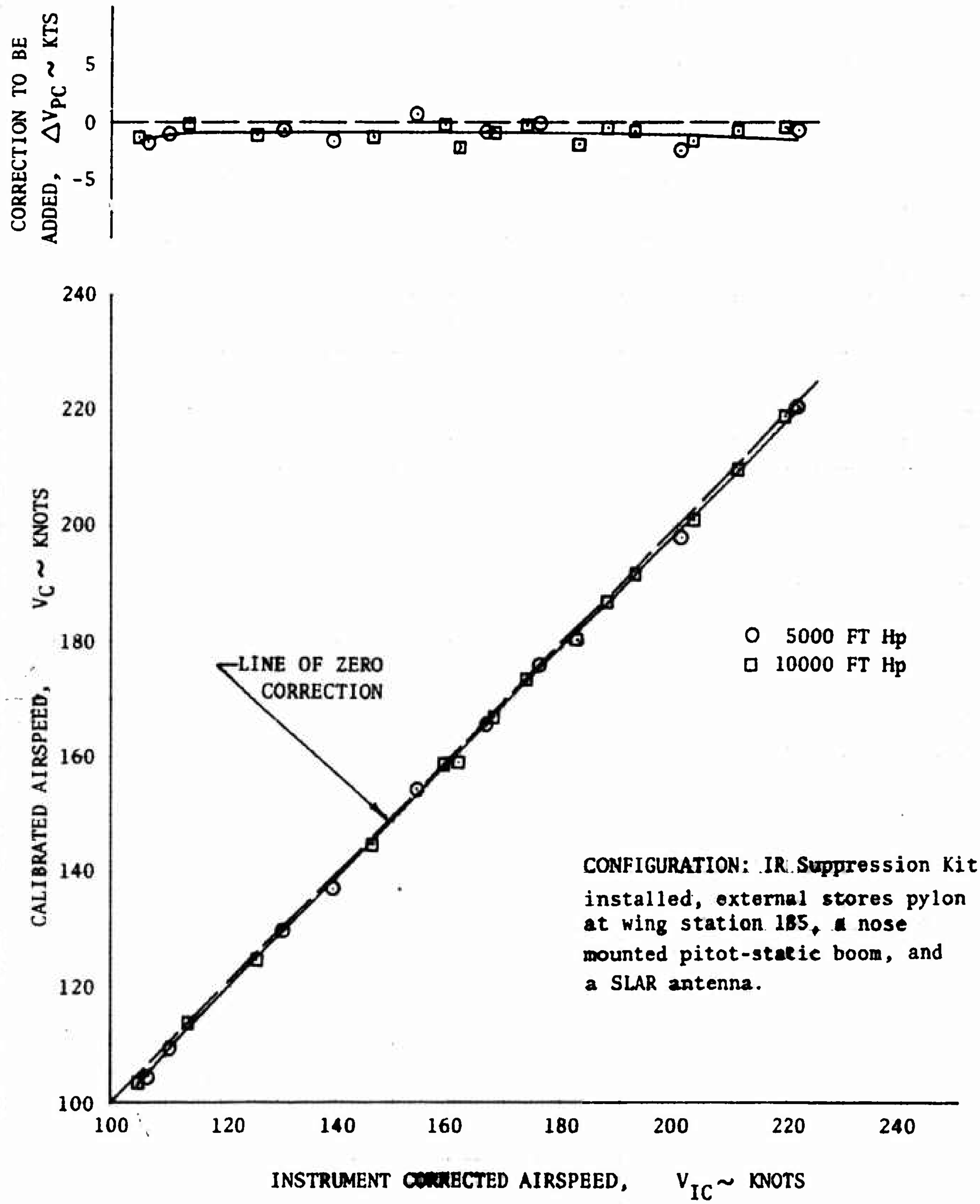


FIGURE 2
LEVEL FLIGHT PERFORMANCE SUMMARY
GENERALIZED SPEED POWER POLARS
OV-1B USA S/N 64-14246

CONFIGURATION: NOTED

STD GROSS WEIGHT: 12,650 LB

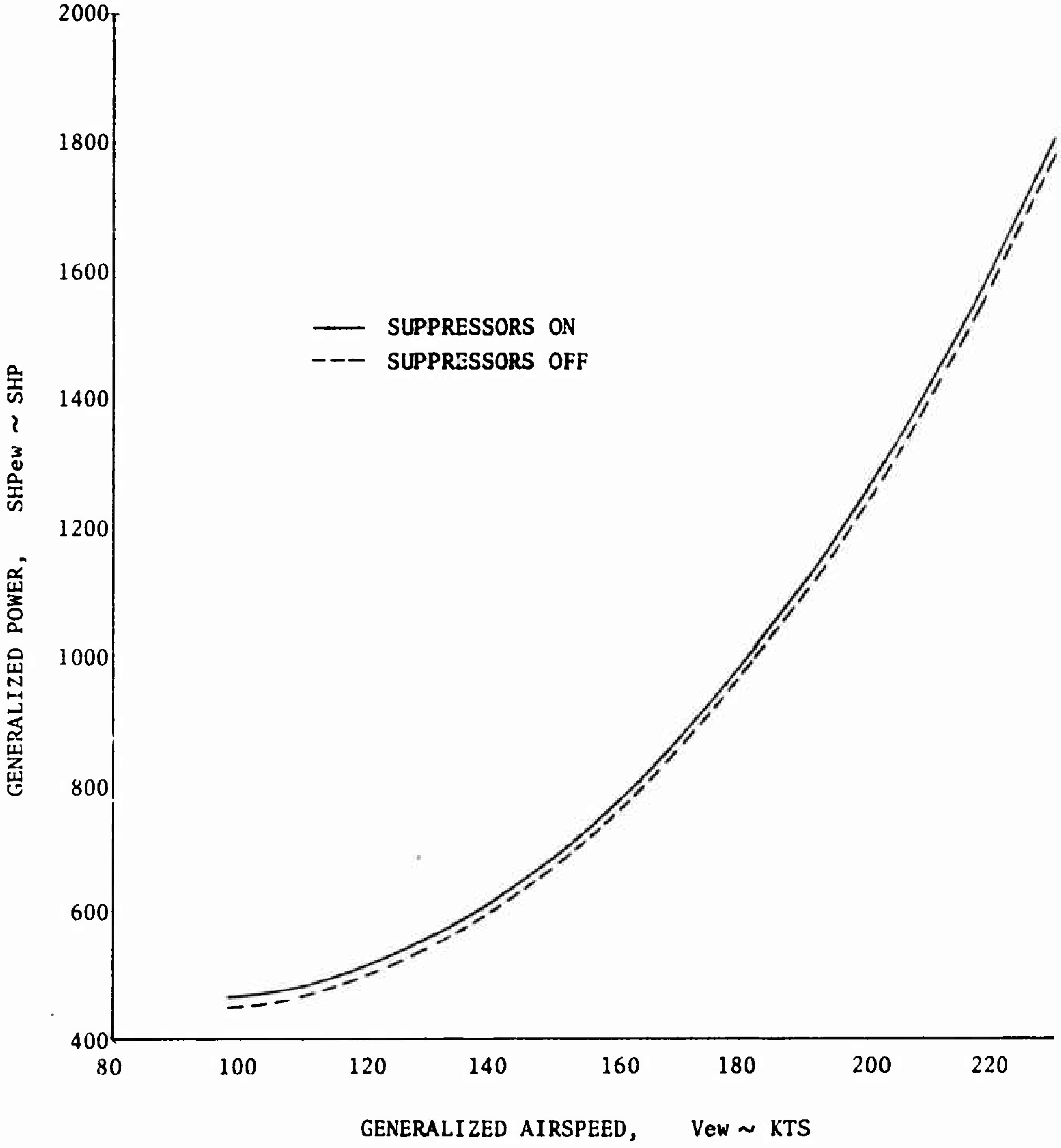


FIGURE 3
LEVEL FLIGHT PERFORMANCE
GENERALIZED SPEED POWER POLAR
OV-1B USA S/N 64-14246

CONFIGURATION: SUPPRESSORS ON STD GROSS WEIGHT: 12,650 LB

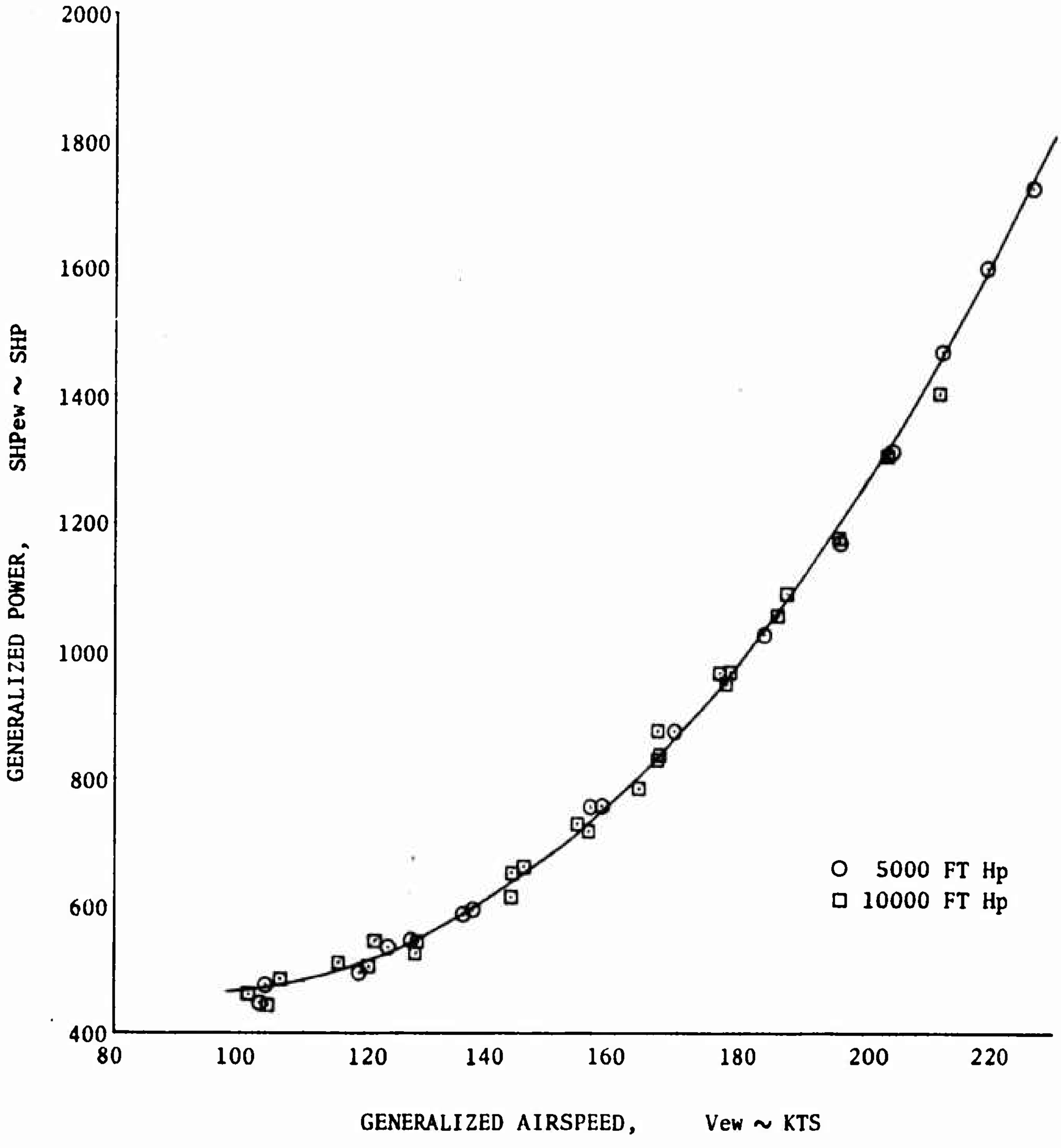


FIGURE 4
LEVEL FLIGHT PERFORMANCE
GENERALIZED SPEED POWER POLAR
OV-1B USA S/N 64-14246

CONFIGURATION: SUPPRESSORS OFF STD GROSS WEIGHT: 12,650 LB

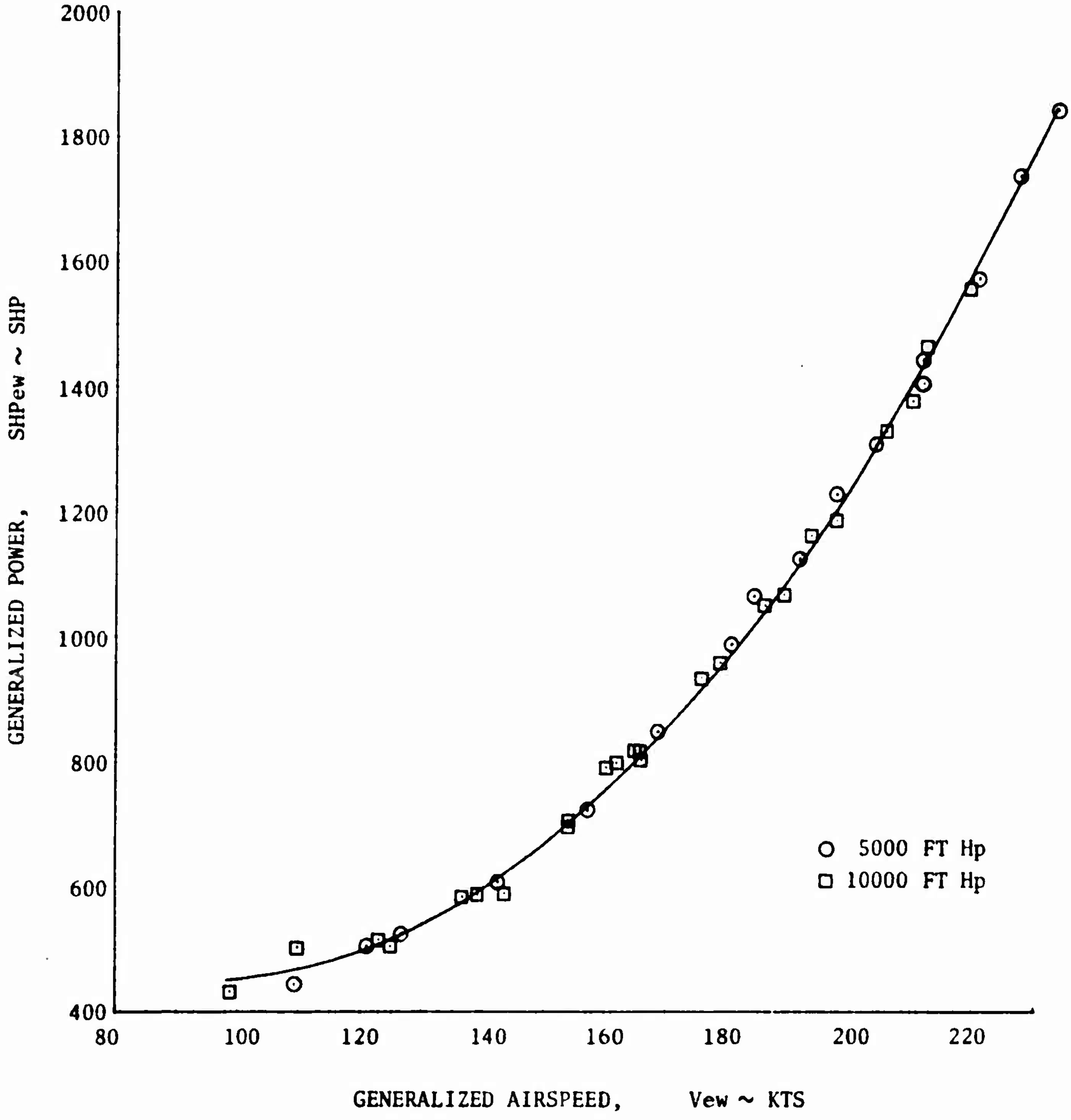


FIGURE 5
STATIC LONGITUDINAL STABILITY
OV-1B USA S/N 64-14246

SYMBOL	TRIM PRESSURE ALTITUDE FT	TRIM AIRSPEED KCAS	GROSS WEIGHT LB	C.G. LOCATION IN.	CONFIGURATION
○	5000	167.5	12,830	160.5	SUPPRESSORS ON
□	5000	167.5	12,520	160.1	SUPPRESSORS OFF

NOTE: SHADED SYMBOLS DENOTE TRIM

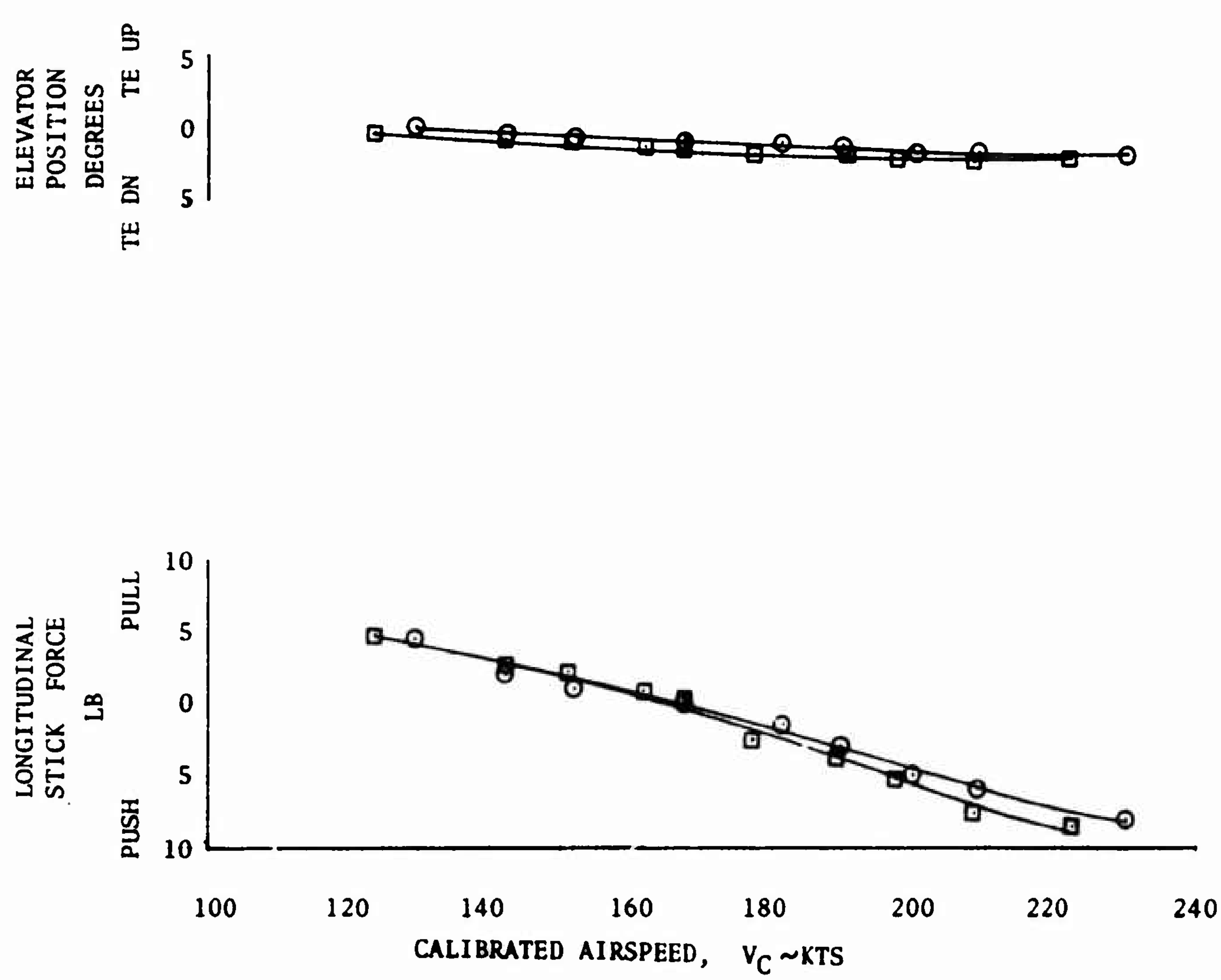


FIGURE 6

STATIC LATERAL-DIRECTIONAL STABILITY

OV-1B USA S/N 64-14246

SYMBOL	PRESSURE ALTITUDE FT	TRIM AIRSPEED KCAS	GROSS WEIGHT LB	C.G. LOCATION IN.	CONFIGURATION
○	5000	167	12,540	160.6	SUPPRESSORS ON
□	5000	168	12,730	160.1	SUPPRESSORS OFF

NOTE: SHADED SYMBOLS DENOTE TRIM

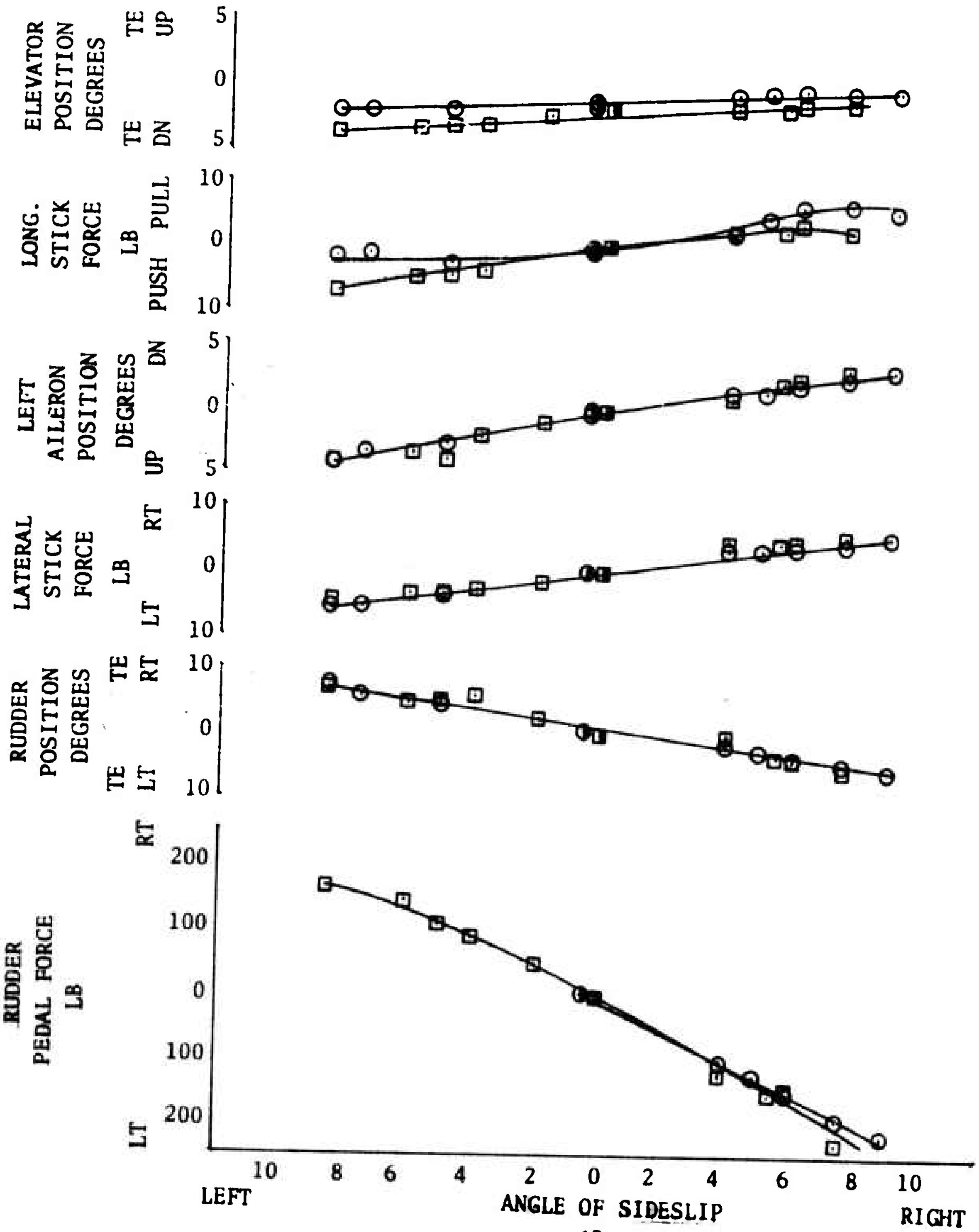


FIGURE 7
ENGINE CHARACTERISTICS
T53-L-7 ENGINE S/N LE05249

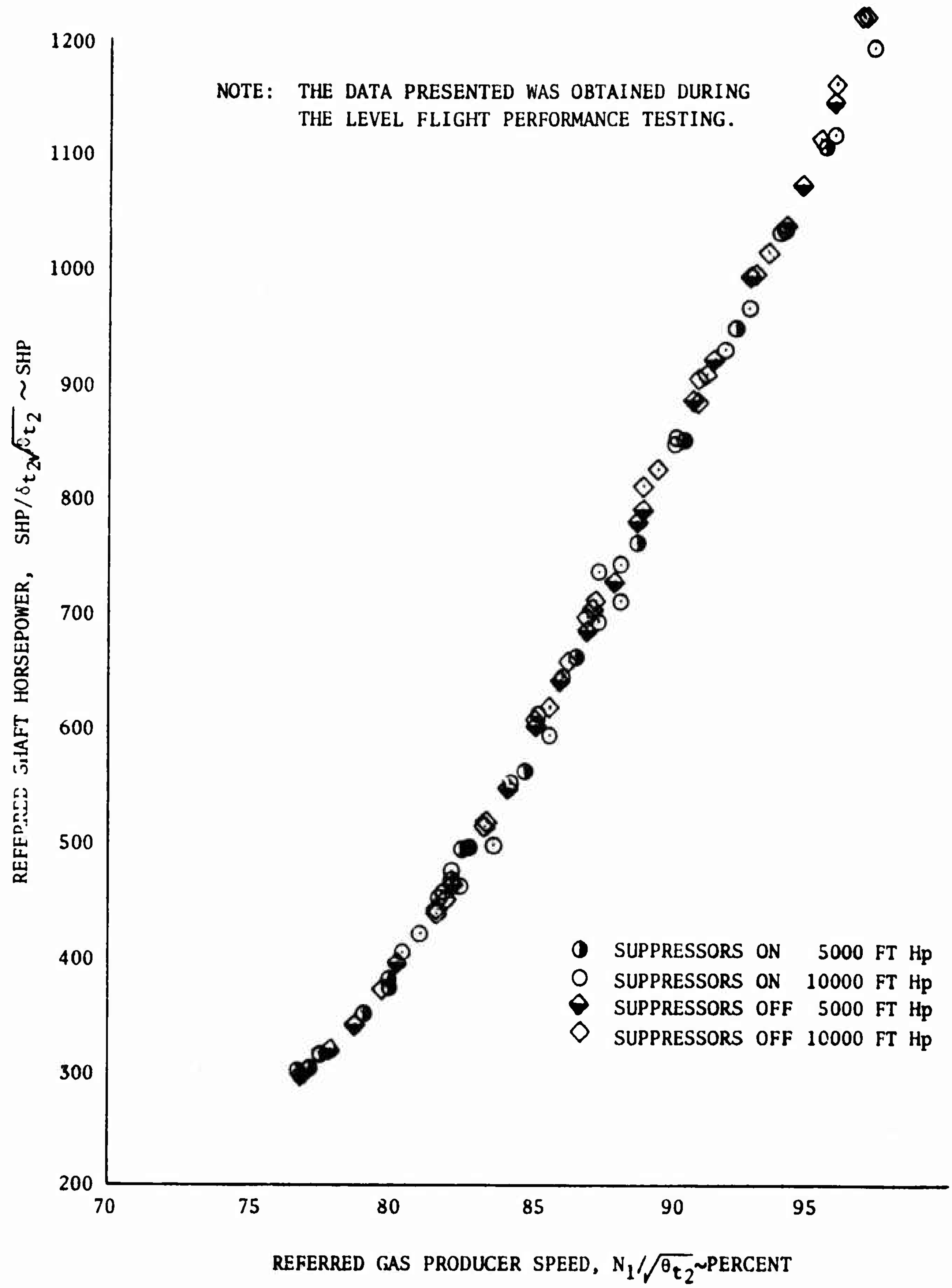


FIGURE 8
ENGINE CHARACTERISTICS
T53-L-7 ENGINE S/N LE05249

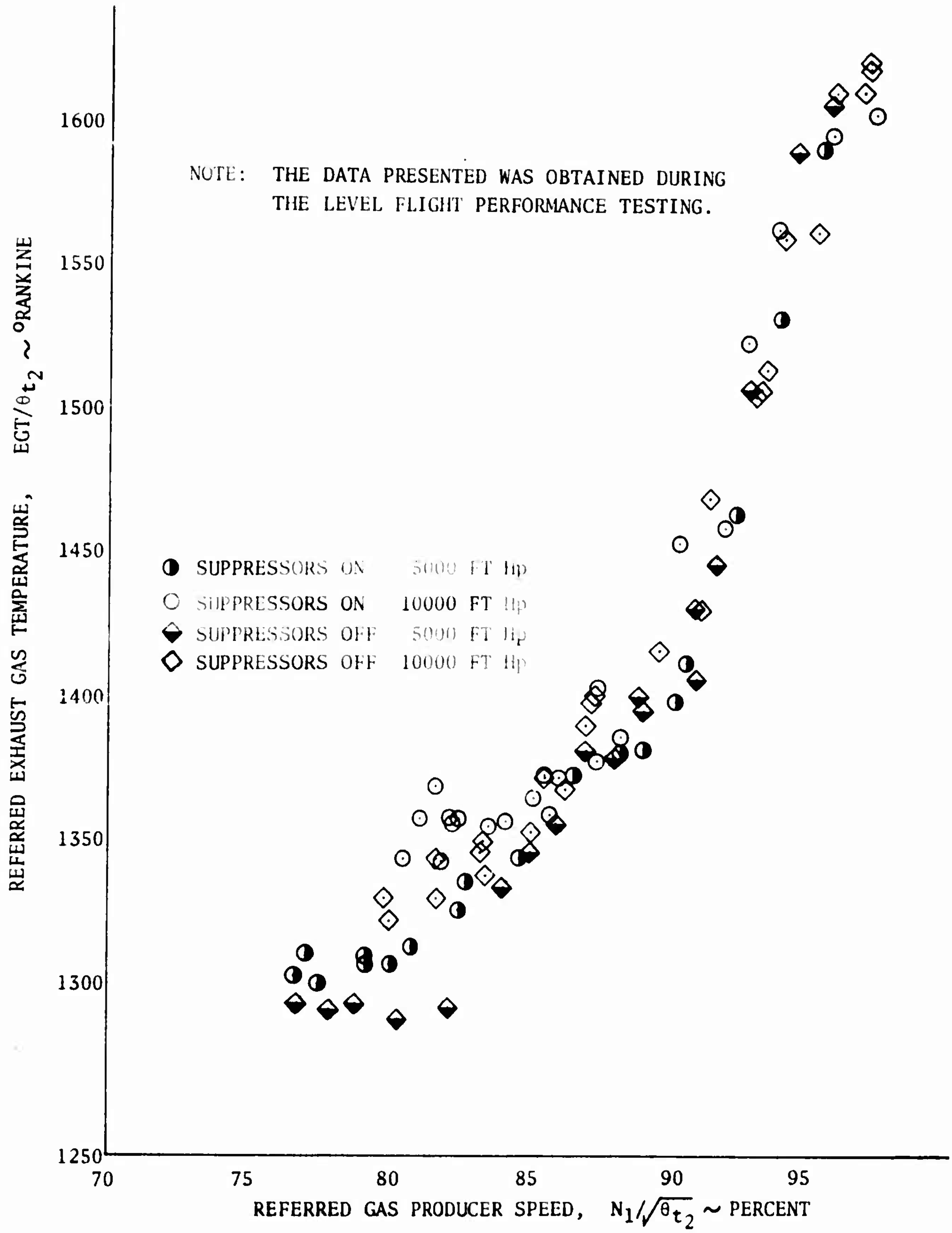


FIGURE 9
ENGINE CHARACTERASTICS
T53-L-7 ENGINE S/N LE05249

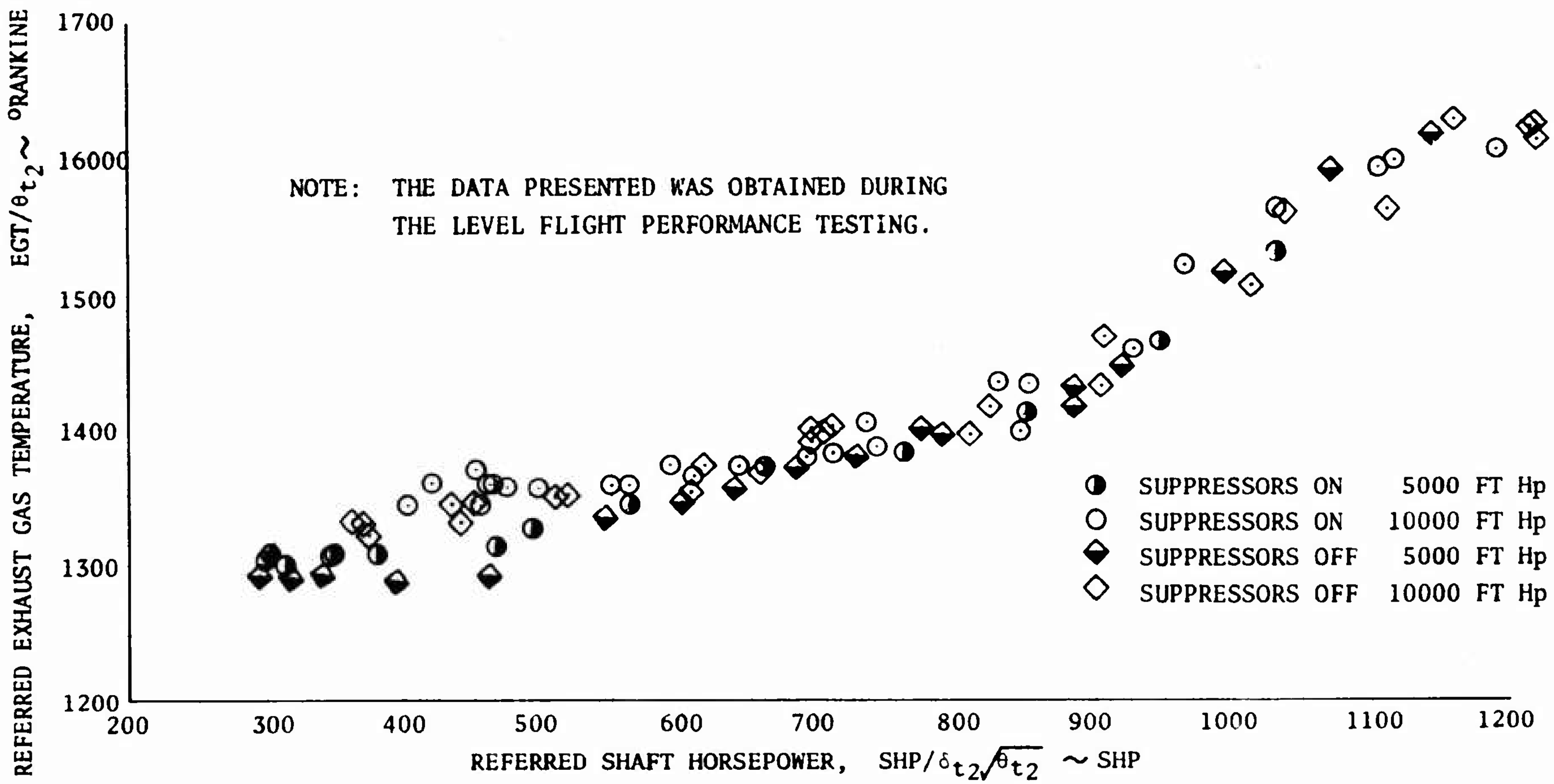


FIGURE 10
ENGINE CHARACTERISTICS
T53-L-7 ENGINE S/N LE05249

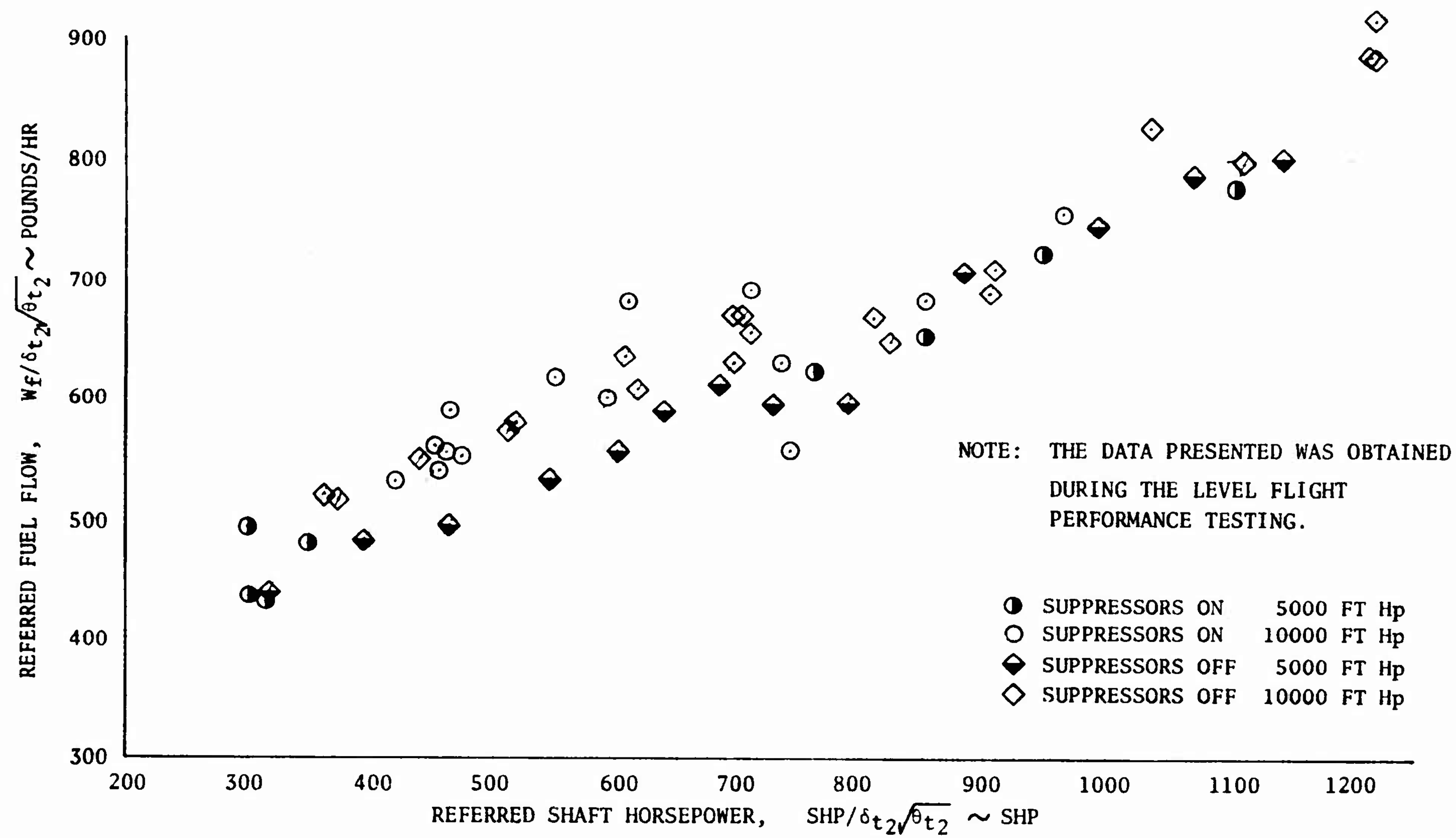


FIGURE 11

- MANUFACTURER RECOMMENDED POWER SCHEDULES

STANDARD DAY | ALTITUDE AS NOTED
MODEL(S) OV-1B
DATA AS OF: 23 FEBRUARY 1967 | CONFIGURATION: ALL | ENGINE(S): (2) T-53-L7
DATA BASIS: CALCULATED | FUEL GRADE: JP-4

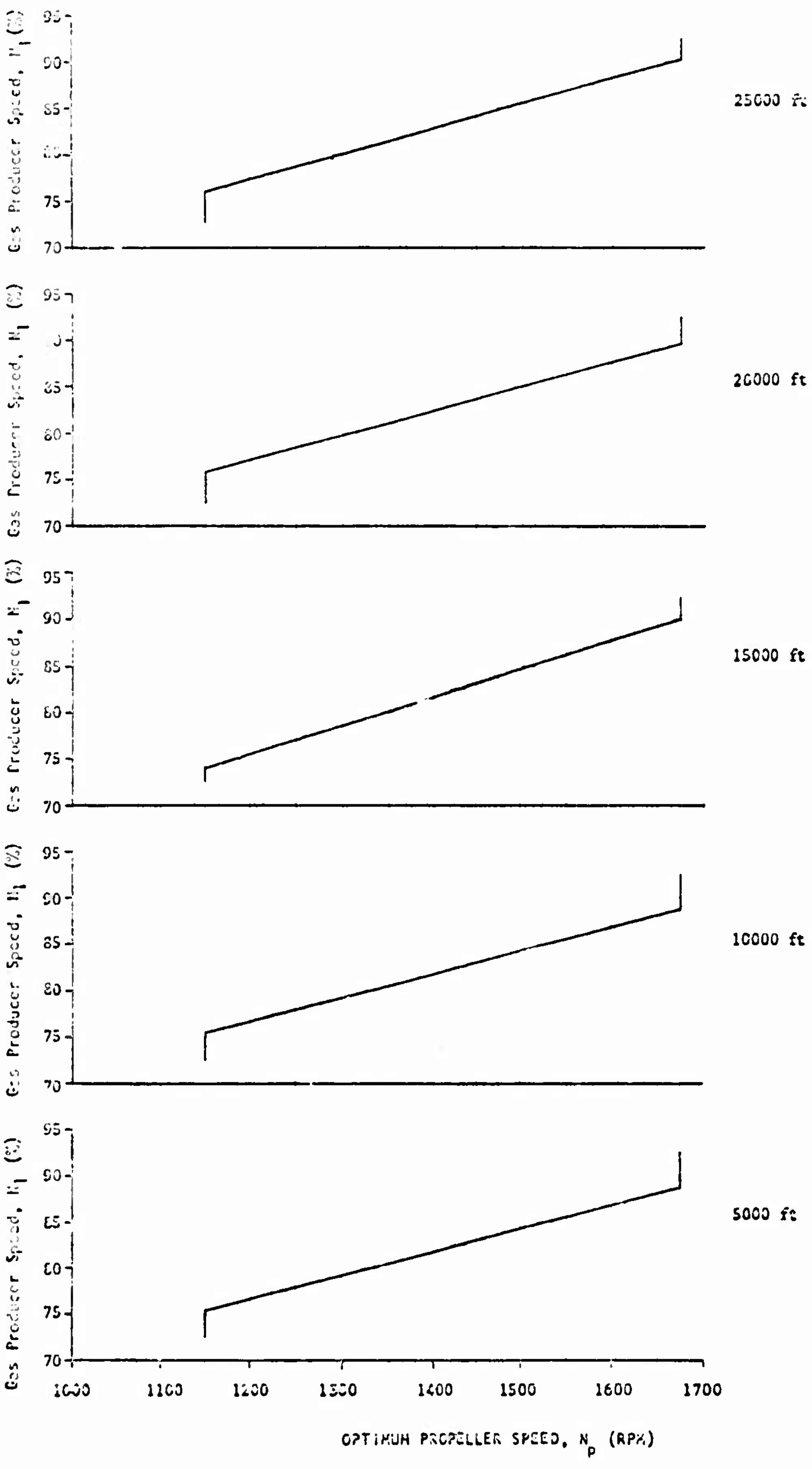


FIGURE 12 GENERALIZED SPEED-POWER PLOT

ALL ALTITUDES

MODEL: OV-1B
DATA AS OF: 24 MARCH 1967
DATA BASIS: FLIGHT TEST

CONFIGURATION:
WITHOUT EXTERNAL
FUEL TANKS (1 ENGINE)

ENGINE: AS NOTED
FUEL GRADE: JP-4

GW_{STD} = 12,650 LBS

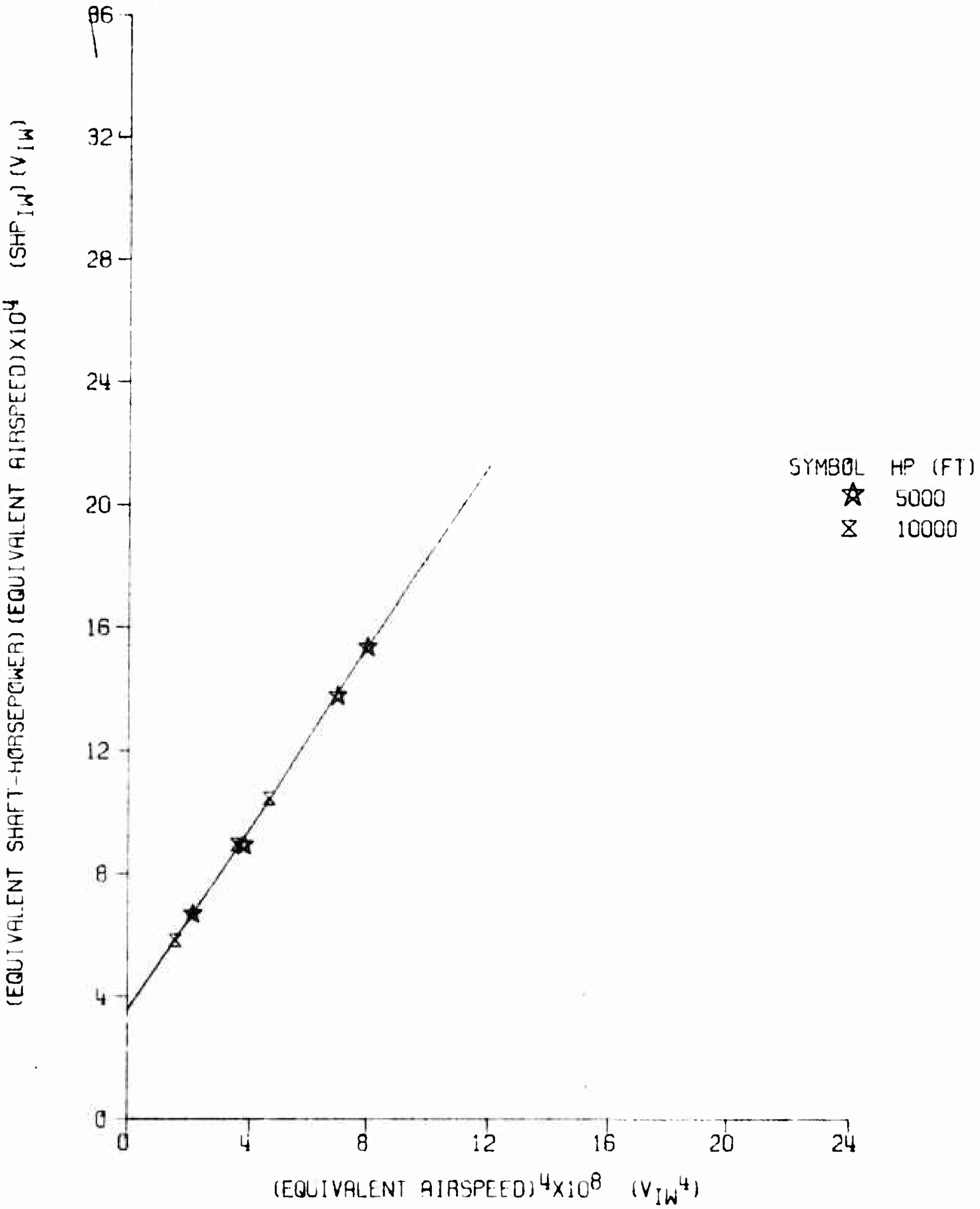


FIGURE 13 GENERALIZED SPEED-POWER PLOT

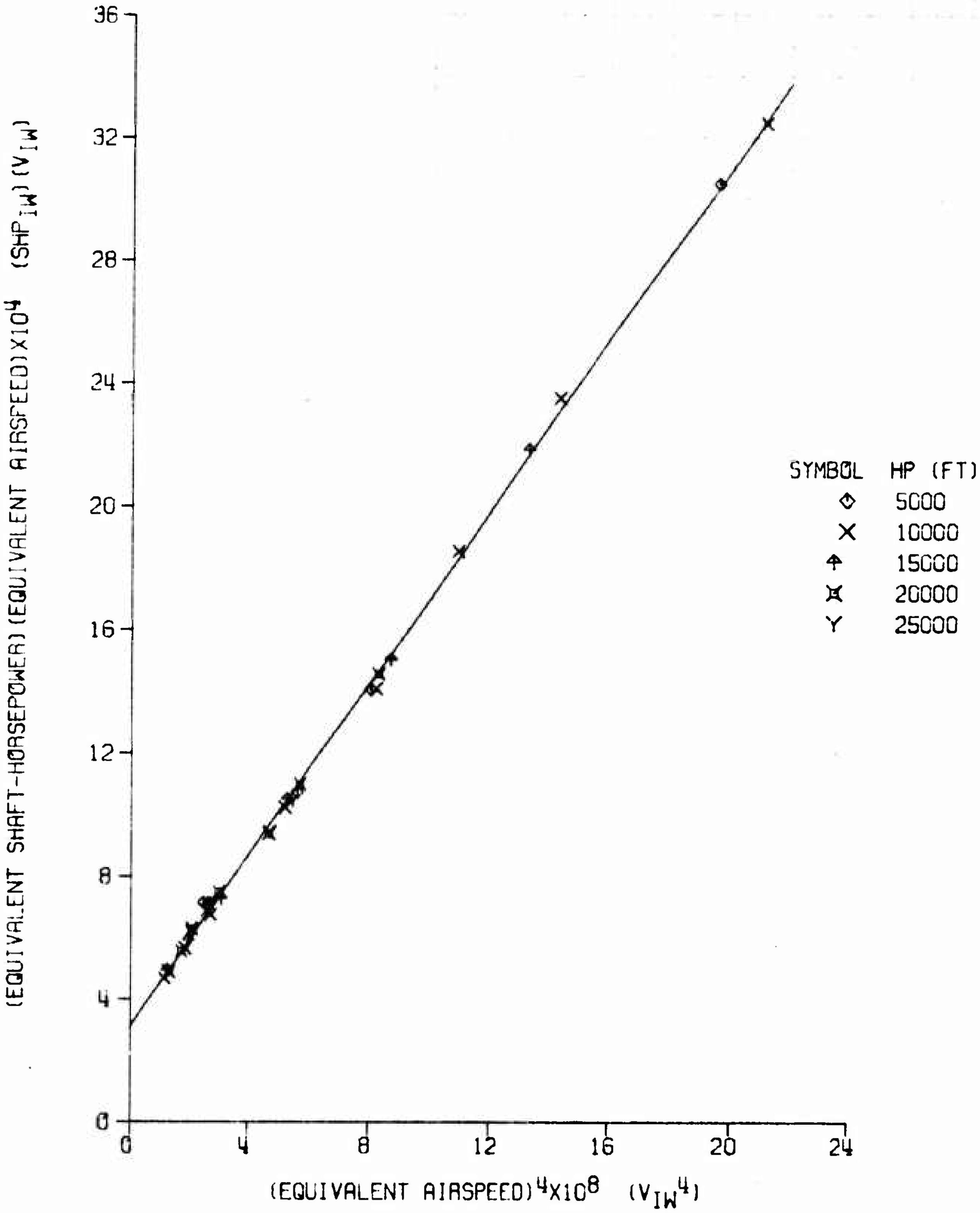
ALL ALTITUDES

MODEL: OV-1B
DATA AS OF: 24 MARCH 1967
DATA BASIS: FLIGHT TEST

CONFIGURATION:
WITHOUT EXTERNAL
FUEL TANKS (2 ENGINE)

ENGINE: AS NOTED
FUEL GRADE: JP-4

GW_{STD} = 12,650 LBS.



APPENDIX III. TEST INSTRUMENTATION

GENERAL

1. The instrumentation in the OV-1B, USA S/N 64-14246, was installed, calibrated and maintained by USAASTA instrumentation personnel or by USAAVLABS personnel. Some calibrations were accomplished by Air Force Flight Test Center personnel. In addition to the instrumentation listed, the aircraft was equipped with a pitot-static boom, incorporating angle of attack and angle of sideslip vanes. The following is a list of test instrumentation.

ITEM	PHOTOPANEL	COCKPIT	OSCILLOGRAPH
Compressor inlet pressure	C		
Compressor inlet temperature	C		
Airspeed	C	C	
Altimeter	C	C	
#1 Engine torque	C		
#2 Engine torque	C		
#1 Engine N_1	C		
#2 Engine N_1	C		
#1 Engine N_2	C		
#2 Engine N_2	C		
Outside air temperature	C	C	
Fuel temperature	C		
#1 Engine fuel counter	C	C	
#2 Engine fuel counter	C	C	
#1 Engine turbine outlet temperature		C	

ITEM	PHOTOPANEL	COCKPIT	OSCILLOGRAPH
#2 Engine turbine outlet temperature		C	
Longitudinal stick force			C
Lateral stick force			C
Rudder pedal force			C
Elevator position			C
Aileron position			C
Rudder position			C
Angle of sideslip			C
Ambient pressure[1]			C
Differential pressure[1]			C
Temperature[1]			C
Accelerometer[1]			C

[1]Instrumentation installed, calibrated and maintained by USAAVLABS, Fort Eustis, Virginia.

C = Calibrated

IR SUPPRESSOR INSTRUMENTATION

2. Instrumentation furnished, calibrated and maintained by USAAVLABS was used to monitor conditions in the IR suppressor. A description of the special instrumentation follows:

a. Pressure: Pressure was measured using pressure transducers. These transducers measured both an ambient pressure in the nacelle and a differential pressure between the nacelle and various locations in the IR suppressor. The electrical output of the transducer was recorded on an oscillograph.

b. Acceleration: Two servo accelerometers were used to measure accelerations and frequencies in the horizontal and vertical planes. The accelerometers were mounted on the aft end of the suppressor. The electrical output from each accelerometer was recorded on an oscillograph.

c. Temperature: Temperatures were measured at various locations in the suppressor by the use of iron-constantan thermocouples. The electrical voltage from each thermocouple was amplified and recorded on an oscillograph.

FUEL FLOW CORRECTION

3. The fuel flow was used to determine the change in weight during the test flight. This weight was then used to correct shaft horsepower and velocity to generalized shaft horsepower (SHP_{ew}) and generalized velocity (V_{ew}). Some inaccuracy existed in the fuel flow measurement. The ability of the fuel flow meter to accurately measure fuel used was degraded in that some of the fuel was returned to the fuel tank from the engine fuel controls through the fuel vapor return line. The quantity of the return fuel flow was not measured; however, preflight and postflight weighings indicated that the return flow did not exceed 70 pounds per hour. The error introduced into SHP_{ew} and V_{ew} calculations as a result of fuel burnoff inaccuracy was negligible. Shaft horsepower was determined using engine torque and engine rpm. Referred fuel flow was not used to determine shaft horsepower since the engines were not calibrated.

APPENDIX IV. GLOSSARY

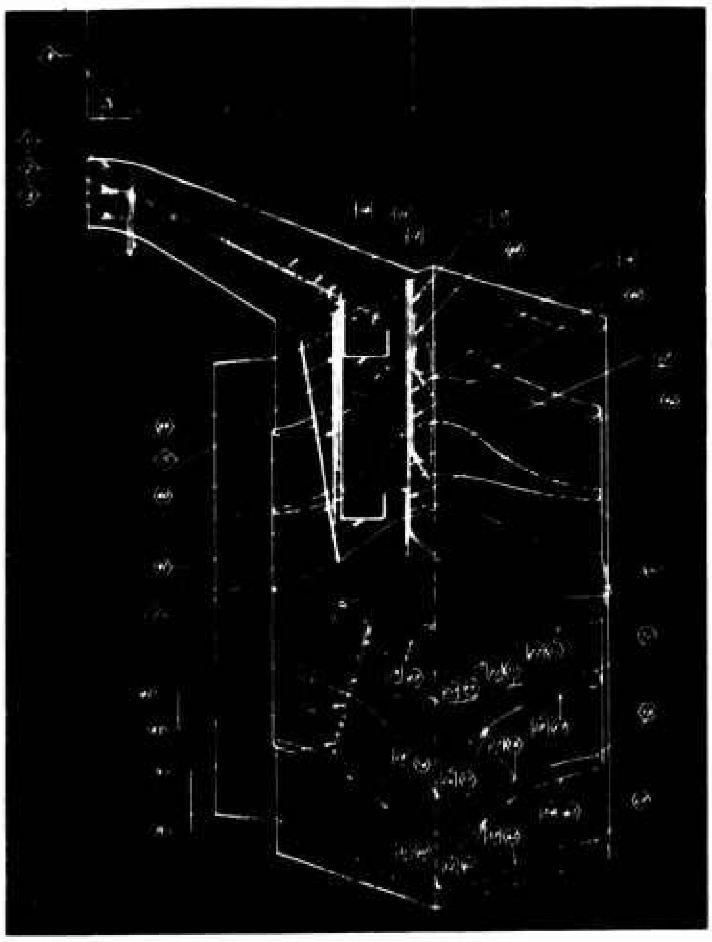
SYMBOL	DEFINITION	UNIT
EGT	Exhaust gas temperature	°F
ESCG	Center of gravity at engine start	Inches
ESGW	Gross weight at engine start	Pounds
GRWT	Gross weight	Pounds
g	Acceleration of gravity	Feet/Second^2
Hp	Pressure altitude	Feet
KCAS	Calibrated airspeed	Knots
KTAS	True airspeed	Knots
N_1	Gas producer speed	Percent
N_2	Propeller speed	Rpm
P_N	Nacelle static pressure	Pounds per sq in.
P_{t_2}	Compressor inlet total pressure	Inches Hg
P_o	Sea level standard day static pressure	Inches Hg
PAMB	Free stream static pressure	Pounds per sq in.
SHP_t	Test day shaft horsepower	
SHP_{ew}	Generalized shaft horsepower parameter	
TE	Trailing edge	
T_{t_2}	Compressor inlet total temperature	°R
T_o	Sea level standard day static temperature	°R
V_C	Calibrated airspeed	Knots
V_{ew}	Generalized airspeed parameter	Knots

SYMBOL	DEFINITION	UNIT
V_{IC}	Instrument corrected airspeed	Knots
V_t	True airspeed	Knots
W_f	Fuel flow	Pounds/hr
W_s	Standard gross weight	Pounds
W_t	Test day gross weight	Pounds
ΔV_{PC}	Position error correction for airspeed	Knots
δ_{t_2}	Ratio of compressor inlet total pressure to sea level standard day pressure	Dimensionless
θ_{t_2}	Ratio of compressor inlet temperature to sea level standard day temperature	Dimensionless
σ	Ratio of test altitude density to sea level standard density	Dimensionless

APPENDIX V. IR SUPPRESSION KIT DATA

Due to the classification of this material, Appendix V, IR Suppression Kit Data (pressure, temperature and vibration) has been forwarded to USAAVLABS separately and is not included in this report.

FIGURE A. INFRARED SUPPRESSOR DIAGRAM
PRESSURE AND TEMPERATURE PROBE LOCATIONS



◇ TOTAL PRESSURE TAP
□ STATIC PRESSURE TAP
○ THERMOCOUPLE

Pressure taps and thermocouples are displaced circumferentially one inch in these areas.

NOTE:
1. Pressure taps 12, 13 and 14 are located on the side of the ram air scoop.
2. Pressure taps 1, 2 and 3 are located on the center line of the ram air scoop.
3. Thermocouple 42 and pressure tap 8 are located on the strut not shown.
4. Thermocouple 38 is located on the left side of the ram air scoop opposite pressure tap 2.

APPENDIX VI. PHOTOGRAPHS

Photo 2. Left Rear View of IR Suppression Kit Installation.

Photo 3. Rear View of IR Suppression Kit Installation.

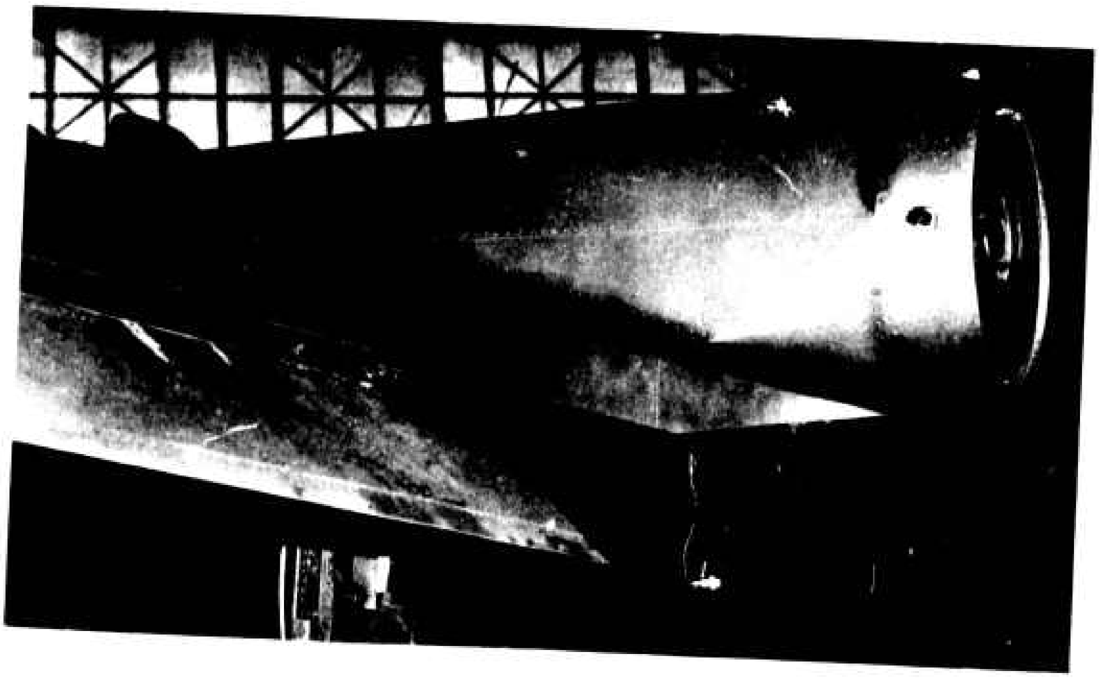


Photo 4. Close-up of Left Engine IR Suppression Kit Shroud Assembly.

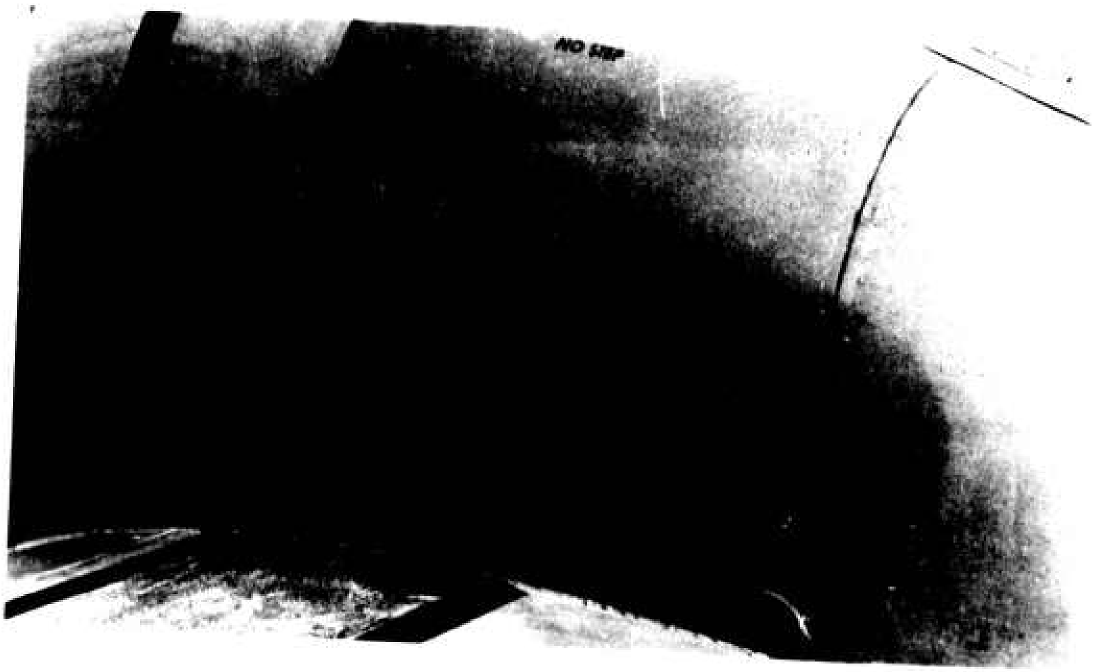


Photo 5. Carbon Build-up at Right Engine Nacelle Outboard Cooling Inlet.

Photo 6. Instrumentation Wiring and Temperature-Sensitive Paint on Outboard of Left Engine Nacelle (Shroud Removed).

Photo 7. Blistered Paint on Sides of Left Engine Nacelle (Shroud Removed).

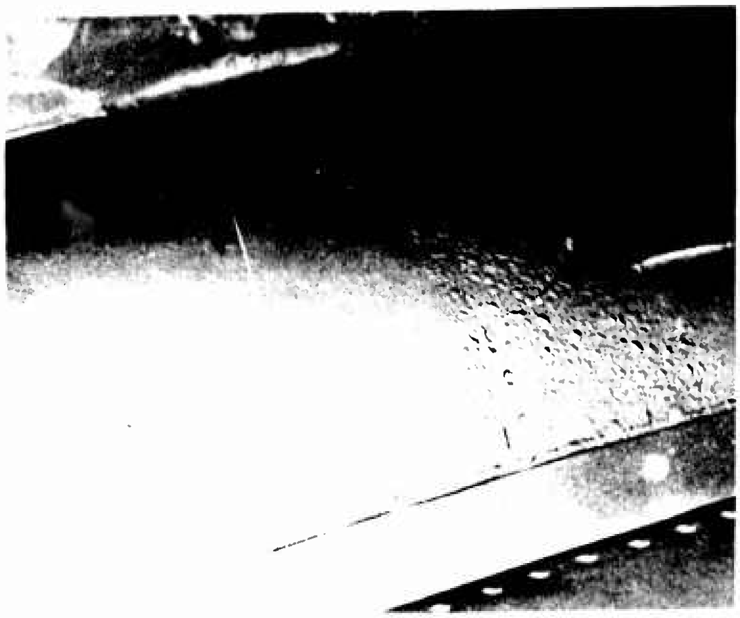


Photo 8. Close-up of Paint Blistering, Left Engine Nacelle.

Photo 9. Paint Blistering of Right Engine Nacelle (Shroud Removed).

APPENDIX VII. PILOT'S RATING SCALE

CONTROLLABLE CAPABLE OF BEING CONTROLLED OR MANAGED IN CONTEXT OF MISSION, WITH AVAILABLE PILOT ATTENTION	ACCEPTABLE MAY HAVE DEFICIENCIES WHICH WARRANT IMPROVEMENT, BUT ADEQUATE FOR MISSION. PILOT COMPENSATION, IF REQUIRED TO ACHIEVE ACCEPTABLE PERFORMANCE, IS FEASIBLE.	SATISFACTORY MEETS ALL REQUIREMENTS AND EXPECTATIONS, GOOD ENOUGH WITHOUT IMPROVEMENT CLEARLY ADEQUATE FOR MISSION.	EXCELLENT, HIGHLY DESIRABLE	A1
			GOOD, PLEASANT, WELL BEHAVED	A2
			FAIR. SOME MILDLY UNPLEASANT CHARACTERISTICS. GOOD ENOUGH FOR MISSION WITHOUT IMPROVEMENT.	A3
		UNSATISFACTORY RELUCTANTLY ACCEPTABLE. DEFICIENCIES WHICH WARRANT IMPROVEMENT. PERFORMANCE ADEQUATE FOR MISSION WITH FEASIBLE PILOT COMPENSATION.	SOME MINOR BUT ANNOYING DEFICIENCIES. IMPROVEMENT IS REQUESTED. EFFECT ON PERFORMANCE IS EASILY COMPENSATED FOR BY PILOT.	A4
			MODERATELY OBJECTIONABLE DEFICIENCIES. IMPROVEMENT IS NEEDED. REASONABLE PERFORMANCE REQUIRES CONSIDERABLE PILOT COMPENSATION.	A5
			VERY OBJECTIONABLE DEFICIENCIES. MAJOR IMPROVEMENTS ARE NEEDED. REQUIRES BEST AVAILABLE PILOT COMPENSATION TO ACHIEVE ACCEPTABLE PERFORMANCE.	A6
	UNACCEPTABLE DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT. INADEQUATE PERFORMANCE FOR MISSION EVEN WITH MAXIMUM FEASIBLE PILOT COMPENSATION.		MAJOR DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT FOR ACCEPTANCE. CONTROLLABLE. PERFORMANCE INADEQUATE FOR MISSION, OR PILOT COMPENSATION REQUIRED FOR MINIMUM ACCEPTABLE PERFORMANCE IN MISSION IS TOO HIGH	U7
			CONTROLLABLE WITH DIFFICULTY. REQUIRES SUBSTANTIAL PILOT SKILL AND ATTENTION TO RETAIN CONTROL AND CONTINUE MISSION.	U8
			MARGINALLY CONTROLLABLE IN MISSION. REQUIRES MAXIMUM AVAILABLE PILOT SKILL AND ATTENTION TO RETAIN CONTROL.	U9
UNCONTROLLABLE CONTROL WILL BE LOST DURING SOME PORTION OF MISSION.			UNCONTROLLABLE IN MISSION.	10

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 (USAASTA) Edwards Air Force Base, California 93523	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE
ENGINEERING FLIGHT TEST OF AN IR SUPPRESSION KIT INSTALLATION ON THE OV-1B AIRCRAFT

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
FINAL REPORT - December 1967 through May 1969

5. AUTHOR(S) (First name, middle initial, last name)
Robert F. Forsyth, Major, TC, US Army, Project Officer/Pilot
Gerald Higley, SP 5, US Army, Project Engineer

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
July 1969	45	8

8a. CONTRACT OR GRANT NO b. PROJECT NO USAAVSCOM 67-23 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) USAASTA 67-23 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) N/A

10. DISTRIBUTION STATEMENT
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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Commanding Officer, US Army Aviation Materiel Laboratories, ATTN: SAVFE-SS, Fort Eustis, Virginia 23604

13. ABSTRACT

The engineering flight test of the OV-1 Hayes Infrared (IR) Suppression Kit installation was conducted at Edwards Air Force Base, California, from 23 January through 22 March 1968, by the US Army Aviation Systems Test Activity for the US Army Aviation Materiel Laboratories. The performance and flying qualities of the aircraft with the suppression kit installed was compared to that of the standard production aircraft. Additionally, the pressure loss, temperature rise, and vibration characteristics of the IR suppressor were measured. The performance and flying qualities of the OV-1 were not significantly affected by the suppression kit installation. Two deficiencies were detected during the test: exhaust gas blow-by between the engine shroud and the suppressor shroud adapter and high skin temperatures in the area where the suppression kit fairing joined the engine nacelle. The suppressor pressure, temperature and vibration data were forwarded to the US Army Aviation Material Laboratories for analysis in accordance with the US Army Aviation Systems Command's instructions.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
OV-1 Hayes IR Suppression Kit						
Performance						
Flying qualities						
Pressure						
Temperature						
Vibration						
Characteristics						
Not significantly affected						
Exhaust gas blow-by						
High skin temperatures						