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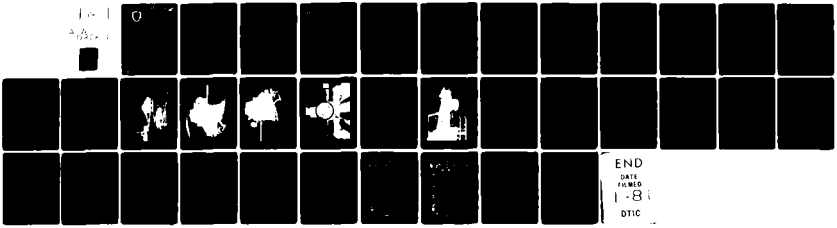

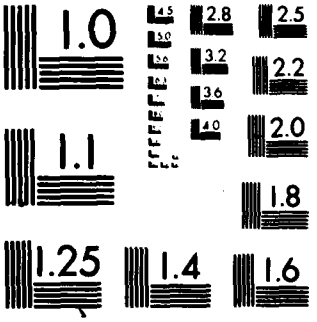

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USAAEFA PROJECT NO. 79-09

AD A092614

PRELIMINARY AIRWORTHINESS EVALUATION AH-1S (PROD) HELICOPTER EQUIPPED WITH A SUBSTITUTE STRAIGHT EXHAUST PIPE

FINAL REPORT

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

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Hot Metal Plus Plume (HMPP) Suppressor
Substitute Straight Exhaust Pipe

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

A limited performance and handling qualities evaluation and an engine and transmission cooling survey of an AH-1S (PROD) Helicopter equipped with a substitute straight exhaust pipe was performed at Edwards Air Force Base between 20 and 23 August 1979. A total of 8 hours, 6.3 of which were productive, was required. No significant changes in performance or handling qualities were found as a result of the substitute straight exhaust pipe installation. The engine and transmission cooling characteristics were similar to those of a production AH-1S and were satisfactory. No previously unreported shortcomings or deficiencies were identified.

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DEPARTMENT OF THE ARMY
HQ, US ARMY AVIATION RESEARCH AND DEVELOPMENT COMMAND
4300 GOODFELLOW BOULEVARD, ST. LOUIS, MO 63120

DRDAV-DI

23 JUL 1980

SUBJECT: Directorate for Development and Qualification Position on the Final Report of USAAEFA Project No. 79-09, Preliminary Airworthiness Evaluation AH-1S (PROD) Helicopter Equipped with a Substitute Straight Exhaust Pipe

SEE DISTRIBUTION

1. The purpose of this letter is to establish the Directorate for Development and Qualification position on the subject report. The evaluation was conducted to evaluate the suitability of a substitute straight exhaust pipe for production AH-1S helicopters as a result in delivery delays of the standard Hot Metal Plus Plume (HMPP) IR suppressors. The straight pipe characteristics were acceptable, as determined by the subject evaluation, and it was subsequently used so that production AH-1S helicopters could be functionally flight tested and thereby minimize delivery delays.

2. This Directorate agrees with the report findings and conclusions. Based on the test results, the AH-1S handling qualities and performance with the substitute straight pipe installed were not degraded and engine and transmissions temperatures were within acceptable limits.

FOR THE COMMANDER:

Charles C. Crawford

CHARLES C. CRAWFORD, JR.
Director of Development
and Qualification

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INTRODUCTION

BACKGROUND

1. The United States Army is under contract with Garrett AirResearch Manufacturing Company of California (GAMC) for the development of a hot metal plus plume (HMPP) suppressor for installation on the AH-1S (Prod) helicopter. The United States Army Aviation Engineering Flight Activity (USAAEFA) conducted a Preliminary Airworthiness Evaluation (PAE) of the AH-1S (Prod) helicopter with the HMPP suppressor installed in March 1978 (Reference 1, Appendix A). The suppressor will be provided to Bell Helicopter Textron (BHT) for installation on the AH-1S (Prod) helicopter as government furnished equipment. Qualification problems and delays in awarding a production contract have resulted in delivery delays of the suppressor to BHT. To minimize impact on BHT functional and acceptance flight testing and subsequently scheduled delivery of the AH-1S (Prod) helicopter, a substitute straight exhaust pipe was designed by GAMC and fabricated by Corpus Christi Army Depot. It is not expected that the Army will take actual delivery of the AH-1S (Prod) helicopter with the substitute straight exhaust pipe installed. In May 1979, the United States Army Aviation Research and Development Command (AVRADCOM) tasked USAAEFA to conduct a PAE on the AH-1S (Prod) helicopter with the substitute straight exhaust pipe installed (Reference 2, Appendix A) in accordance with the approved test plan (Reference 3, Appendix A). Heat damage to the test helicopter tailboom insulation and interior surface was detected during initial aircraft preparation for testing with the substitute straight exhaust pipe installed. This prompted conducting an unscheduled tailboom temperature survey (Project No. 79-14) which was conducted in July 1979 (Reference 7, Appendix A) prior to commencement of the substitute straight exhaust pipe evaluation.

TEST OBJECTIVES

2. The objectives of the PAE were as follows:

a. Conduct limited handling qualities testing to determine any significant variations attributable to installation of the substitute straight exhaust pipe.

b. Conduct limited performance testing to determine the change in level flight performance attributable to the substitute straight exhaust pipe installation.

c. Conduct a limited engine and transmission survey to evaluate their cooling characteristics with the substitute exhaust pipe installed.

DESCRIPTION

3. The AH-1S (Prod) helicopter is a tandem-seat, two-place helicopter with a two-bladed teetering main rotor and a two-bladed tractor tail rotor. The helicopter is powered by a Lycoming T-53-L-703 turboshaft engine derated from 1800 shaft horsepower (SHP) at sea-level standard-day conditions, to the main transmission torque limit of 1290 SHP. Distinctive features of the helicopter include a narrow fuselage, stub wings with four stores stations, a flat-plate canopy, and an infrared (IR) exhaust system. A more detailed description of the AH-1S (Prod) helicopter is presented in the Operator's Manual (Reference 4, Appendix A) with a description of the substitute straight exhaust pipe contained in Appendix B.

4. The production HMPP suppressor consists of three major components: an engine exhaust-duct assembly, an aft engine cowling, and a plug assembly. The substitute straught exhaust pipe replaces the plug assembly component and attaches to the test helicopter in the same manner and using the same hardware required for the production HMPP suppressor plug assembly installation. The AN/ALQ-144 IR jammer installed on the HMPP suppressor during USAAEFA Project No. 77-33 (Reference 1, Appendix A) was not installed during this evaluation.

TEST SCOPE

5. The PAE was conducted between 20 and 23 August 1979 at Edwards Air Force Base, California. Six flights were conducted for a total flight time of 8 hours, of which 6.3 hours were productive. Table 1 presents the general performance and handling qualities test conditions and Table 2 presents the results of the engine and transmission survey. The performance and handling qualities results were compared with the results contained in Reference 1, Appendix A. The helicopter engine cooling characteristics were tested for compliance with Lycoming Model Specification No. 104.43 for T53-L-703 engines, revised 15 October 1978 (Reference 5). Flight restrictions of the Operator's Manual and the airworthiness release (Reference 6) were observed throughout the test program.

TABLE 1. PERFORMANCE AND HANDLING QUALITIES TEST CONDITIONS[1]

TEST	AVERAGE DENSITY ALTITUDE (ft)	TRIM AIRSPEED (KCAS)[2]	CENTER OF GRAVITY LOCATION	CONFIGURATION	REMARKS
Level Flight Performance	7460 and 9100	40 to 134	FWD	Clean	Constant w/ δ and $N_v/\sqrt{\theta}$
Static Longitudinal Stability	6580 and 7280	66, 124	AFT	8-TOW	
Static Lateral-Directional Stability	5820	123	AFT	8-TOW	
Dynamic Stability	5000	65	FWD	Clean	Qualitative only

[1] Engine start gross weight = 10,000 lb
[2] KCAS = knots calibrated airspeed

TABLE 2. ENGINE AND TRANSMISSION COOLING SURVEYS TEST RESULTS

	OAT[1]/MAX TEMP RECORDED °F				TEMP CORRECTED TO 125° F AMBIENT[2]			
TEST	ENG COMP	IGN UNIT	TRANS OIL	ENG OIL	ENG COMP	IGN UNIT	TRANS[3] OIL	ENG[4] OIL
GROUND (100% RPM)	84/124	84/111	84/136	84/127	165	152	177	168
CLIMB	70/122	70/100	70/162	70/144	177	155	217	199
LEVEL FLIGHT	64/115	64/99	64/160	75/140	176	160	221	190
DESCENT	75/117	70/91	79/158	70/136	167	146	204	191
RAMP PRIOR TO SHUTDOWN	88/136	90/100	88/162	90/144	173	135	199	179

[1] OAT = outside air temperature
[2] Corrected temperature = test temperature + (125° - OAT)
[3] Max allowable temperature = 230° F
[4] Max allowable temperature = 199.4° F

TEST METHODOLOGY

6. Standard performance and handling qualities test techniques were employed (References 8 and 9). Prior to flight testing the aircraft, during the engine and transmission survey, the oil cooler thermostatic bypass valve in the engine oil cooling system was blocked closed to prevent oil cooler bypass flow. Temperatures were allowed to stabilize for a minimum of two minutes prior to recording temperature data. All temperature data were compared against specification requirements (Reference 5) and results of Reference 7. Data were recorded on magnetic tape in a pulse-code modulated format and manually on flight data cards. The instrumentation used is listed in Appendix C. The test techniques and data analysis methods are discussed in Appendix D.

RESULTS AND DISCUSSION

GENERAL

7. Limited performance and handling qualities tests, and an engine and transmission cooling survey were performed on an AH-1S (Prod) helicopter with a substitute straight exhaust pipe installed. The tests were conducted to determine the effects on the handling qualities, engine and transmission cooling characteristics, and performance of the AH-1S (Prod) helicopter with the substitute straight exhaust pipe installed. No change in handling qualities or performance was noted by the substitute straight exhaust pipe installation. The engine and transmission cooling characteristics are similar to those of a production AH-1S and are documented in Reference 7, Appendix A.

LEVEL FLIGHT PERFORMANCE

8. The level flight performance of the AH-1S (Prod) helicopter with substitute straight exhaust pipe installed was evaluated at the general conditions listed in Table 1. Level flight performance was flown, at thrust coefficients (C_T) of approximately 0.0052 and 0.0056. Results are presented in Figures 1 and 2, Appendix E. No change in equivalent flat plate area between the substitute straight exhaust pipe and the HMPP suppressor was apparent from a comparison of Figures 1 and 2 with data from Reference 10, Appendix A.

HANDLING QUALITIES

Control Positions in Trimmed Forward Flight

9. Control positions in trimmed forward flight were evaluated in conjunction with level flight performance tests at the conditions on Table 1. Test data are presented in Figures 3 and 4, Appendix E. The control positions in trimmed forward flight were not significantly affected by installation of the substitute straight exhaust pipe.

Static Longitudinal Stability

10. Static longitudinal stability characteristics were evaluated at the conditions listed in Table 1. Test techniques are described in Appendix D. The variation of control positions with airspeed is presented in Figures 5 and 6, Appendix E. A comparative evaluation of these curves with those of USAAEFA Project Report No. 77-33 at any given airspeed show a distinct similarity in gradient but a minor difference in control displacement for cyclic and pedal controls. The static longitudinal stability of the AH-1S (Prod) helicopter was not significantly affected by installation of the subsitute straight exhaust pipe and is satisfactory.

Static Lateral-Directional Stability

11. Static lateral-directional stability characteristics were evaluated at the conditions listed in Table 1, using the techniques described in Appendix D. Test results are presented in Figure 7, Appendix E. A comparative evaluation of this curve to that of Figure 23, USAAEFA Project Report No. 77-33, shows a distinct

similarity in gradient with a minor difference in control displacement. The static lateral-directional stability of the AH-1S (Prod) helicopter was not significantly affected by installation of the substitute straight exhaust pipe and is satisfactory.

Dynamic Stability

12. The lateral-directional (Dutch roll) characteristics were evaluated at the conditions listed in Table 1 using the techniques described in Appendix D. The lateral-directional oscillation observed was characterized by an approximately three-second period and a roll to yaw ratio of one to two. Damping of the lateral-directional oscillation was acceptable at all airspeeds tested. An annoying Dutch roll oscillation (reported in USAAEFA Project Report No. 77-33) was observed during initial testing, but was eliminated by changing the stability augmentation system (SAS) amplifier sensor box. Within the scope of this test, the dynamic stability characteristics of the AH-1S (Prod) helicopter with substitute straight exhaust pipe installed are satisfactory.

ENGINE AND TRANSMISSION COOLING SURVEY

13. An engine and transmission cooling survey of the AH-1S (Prod) with substitute straight exhaust pipe installed was conducted at the conditions listed in Table 2. Temperatures were obtained from thermocouples located as indicated in Appendix C and Reference 7, Appendix A. Engine and transmission temperatures were recorded during ground run, climb, level flight, descent, and prior to engine shutdown. Additional engine and transmission cooling data were obtained during an unscheduled tailboom temperature survey conducted on the test helicopter in July 1979 (Reference 7, Appendix A). During testing ambient temperatures ranged from 64° to 90° Fahrenheit (F). The engine compartment ambient temperature remained below 137° F, and the ignition unit box temperature was less than 112° F. Transmission oil (IN) temperature and engine oil (IN) temperature stabilized during all flights at approximately 160° and 140° F, respectively. All engine temperatures were below maximum allowable engine specification requirements (Reference 5, Appendix A) and below those reported in Reference 7. Within the scope of this test, AH-1S (Prod) helicopter substitute straight exhaust pipe allows adequate engine and transmission cooling.

CONCLUSIONS

GENERAL

14. No significant changes in performance, handling qualities, or engine and transmission cooling characteristics were found as a result of the substitute straight exhaust pipe installation. No previously unreported shortcomings or deficiencies were identified.

SPECIFICATION COMPLIANCE

15. The engine cooling characteristics of the AH-1S (Prod) helicopter with substitute straight exhaust pipe installed met the requirements of the engine specification (Reference 5, Appendix A).

RECOMMENDATIONS

16. The substitute straight exhaust pipe can be used in lieu of the HMPP suppressor during BHT functional and acceptance testing of the AH-1S (Prod) helicopter.

APPENDIX A. REFERENCES

1. Final Report, United States Army Aviation Engineering Flight Activity (USAAEFA), Project No. 77-33, *Preliminary Airworthiness Evaluation of the AH-1S Helicopter Equipped with a Garrett Infrared Radiation Suppressor and AN/ALQ-144 Jammer*, May 1978.

2. Test Request, Aviation Research and Development Command (AVRADCOM), DRDAV-EQ, 2 May 1979, subject: Preliminary Airworthiness Evaluation of the AH-1S Substitute Straight Exhaust Pipe.

3. Test Plan, USAAEFA, Project No. 79-09, *Preliminary Airworthiness Evaluation AH-1S Helicopter with Substitute Straight Exhaust Pipe*, May 1979.

4. Technical Manual, TM 55-1520-236-10, *Operator's Manual, Army Model AH-1S (Prod) Helicopter*, 29 April 1977, with changes 1 through 5.

5. Engine Specification, Lycoming Model Specification No. 104.43, *T53-L-703 Engine*, revised 15 October 1978.

6. Letter, AVRADCOM, DRDAV-EQ, 3 August 1979, subject: Airworthiness Release for Preliminiary Airworthiness Evaluation (PAE) of JAH-1S Helicopter SN 76-22573 Equipped with a Garrett Hot Metal Plus Plume Suppressor Cowling and a Straight Exhaust Pipe, USAAEFA Project No. 79-09.

7. Letter Report, USAAEFA, Project No. 79-14, *AH-1S Helicopter Tailboom 3-Way Temperature Survey*, 4 October 1979.

8. Flight Test Manual, Naval Air Test Center, FTM No. 102, *Helicopter Performance Testing*, 28 June 1968.

9. Flight Test Manual, Naval Air Test Center, FTM No. 101, *Helicopter Stability and Control*, 10 June 1968.

10. Final Report, USAAEFA, Project No. 77-38, *Production Validation Test - Government Kaman K747 Improved Main Rotor Blade*, (Unpublished).

APPENDIX B. DESCRIPTION

GENERAL

1. The test helicopter, U.S. Army SN 76-22573, was an AH-1S (Prod) modified to accommodate the infrared (IR) suppressor. The principal structural modification was the redesign of the cowling which provided support for the IR suppressor. Photos 1 through 4 show the test helicopter with the substitute straight exhaust pipe installed.

IR SUPPRESSOR SYSTEM

2. The IR suppressor system consisted of three major components: the cowling assembly, the exhaust duct, and the substitute straight exhaust pipe. The substitute pipe replaced the plug-typed IR suppressor used on the Hot Metal Plus Plume (HMPP) suppressor during USAAEFA Project No. 77-23 (Reference 1, Appendix A). The substitute pipe was attached to the test helicopter in the same manner and using the same hardware as the HMPP suppressor.

Photo 1. AH-1S with Substitute Straight Exhaust Pipe Installed

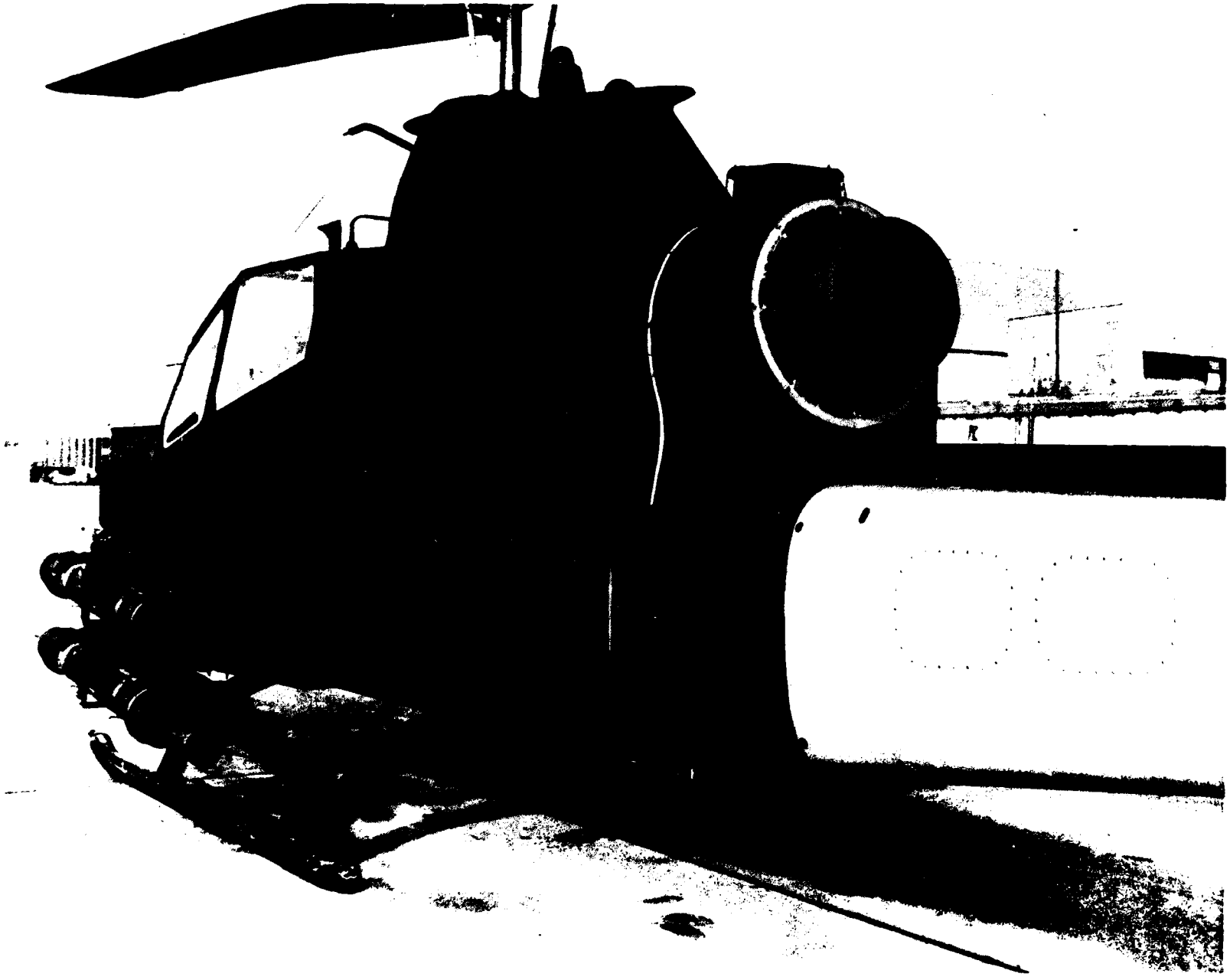


Photo 2. Left View of Substitute Straight Exhaust Pipe

Photo 3. Right Rear View of Substitute Straight Exhaust Pipe

Photo 4. Rear View of Substitute Straight Exhaust Pipe

APPENDIX C. INSTRUMENTATION

1. Test instrumentation was installed, calibrated, and maintained by USAAEFA personnel. The main instrumentation package (Photo 1) was located in the ammunition compartment area (FS 115) and a visual display located in the engineer flight station (FS 60) provided temperature parameters onboard the aircraft. Thermocouples were located in the engine compartment and on the tailboom and were manually recorded in the cockpit by the flight engineer. The engine torquemeter calibration is shown in Figure 1. Boom airspeed system calibration is shown in Figure 2.

2. The following test instrumentation and special equipment were installed:

Pilot Panel

Airspeed (boom)
Altitude (boom)
Rate of climb (boom)
Rotor speed (test)
Engine torque
Engine gas producer speed
Engine turbine gas temperature
Free air temperature
Angle of sideslip
Event Switch

Copilot Panel

Airspeed (boom)
Altitude (boom)
Rotor speed (test)
Engine torque (test)
Engine gas producer speed
Engine turbine gas temperature
Free air temperature (test)
Fuel used
Run number
Time code display
Instrumentation control
Event switch
Cable tension

Thermocouples:

Engine compartment (right hand side aft firewall)
Ignition unit skin (between lower support clamp and ignition box)
Transmission oil "in" (one inch upstream of standard transmission oil thermocouple)
Engine oil "in" (same location as standard engine oil thermocouple)
Approximate boom station 63 (inside skin left and right)
Approximate boom station 80.4 (inside skin left and right)
Approximate boom station 95 (inside skin left and right)

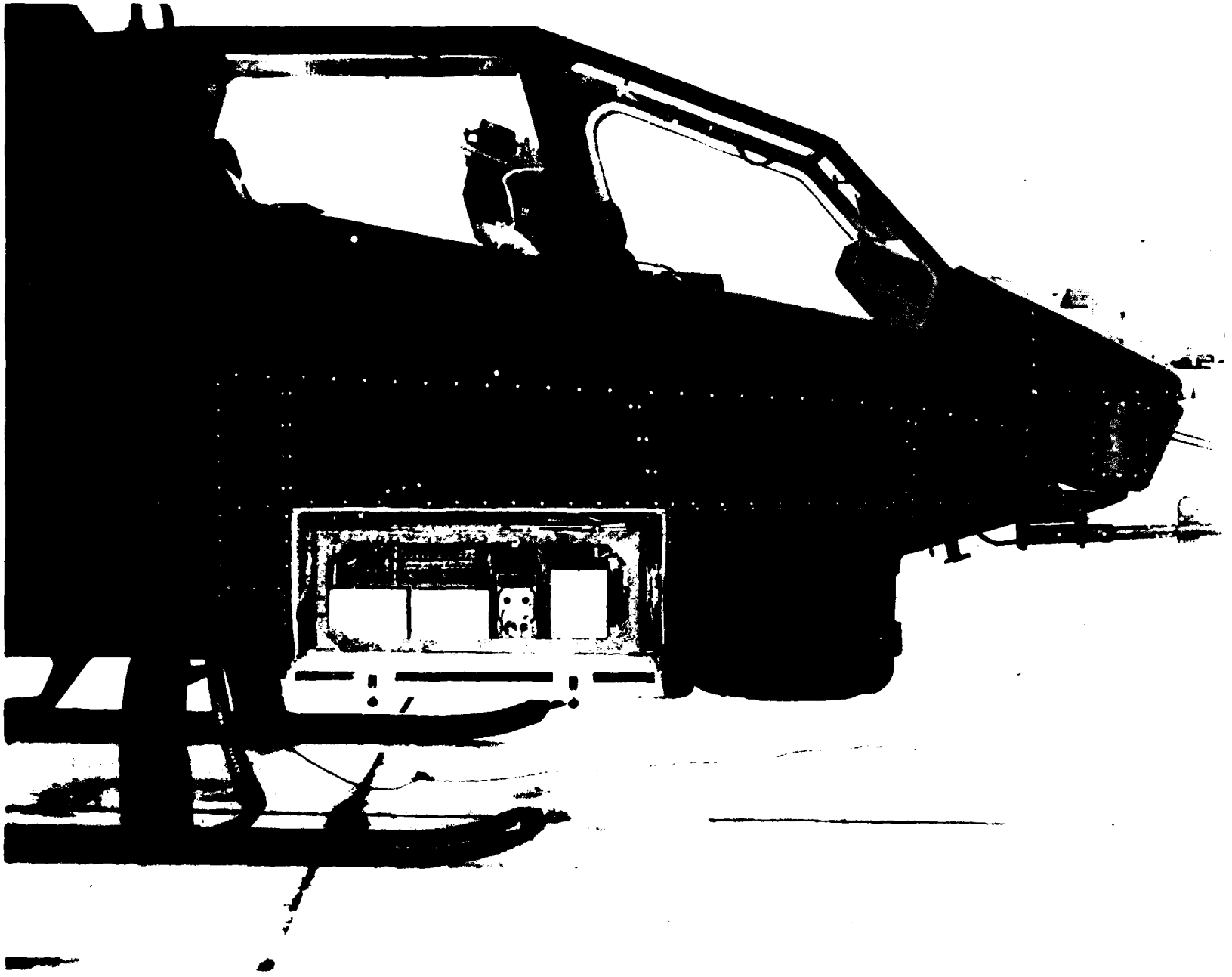


Photo 1. PCM Instrumentation Package in Ammunition Bay

FIGURE 1
ENGINE TORQUEMETER CALIBRATION
AH-1S USA S/N 76-22573
LYCOMING ENGINE MODEL T53-L-703 SN 13145Z

NOTE: 1. TORQUEMETER CALIBRATION DATA PROVIDED BY LYCOMING BASED ON TEST CONDUCTED 13 JULY 1978.

2. N_p - 6604 RPM

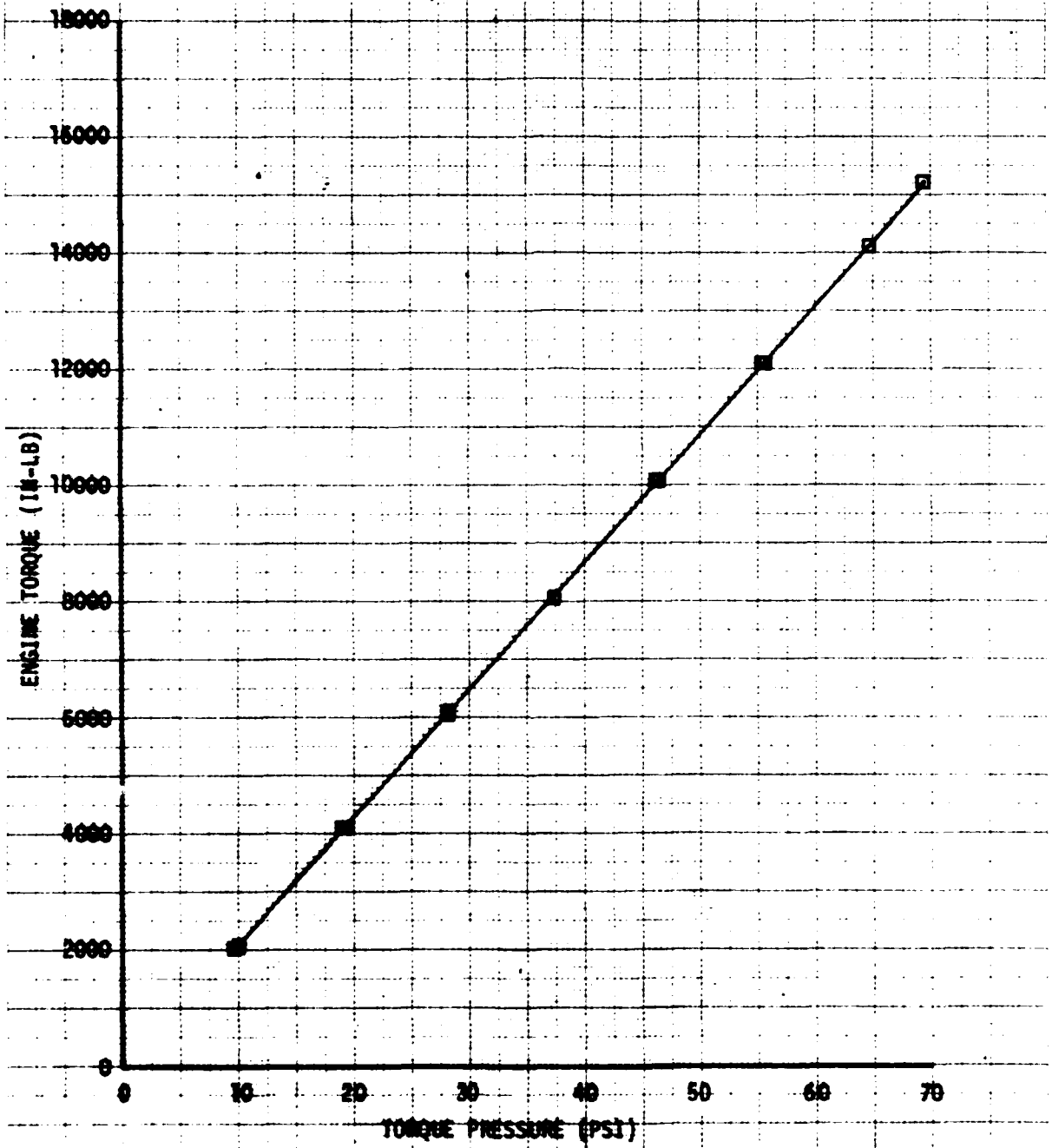
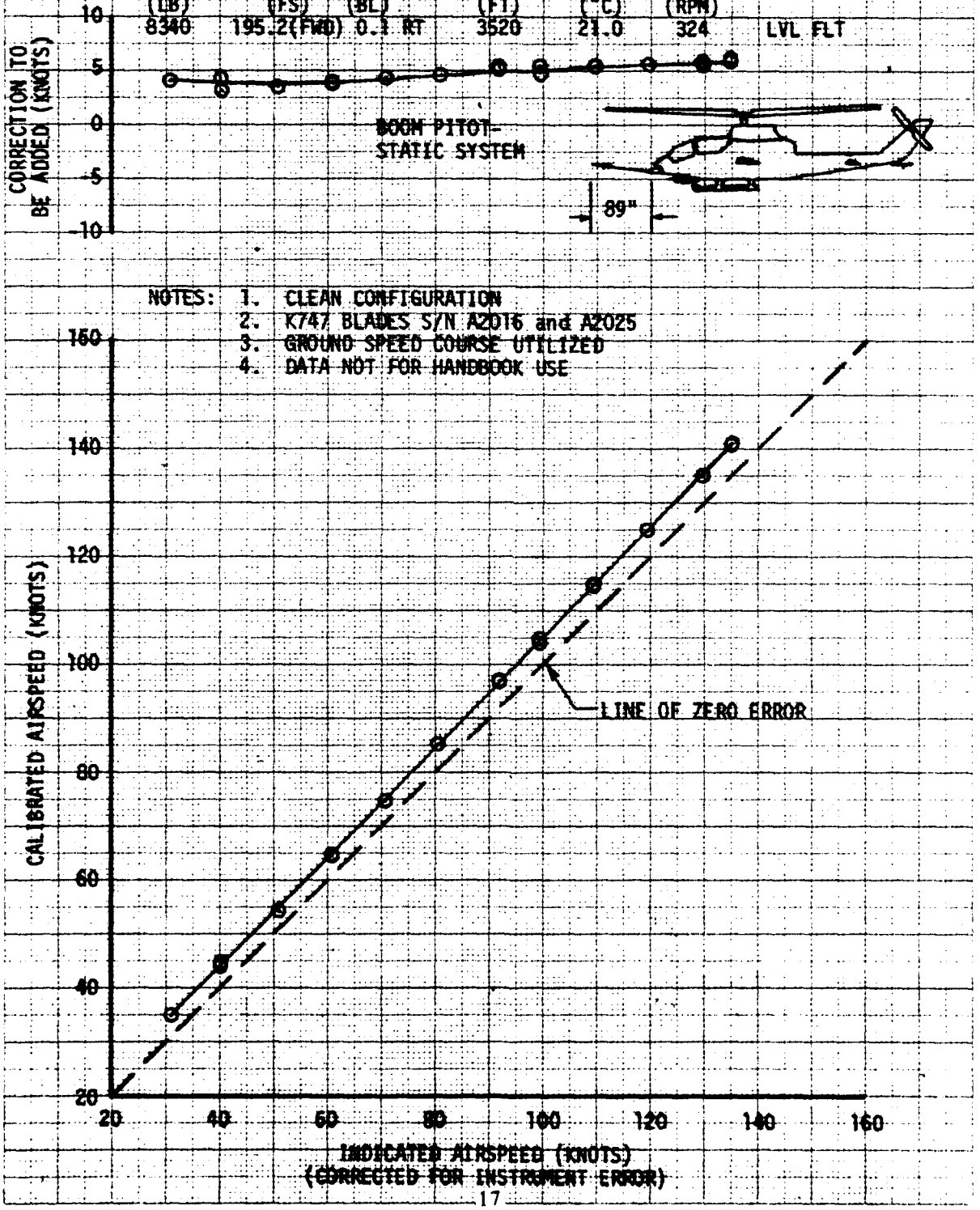


FIGURE 2
BOOM AIRSPEED CALIBRATION
AH-1S USA S/N 76-22573

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALTITUDE (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	TRIM FLIGHT CONDITION
8340	195.2(FWD)	0.1 RT	3520	21.0	324	LVL FLT



Approximate boom station 80.4 (outside skin right)
Approximate boom station 115 (inside skin left and right)
Approximate boom station 135 (inside left and right)
Approximate boom station 155 (inside left and right)
Approximate boom station 175 (inside left and right)

Magnetic Tape

Time code
Run number
Event
Airspeed (boom)
Altitude (boom)
Total air temperature
Rotor RPM
Fuel used
Fuel temperature
Engine torque
Engine turbine gas temperature
Engine gas producer speed (N_1)
Engine output shaft speed (N_2)
Control Positions
- Longitudinal
- Lateral
- Directional
- Collective

Angle of attack
Angle of sideslip

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

GENERAL

1. Conventional test techniques were used in the tests. Detailed descriptions of all test techniques are contained in References 8 and 9, Appendix A, except where referred to in the following paragraphs.

LEVEL FLIGHT PERFORMANCE

2. Each level flight performance flight was designed to obtain one curve of C_P versus μ at a constant value of C_T. The flight technique was to stabilize at zero sideslip at incremental airspeeds from approximately 40 knots indicated airspeed (KIAS) to the maximum level flight airspeed attainable. At each test condition, torque, altitude, airspeed, and rotor speed were held constant for at least one minute prior to recording data. Altitude was increased between data points as a function of fuel burnoff in order to maintain a constant ratio of gross weight to air pressure ratio (w/δ). Also, main rotor speed (N) was varied as a function of ambient air temperature in order to maintain a constant ratio of main rotor speed to the square root of the air temperature ratio ($N/\sqrt{\theta}$).

3. The nondimensional coefficients listed below were used to generalize the level flight performance data obtained during this evaluation.

a. Coefficient of power (C_P):

$$C_P = \frac{SHP \times 550}{\rho A(\Omega R)^3} \qquad \text{(D-1)}$$

b. Coefficient of thrust (C_T):

$$C_T = \frac{GW}{\rho A(\Omega R)^2} \qquad \text{(D-2)}$$

c. Advance ratio (μ):

$$\mu = \frac{1.6878V_T}{\Omega R} \qquad \text{(D-3)}$$

d. Advancing blade tip mach number (M_{tip}):

$$M_{tip} = \frac{1.6878V_T + (\Omega R)}{a} \qquad \text{(D-4)}$$

Where:

SHP = Engine output shaft horsepower

550 = Conversion factor (ft lb/sec/SHP)

ρ = Air density (slug/ft^3)

A = Main rotor disc area (ft^2)

Ω = Main rotor angular velocity (radian/sec)

R = Main rotor radius (ft)

GW = Aircraft gross weight (lb)

V_T = True airspeed (kt)

a = Speed of sound (ft/sec)

1.6878 = Conversion factor (ft/sec/kt)

Calibrated airspeed was obtained by correcting indicated airspeed for position error using Figure 2, Appendix C. True airspeed was calculated using calibrated airspeed (V_{CAL}) and density ratio (σ) as follows:

$$V_T = V_{CAL}/\sqrt{\sigma} \qquad \text{(D-5)}$$

Where:

$\sigma = \rho/.0023769$

4. Engine output shaft torque was determined from the engine manufacturer's differential torque pressure system. The relationship of measured differential torque pressure (psi) to engine output shaft torque (in lb) is illustrated in Figure 2, Appendix C. The output SHP was determined from the engine output shaft torque and rotational speed by the following equation:

$$SHP = 20.38362 \times N_R \times Q \times 1.586663 \times 10^{-5} \qquad \text{(D-6)}$$

Where:

N_R = Rotor shaft rotational speed (RPM)

20.38362 = Gear ratio of transmission

1.586663×10^{-5} = Conversion factor (SHP/RPM/in lb)

SHP = Shaft horsepower

Q = Engine output shaft torque (in lb)

5. By rearrainging equation 2 as follows:

$$C_T = \frac{GW/\delta}{\rho_0 A(\frac{\pi R}{30})^2(\frac{N}{\sqrt{\theta}})^2}$$

It can be seen that C_T will be constant if GW/δ and $N/\sqrt{\theta}$ are constant. During these tests, the target GW/δ was different for each flight, but the target $N/\sqrt{\theta}$ was 324 RPM for all flights. The reason for maintaining constant $N/\sqrt{\theta}$ was to minimize the difference in compressability effects between flights.

6. Test-day level flight power was corrected to standard-day conditions by assuming the test-day dimensionless parameters C_{P_t}, C_{T_t}, and μ_t are independent of atmospheric conditions. Consequently, the standard-day dimensionless parameters C_{P_s}, C_{T_s}, and μ_s, are identical to C_{P_t}, C_{T_t}, and μ_t, respectively. From the definition of equation 1, the following relationship can be derived:

$$SHP_s = SHP_t \frac{\rho_s}{\rho_t} (\frac{\Omega_s}{\Omega_t})^3$$

Where:

SHP = Engine output shaft horsepower

μ = Air density

t = Test day

s = Standard day

Ω = Main rotor angular velocity (rad/sec)

ENGINE AND TRANSMISSION COOLING CHARACTERISTICS

7. Engine and transmission temperatures were recorded during ground run, climb, level flight, descent, and prior to engine shutdown. Temperatures were recorded on all flights at these conditions. The maximum temperature at each condition is presented in Table 2 and corrected to 125° F with the following equation:

Tcorrection = Tmax + (125°F - OAT)

APPENDIX E. TEST DATA

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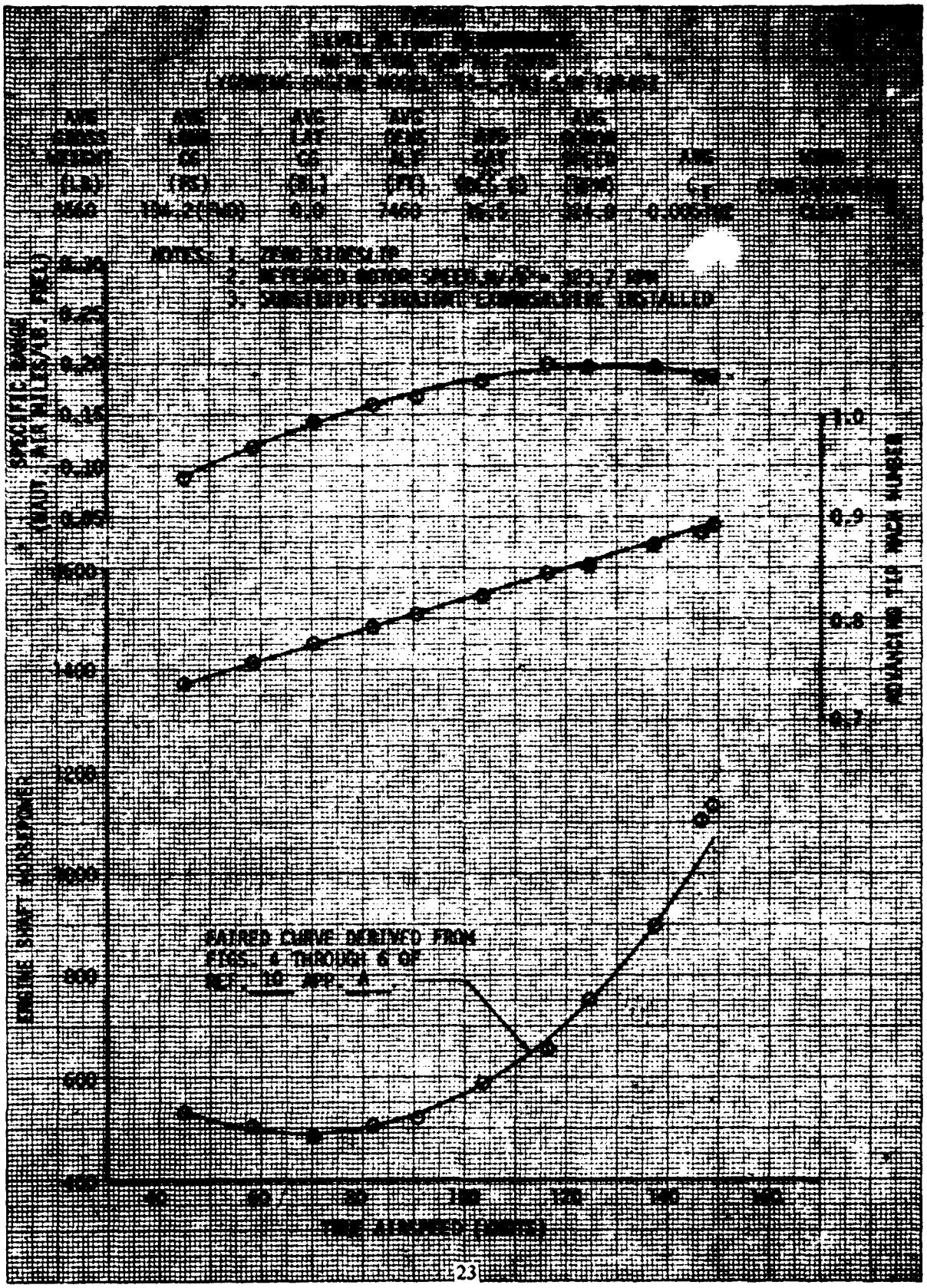


AVG GROSS WEIGHT (LB)
AVG LONG CG (PS)
AVG LAT CG (BL)
AVG DENS ALT (FT)
AVG GAT (DEG C)
AVG ROTOR SPEED (RPM)
AVG C_T
NOTES: 1. ZERO SIDESLIP
2. REFERRED MOTOR SPEED
3. SUBSTITUTE SIMULATOR EXPANSIVE INSTALLED
SPECIFIC RANGE (NAUT. AIR MILES/LB. FUEL)
ENGINE SHAFT HORSEPOWER
ADVANCING TIP MACH NUMBER
FAIRED CURVE DERIVED FROM FIGS. 4 THROUGH 6 OF REF. 10 APP. A
TRUE AIRSPEED (KNOTS)

FIGURE 2
LEVEL FLIGHT PERFORMANCE
AH-1S USA 76-22579
LYCOMING ENGINE MODEL T53-L-703 S/N 131452

AVG GROSS WEIGHT (LB)	AVG LONG CG (FS)	AVG LAT CG (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)	AVG C_T	WING CONFIGURATION
8560	194.2(FWD)	0.0	9100	19.0	324.0	0.005596	CLEAN

NOTES: 1. ZERO SIDESLIP
2. REFERRED ROTOR SPEED, $N/\sqrt{\theta}$ = 321.8 RPM
3. SUBSTITUTE STRAIGHT EXHAUST PIPE INSTALLED.

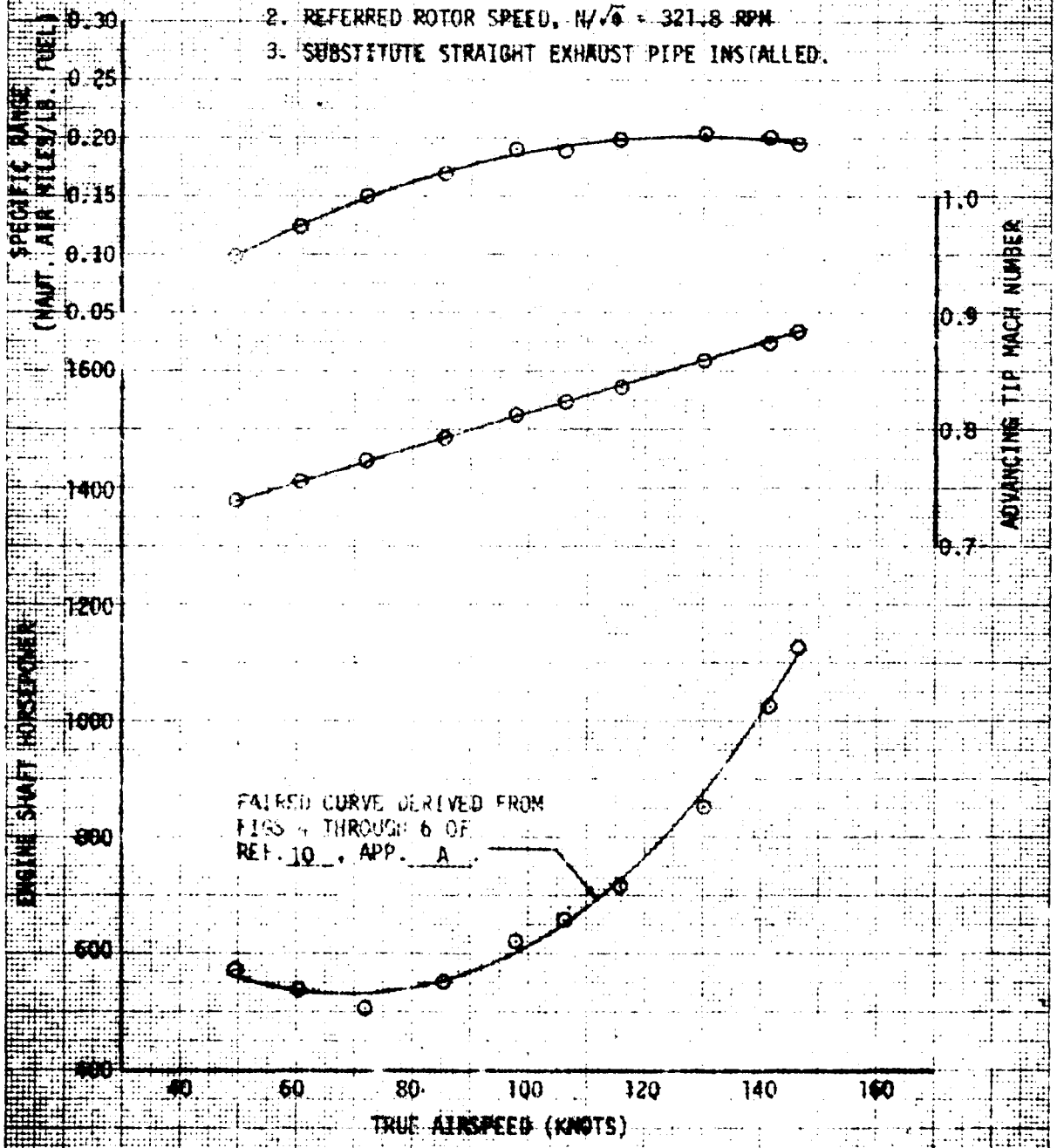
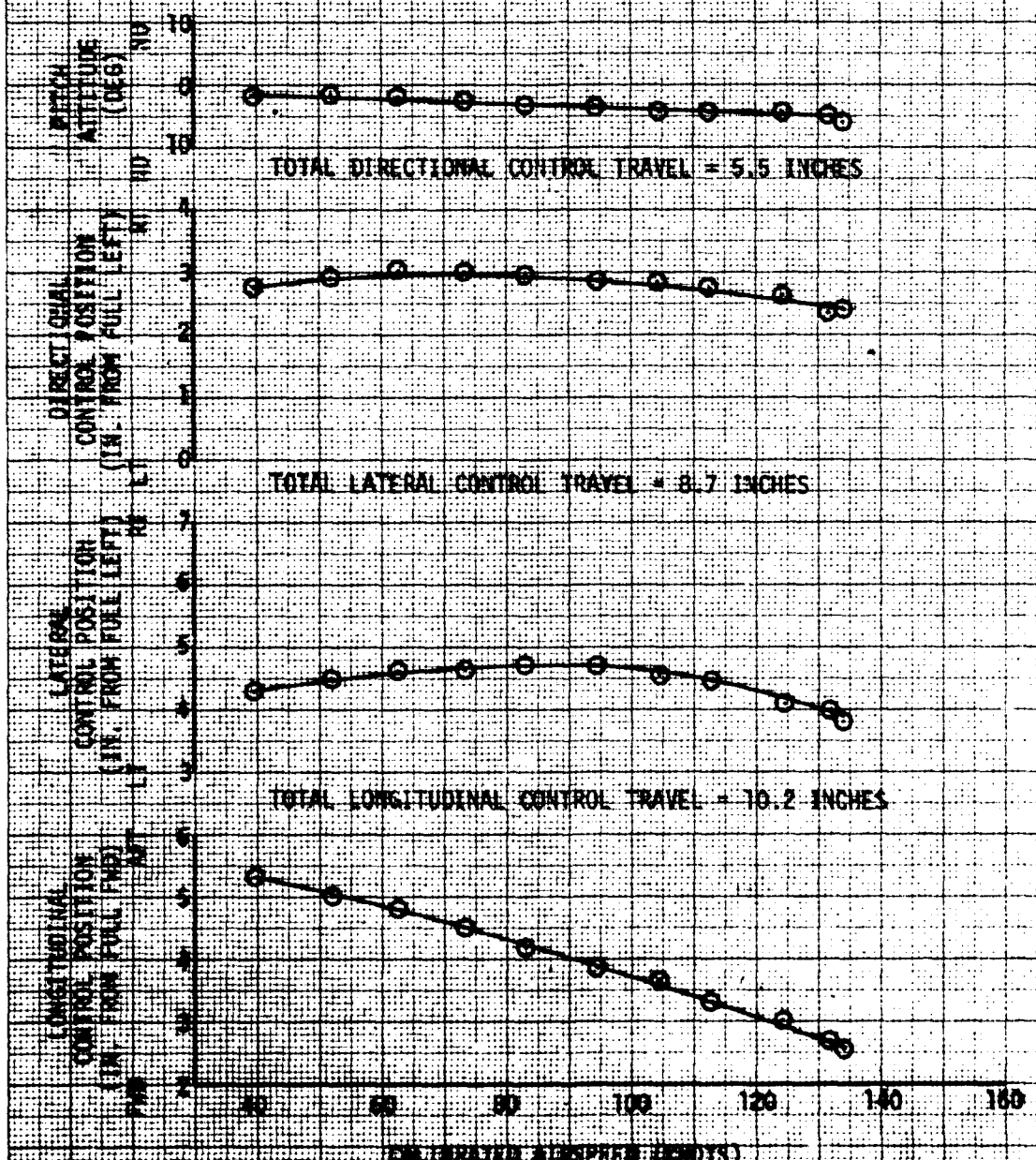


FIGURE 3
CONTROL POSITIONS IN TRIMMED FORWARD FLIGHT
AH-1S USA S/N 76-22573

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALT (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	WING CONFIGURATION
8660	194.2(FWD)	0.0	7460	15.5	324	CLEAN

SUBSTITUTE STRAIGHT EXHAUST PIPE INSTALLED



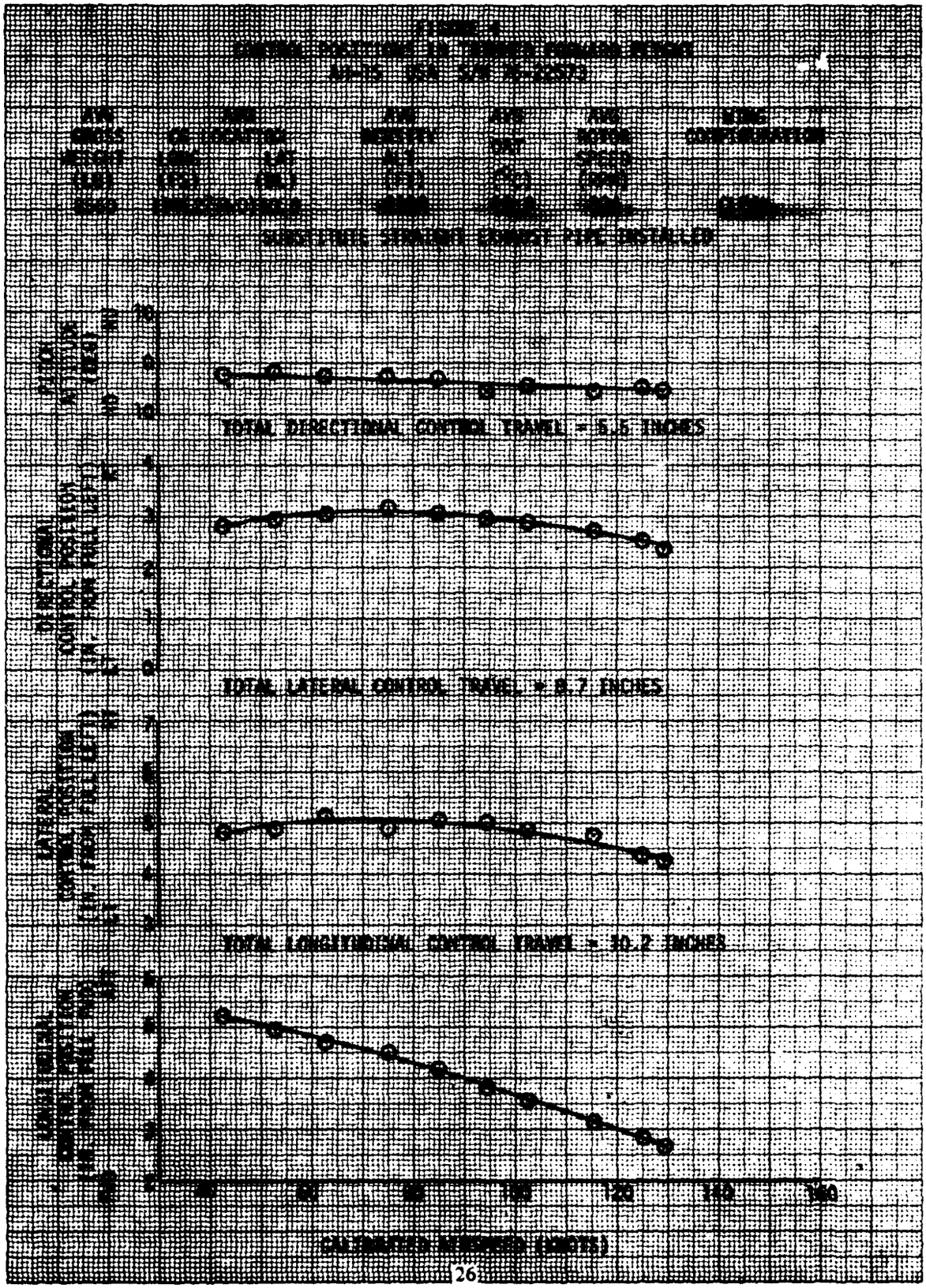

TOTAL DIRECTIONAL CONTROL TRAVEL = 5.5 INCHES
TOTAL LATERAL CONTROL TRAVEL = 8.7 INCHES
TOTAL LONGITUDINAL CONTROL TRAVEL = 10.2 INCHES

FIGURE 5
COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY
AH-1S USA S/N 76-22573

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALT (FT)	AVG OAT (°C)	AVG MOTOR SPEED (RPM)	TRIM FLIGHT CONDITION	SCAS [illegible]	WING [illegible]
9220	197.1(MID)	0.1 (RT)	6580	22.0	324	LEVEL	ON	B-TOW

NOTES: 1. SHADED SYMBOL DENOTES TRIM
2. SUBSTITUTE STRAIGHT EXHAUST PIPE INSTALLED

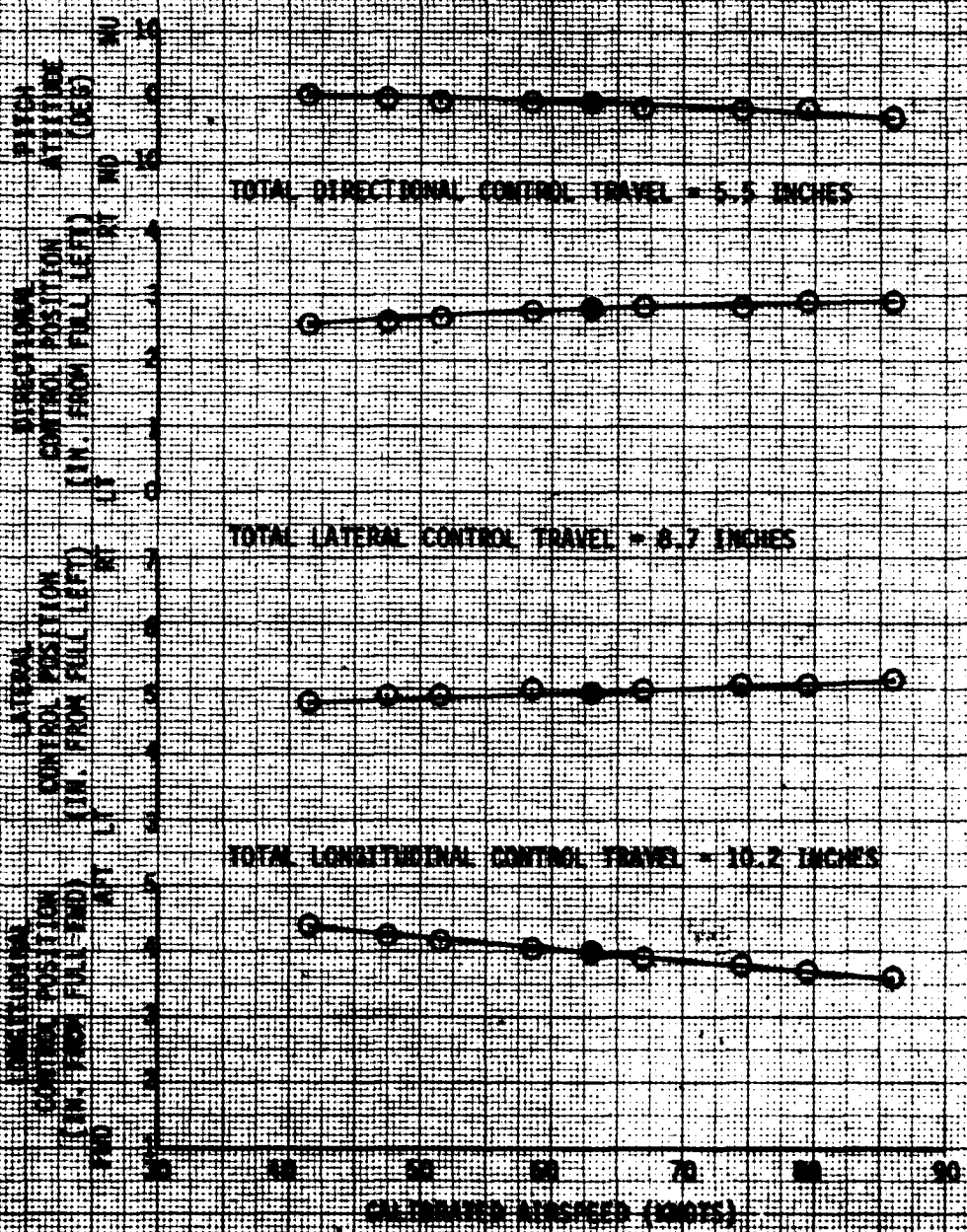
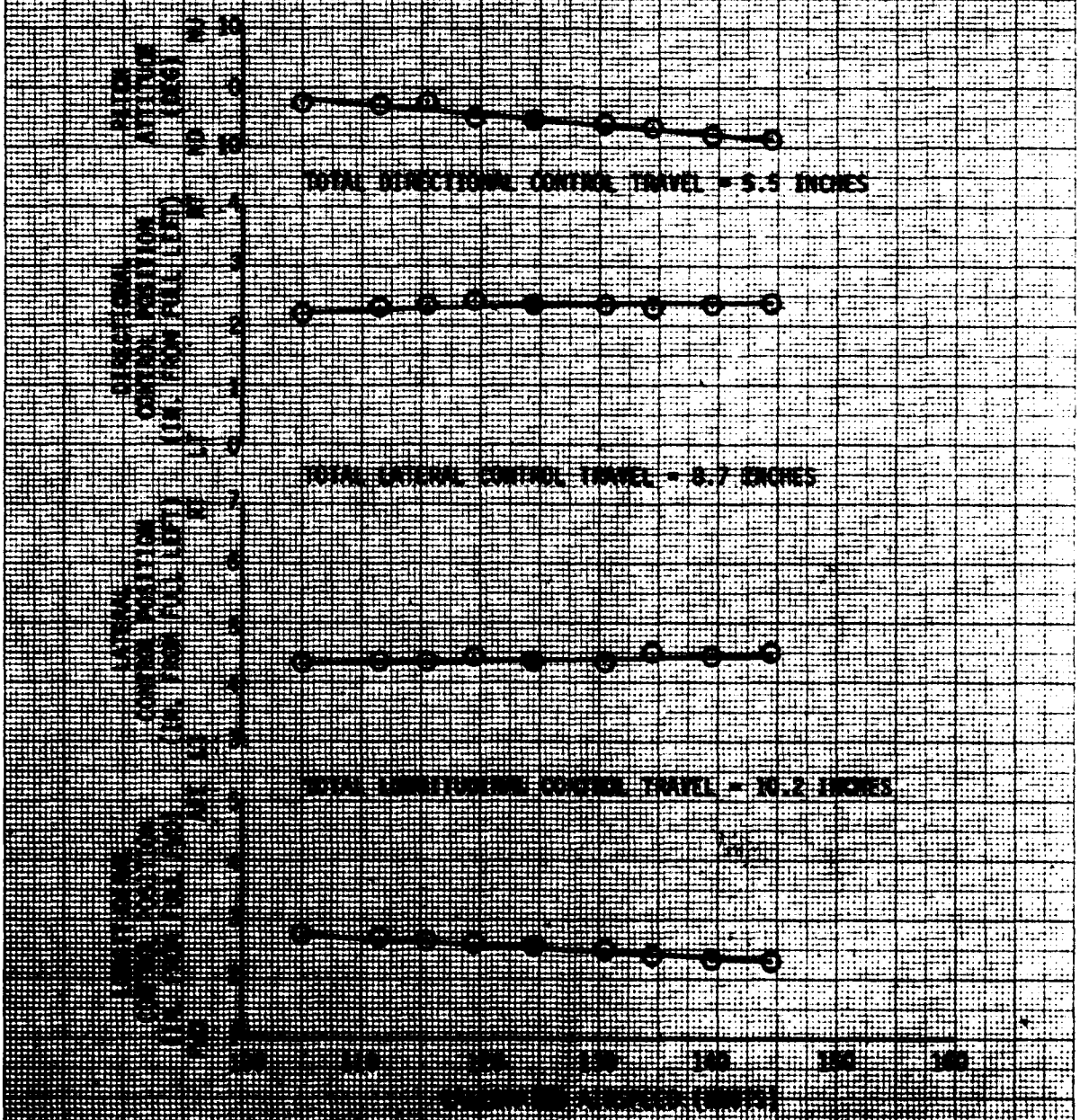
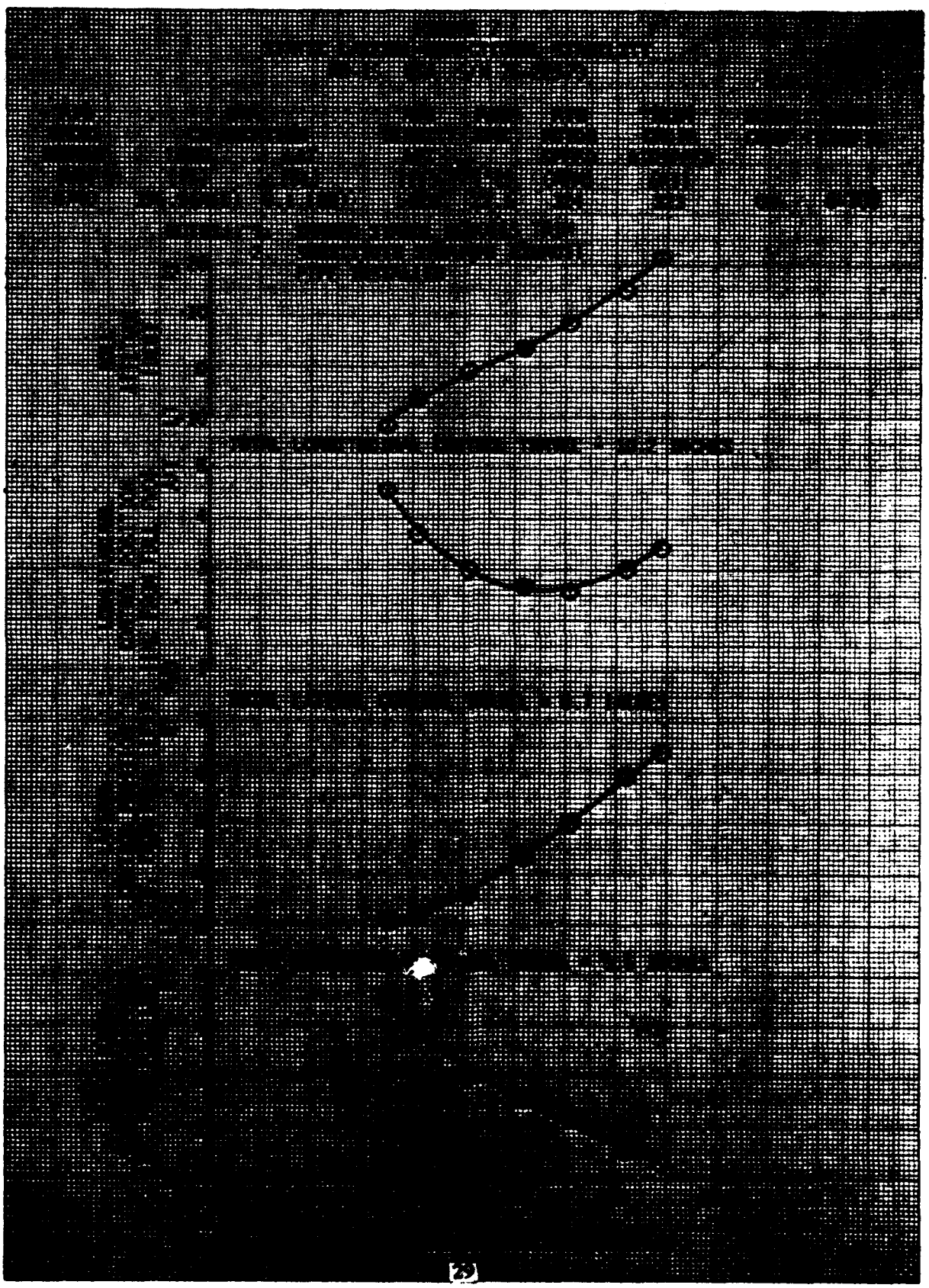


FIGURE 6
COLLECTIVE-FIXED STATIC LONGITUDINAL STABILITY
AH-1S USA S/N 76-22573

AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENSITY ALT (FT)	AVG OAT (°C)	AVG ROTOR SPEED (RPM)	TRIM FLIGHT CONDITION	SCAS COND	WING CONFIG
6960	197.0(AFT)	0.1 (RT)	7200	21.0	324	LEVEL	ON	0-TOW

NOTES: 1. SHADED SYMBOL DENOTES TRIM
2. SUBSTITUTE STRAIGHT EXHAUST PIPE INSTALLED





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