USAAEFA PROJECT NO. 82-09

AD-A148 676

PRELIMINARY AIRWORTHINESS EVALUATION OF UH-60A WITH AN IMPROVED AIRSPEED SYSTEM

MARVIN L. HANKS
MAJ, CE
PROJECT OFFICER/PILOT

ROBERT MacMULLIN
CPT, AR
PROJECT PILOT

GARY L. SKINNER
PROJECT ENGINEER

APRIL 1983

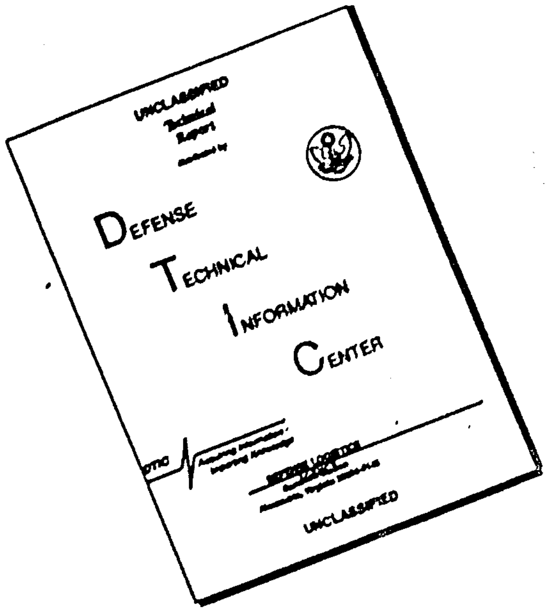
FINAL REPORT

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

84 12 11 081

USAAEFA

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

DISCLAIMER NOTICE

The findings of this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

DISPOSITION INSTRUCTIONS

Destroy this report when it is no longer needed. Do not return it to the originator.

TRADE NAMES

The use of trade names in this report does not constitute an official endorsement or approval of the use of the commercial hardware and software.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER USAAEFA PROJECT NO. 82-09	2. GOVT ACCESSION NO. AD-A148 676	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PRELIMINARY AIRWORTHINESS EVALUATION OF UH-60A WITH AN IMPROVED AIRSPEED SYSTEM		5. TYPE OF REPORT & PERIOD COVERED 5 OCT 1982 - 21 APR 83 FINAL
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) MARVIN L. HANKS ROBERT MACMULLIN GARY L. SKINNER		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US ARMY AVN ENGINEERING FLIGHT ACTIVITY EDWARDS AIR FORCE BASE, CA 93523		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 68-3BE109-01-68-EC
11. CONTROLLING OFFICE NAME AND ADDRESS US ARMY AVN RESEARCH & DEVELOPMENT COMMAND 4300 GOODFELLOW BOULEVARD ST. LOUIS, MO 63120		12. REPORT DATE APRIL 1983
		13. NUMBER OF PAGES 157
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Preliminary Airworthiness Evaluation
UH-60A (Black Hawk) Helicopter
Airspeed System Characteristics
Handling Qualities
Modified Overhead Configuration

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

The United States Army Aviation Engineering Flight Activity supported a contractor engineering effort to correct the nose-down pitch-over during takeoff and the large, variable position error in the low-speed flight regime of the UH-60A (Black Hawk) helicopter. A Preliminary Airworthiness Evaluation was then conducted with the improved airspeed and stabilator systems in their final configuration as defined by the contractor. Handling qualities and airspeed system characteristics were evaluated for two modified overhead and one nose probe configuration. In addition, airspeed system tests were

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) conducted on a second nose probe configuration. Testing was performed from 5 October 1982 through 21 April 1983 at Edwards Air Force Base, California (elevation 2302 feet). Sixty-four flights in 31 different test combinations were flown on the test aircraft (US Army serial number 77-22716) for a total of 66.2 productive flight hours. Based on the modified overhead probe systems tested, the takeoff handling characteristics of the clean UH-60A helicopter were improved from the standard production aircraft installation and were acceptable for all gross weights and centers-of-gravity tested, although longitudinal control, stabilator angle, and indicated airspeed reversals were annoying. Pilot workload to maintain an airspeed in high power, low airspeed climbs was significantly reduced in the modified overhead probe systems compared to the production helicopter. In addition, the ship airspeed position error was satisfactory, except during high power climbs. The takeoff pitch-over characteristic was essentially eliminated with the installation of a centerline nose pitot-tube referenced to cabin static and connected to the stabilator, although the system was not fully developed and program constraints prevented further testing. Four shortcomings applicable to the modified overhead probe systems were identified as follows: (1) the annoying longitudinal control, stabilator angle, and indicated airspeed reversals resulting in pitch attitude oscillations during takeoff (upgraded from a deficiency in the standard production aircraft); (2) the high pilot workload required to maintain precise airspeed during transitions to high power, low airspeed climbs; (3) the large, variable airspeed position errors and (4) unreliable airspeed indications in low airspeed, high power climbs. For the modified overhead probe systems the following should be accomplished: (1) evaluate the proposed installation on the External Stores Support System UH-60 helicopter, and (2) evaluate the proposed installation on an extremely light gross weight UH-60 helicopter.

DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY AVIATION SYSTEMS COMMAND
4300 GOODFELLOW BOULEVARD, ST. LOUIS, MO 63120-1798

REPLY TO
ATTENTION OF

DRSAV-ED

SUBJECT: Directorate for Engineering Position on the Final Report of USAAEFA Project No. 82-09, Preliminary Airworthiness Evaluation of UH-60A with an Improved Airspeed System

SEE DISTRIBUTION

1. The purpose of this letter is to establish the Directorate for Engineering position on the subject report. The evaluation was conducted jointly by the US Army Aviation Engineering Flight Activity (USAAEFA) and Sikorsky Aircraft, with the objective of improving the nose-down pitch-over and longitudinal control reversal during takeoff, and the large variable position error in low-speed flight. The nose-down pitch-over was identified in USAAEFA Project No. 77-17, Airworthiness and Flight Characteristics Evaluation, UH-60A (Black Hawk) helicopter as a deficiency. Reconfiguration and extensive testing of the airspeed and stabilator systems was conducted to optimize an improved configuration for all gross weight and center of gravity conditions. USAAEFA exercised responsibility for the flight testing, while the contractor had design engineering responsibility for the configuration. Five airspeed system configurations, including hardware and software, and stabilator program changes were evaluated.

2. The PAE 2 configuration, as defined in Appendix B of the report, results in the best compromise of airspeed system performance while minimizing aircraft modifications, and is the one recommended for incorporation in the production UH-60A. The previously reported deficiencies with the current production system, although not totally eliminated, are reduced to shortcomings, and are considered acceptable for field use.

3. This Directorate agrees with the report Conclusions and Recommendations with one exception, incorporation of the CAUTION with regard to stabilator placard exceedance. The exceedance is minor, and occurs during a rapid push-over acceleration from low speed. The placard limits were initially established with a safety margin that allows for this type of temporary exceedance. Also, the report indicates no adverse handling characteristics were noted during the

DRSAV-ED
SUBJECT: Directorate for Engineering Position on the Final Report of USAAEFA Project No. 82-09, Preliminary Airworthiness Evaluation of UH-60A with an Improved Airspeed System

acceleration. Incorporation of a CAUTION in the Operator's Manual would cause unnecessary precaution by the crew. The recommended CAUTION should therefore not be incorporated in the Operator's Manual.

FOR THE COMMANDER:

RONALD E. GORMONT
Acting Director of Engineering

TABLE OF CONTENTS

INTRODUCTION

BACKGROUND

1. Previous flight evaluations identified two significant problems with the production UH-60A airspeed system. The first problem was a noticeable nose down trim change and pitch oscillation which was particularly evident during slow acceleration takeoffs in the speed range from 50 to 70 knots indicated airspeed (KIAS). An indicated airspeed reversal occurred, driving the stabilator trailing edge down, resulting in a nose down pitching moment. The second problem, a position error variation with aircraft angle of attack, occurred in stabilized flight and resulted in large position errors in the low airspeed flight regime. These problems are aggravated on the UH-60 equipped with the External Stores Support System (ESSS). The US Army Aviation Engineering Flight Activity (USAAEFA) was tasked by the US Army Aviation Research and Development Command (AVRADCOM) (ref 1, app A) to support a contractor flight test effort to correct these problems, then conduct a Preliminary Airworthiness Evaluation (PAE) on the resulting modified configuration for the standard Black Hawk.

TEST OBJECTIVES

2. The objectives of this test were to:

a. Provide the necessary support to the contractor during contractor flight testing and optimization of the UH-60A airspeed system to correct identified problems.

b. Conduct a PAE of the UH-60A with the improved airspeed systems in their final configuration as defined by the contractor.

DESCRIPTION

3. The UH-60A is a twin engine, single main rotor configured helicopter with nonretractable wheel-type landing gear. A moveable, programmable horizontal stabilator is located on the lower portion of the tail rotor pylon. The main and tail rotor are both four-bladed with the capability of manual main rotor blade and tail pylon folding. The cross-beam tail rotor with composite blades is attached to the right side of the pylon and canted 20 degrees upward from the horizontal. Primary mission gross weight is 16,260 pounds (lb), maximum alternate gross weight is 20,250 lb, and special mission gross weight is 22,000 lb. The UH-60A is powered by two General Electric (GE) T700-GE-700 turboshaft engines having an installed power available (30 minute

limit) of 1553 shaft horsepower (shp) each at sea level, standard-day static conditions. Installed dual-engine power is transmission limited to 2828 shp. The aircraft incorporates an automatic flight control system (AFCS) and a command instrument system. The test helicopter, UH-60A US Army S/N 77-22716 (photo 1), is the third production Black Hawk. The aircraft was operated in the standard utility configuration, except for the addition of a modified stabilator and pitot-static system. A detailed description of the modifications to the production aircraft is contained in appendix B. A detailed description of the helicopter is contained in the operator's manual (ref 2, app A).

TEST SCOPE

4. The flight tests of the UH-60A were conducted at Edwards Air Force Base, California (2302 feet) in three phases. Phase I was conducted from 5 October 1982 through 16 December 1982 and consisted of development and evaluation of the PAE 1 system configuration. Phase II was conducted from 17 December 1982 through 21 January 1983 and consisted of an evaluation of the Nose Probe 1 System. Phase III was conducted from 22 January 1983 through 21 April 1983 and consisted of development and evaluation of the PAE 2 and Nose Probe 2 System. Sixty-four flights in 31 different configurations were conducted for a total of 79.4 hours of which 66.2 were productive. USAAEFA calibrated and maintained all test instrumentation and performed all required maintenance on the helicopter. Modifications to the pitot-static and stabilator systems were accomplished under the direction of Sikorsky engineers. Test configurations and loadings are presented in table 1. The limitations contained in the operator's manual (ref 2, app A) as modified by the airworthinesss release (ref 3) were observed. The applicable specification is Military Specification, MIL-I-6115A (ref 4). Testing was conducted in accordance with the test plans (refs 5 and 6) at the conditions shown in tables 2 and 3.

TEST METHODOLOGY

5. A detailed listing of the test instrumentation is contained in appendix C. Established flight test techniques and data reduction procedures were used (refs 7 and 8, app A) and are described in appendix D. A Handling Qualities Rating Scale (HQRS) (fig. 2, app D) was used to augment pilot comments relative to aircraft handling qualities. The flight test data were obtained from test instrumentation displayed on the instrument panel and recorded on magnetic tape installed in the aircraft. Cockpit data

Table 1. Test Configurations [illegible]

1	[illegible]	straight (production)	production	0.0 (production)	S1, S2 on pitot-tubes³ (production)	none	1	[illegible]	[illegible]	[illegible]
2							2			
3							3			
4	4.0 pneumatic						4		347.0 (FWD)	A
5							5		360.0 (AFT)	
6							6	17,000	361.0 (AFT)	
7	2.0 pneumatic						7	17,150		[illegible]
8							8	22,000	360.0 (AFT)	
9							9			
10	0.4 (production)						10			production system
11	1.5 pneumatic						11			C
12				1.0 copilot	copilot VSI cabin vented		12	17,000	361.4 (AFT)	D
13				0.5 copilot			13	16,61[illegible]	[illegible]6.0 (FWD)	E
14					pilot and copilot VSI's cabin vented		14	17,000		Stability [illegible]
15				0.5 pilot and copilot			15	22,000	347.0 (FWD)	[illegible]
16							16	17,000	346.0 (FWD)	F
17							17	22,000	347.0 (FWD)	
18		15 deg inboard					18			G
19		5 deg up					19			H
20		rolled 30 deg outboard				mounted above avionics bay door; static vented to cabin, not connected to stabilator system	20			I_{NP1}
21			30 deg max TE down				21			J_{NP1}
22							22	17,000	360.0 (AFT)	
23		15 deg inboard					23			K_{NP1}
24							24	32,000	347.0 (FWD)	
25	3.25 electric						25			L_{NP1}
26							26			M_{NP1}
27	2.75 electric					nose probe static vented to copilot ship static	27			N_{NP2}
28	1.0 electric					nose probe static cabin vented	28			O_{NP1} PAE 1 Evaluation
29							29			
30							30	20,300	352.5 (MID)	
31							31	16,600	347.0 (FWD)	
32							32			
33							33			
34						nose probe moved to avionics bay door; static vented to cabin, not connected to stabilator system	34	22,000	360.0 (AFT)	O_{NP3} PAE 1 Evaluation Nose Probe 1 Airspeed Calibration
35							35			
36							36	17,100	361.0 (AFT)	
37							37			
38							38		[illegible].5 (MID)	
39		straight (production)		0.35 pilot			39			[illegible]
40										

[illegible]						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]							[illegible]			
[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
[illegible]										
[illegible]							[illegible]	[illegible]	[illegible]	
[illegible]		straight (production)		[illegible]			[illegible]			[illegible]
[illegible]						[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	0.4 (production)	15 deg inboard	collective gain reduced (stab 02)	0.4 copilot			[illegible]		[illegible]	[illegible]
42		straight (production)				stabilizator amplifier; copilot [illegible] airspeed connected only to copilot airspeed indicator	[illegible]			[illegible] Evaluation
43							[illegible]	16,[illegible]		
44							44	22,000	360.0 (AFT)	
[illegible]							[illegible]	17,100	361.0 (AFT)	
46						connected to instrumentation only; static vented to copilot ship source	[illegible]	17,[illegible]	363.2 (AFT)	[illegible]
47		rolled 20 deg outboard					[illegible]	17,100	361.0 (AFT)	[illegible]
48		3 deg up					[illegible]	17,[illegible]	361.4 (AFT)	[illegible]
49	3.0 electric	rolled 15 deg outboard			VSI's cabin vented; S1 switched with S2 at copilot head[3]	14 in. right of center; static cabin vented instrumentation only	[illegible]	17,100	[illegible] (AFT)	[illegible]
50							[illegible]			
51		3 deg up				14 in. right of center; static vented to pilot system; connected to instrumentation only	[illegible]			[illegible]
[illegible]							[illegible]	16,600	346.2 (FWD)	
53		rolled 20 deg outboard, 5 deg down					[illegible]			[illegible]
54		rolled 20 deg outboard, 3 deg down					54			[illegible]
55		Sikorsky wedges: rolled 20 deg outboard, 3 deg down		0.4 pilot and copilot	pilot and copilot VSI's cabin vented		[illegible]	17,100	361.4 (AFT)	[illegible]; FAT - Evaluation; Nose Probe 2 [illegible] Calibration
56							56			
57							57	22,000	359.5 (AFT)	
58							58			
59							59		347.3 (FWD)	
60							60			
61							61	20,250	352.5 (MID)	
62							62	16,500	346.0 (FWD)	
63							63			
64							64			

NOTES:

[1] Orientations are defined as follows:

(a) straight: Pitot-static probes in the standard (production) orientation where probes are generally parallel to the longitudinal axis of the aircraft, level with the horizontal earth reference, and rotated approximately 15 deg outboard from a vertical earth reference. This configuration is the reference orientation for all other configurations.

(b) 15 deg inboard: Pitot-static probes rotated 15 deg inboard about the normal axis of [illegible] mounting pad (PHZ 1, app B).

(c) 5 deg up: Pitot-static probes rotated up toward the rotor system about the lateral axis of the mounting pad. Five degree wedges are installed beneath the [illegible] each probe.

(d) 30 deg outboard: Pitot-static probes rolled outboard about the longitudinal axis of [illegible] mounting pad away from the center of the aircraft. Thirty degree [illegible] installed beneath the base of each probe.

(e) 20 deg outboard: Same as (d) except 20 degree wedges installed beneath each probe.

(f) 3 deg up: Same as (c) except 3 degree wedges installed beneath each [illegible].

(g) 15 deg outboard: Same as (d) except 15 [illegible] installed [illegible]

(h) 20 deg outboard, [illegible]: Pitot-static probes rolled 20 deg outboard about the [illegible]

[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]			
57				[illegible]	[illegible]		[illegible]		[illegible]	[illegible]
58		Sikorsky wedges: rolled 20 deg out-board, 3 deg down		pilot and copilot	cabin center		[illegible]	[illegible]		[illegible]
59							[illegible]		[illegible]	[illegible]
60							60			
61							61	20,350	352.5 (MID)	
62							62	16,500	346.0 (FWD)	
63							[illegible]			
64							64			

NOTES:

¹ Orientations are defined as follows:

(a) straight: Pitot-static probes in the standard (production) orientation where probes are generally parallel to the longitudinal axis of the aircraft, level with the horizontal earth reference, and rotated approximately 15 deg outboard from a vertical earth reference. This configuration is the reference orientation for all other configurations.

(b) 15 deg inboard: Pitot-static probes rotated 15 deg inboard about the normal axis of each mounting pad (PAT 1, app B).

(c) 5 deg up: Pitot-static probes rotated up toward the rotor system about the lateral axis of the mounting pad. Five degree wedges are installed beneath the base of each probe.

(d) 30 deg outboard: Pitot-static probes rolled outboard about the longitudinal axis of the mounting pad away from the center of the aircraft. Thirty degree wedges are installed beneath the base of each probe.

(e) 20 deg outboard: Same as (d) except 20 degree wedges installed beneath each probe.

(f) 3 deg up: Same as (c) except 3 degree wedges installed beneath each probe.

(g) 15 deg outboard: Same as (d) except 15 degree wedges installed beneath each probe.

(h) 20 deg outboard, 5 deg down: Pitot-static probes rolled 20 deg outboard about the longitudinal axis of the mount combined with a 5 deg rotation down away from the rotor system about the lateral axis. A combination of 20 deg and 5 deg wedges installed beneath each probe.

(i) 20 deg outboard, 3 deg down: Same as (h) except 20 deg wedges and 3 deg wedges installed beneath each probe.

(j) Sikorsky wedges: Same as (i) except [illegible] installed beneath each probe.

² [illegible] through [illegible] refer to overhead pitot static and static [illegible] configurations [illegible] through [illegible] refer to nose probe pitot-static system configuration [illegible] combined test of both overhead probe and nose probe [illegible] simultaneously [illegible] probe system was [illegible] only [illegible] identify [illegible] and [illegible] probe systems [illegible] installed.

³ [illegible]

Table 2. Handling Characteristics Test Conditions[1]

Type of Test	Nominal Gross Weight (lb)	Longitudinal Center-of-Gravity (FS)	Nominal Density Altitude (ft)	Trim Airspeed (KIAS)	Pitot-Static Configuration[2]	Remarks
Level Flight	16,100	346 (FWD)	5300[3]	30 to 185	PAE 1 PAE 2 Nose Probe 2	
	16,800	360 (AFT)				
	21,700	347 (FWD)	4800	30 to 125		
	21,800	360 (AFT)				
	16,800	359 (AFT)	5300	30 to 180	Nose Probe 1	
	21,800	360 (AFT)		30 to 125		
	14,800	359 (AFT)	1500	25 to 160	Production	
Climbing and Descending Flight	16,100	346 (FWD)	5000[3]	30, 50, 70, 80, 100, 120	PAE 1 PAE 2 Nose Probe 2	Autorotation to intermediate rated power climbs
	21,100	347 (FWD)				
	21,200	360 (AFT)	4300			
	16,400	361 (AFT)				
	21,200	360 (AFT)	5000		Nose Probe 1	
	16,500	361 (AFT)				
	17,000	347 (FWD)	7200	45 to 120	Production	
Steady Heading Sideslip	15,900	346 (FWD)	5000	80[4]	PAE 1 PAE 2 Nose Probe 2	
	21,000	347 (FWD)				
	21,100	360 (AFT)				
	16,100	361 (AFT)				
	21,200	360 (AFT)			Nose Probe 1	
	16,200	361 (AFT)				

NOTES:

[1]Normal utility configuration, Automatic Flight Control System ON, 100% main rotor speed, doors and windows closed, lateral cg 0.0 (MID)
[2]Detailed configuration descriptions contained in appendix B
[3]Applies to PAE 1 configuration only
[4]Calibrated airspeed

Table 3. Position Error Test Conditions[1]

Type of Test	Gross Weight (lb)	Longitudinal Center-of-Gravity (FS)	Density Altitude (ft)	Calibrated Airspeed (kt)	Pitot-Static Configuration[2]	Remarks
Takeoff Characteristics	16,500 to 15,300	346 (FWD)	700 to 2500	Hover to 120	PAE 1 Nose Probe 1 PAE 2 Nose Probe 2	
	22,000 to 20,600	347 (FWD)				
Approach and Landing Characteristics	22,000 to 21,000	360 (AFT)				
	17,000 to 15,700	361 (AFT)				
Nap-of-the-Earth Flight Characteristics	22,000 to 21,000	360 (AFT)	1500		Production	
Climbing Flight Characteristics	16,000	346 (FWD)	5000	[30, 50, 70, 80, 100, 120][3]	PAE 1 Nose Probe 1 PAE 2 Nose Probe 2	
	21,100	347 (FWD)				
	21,200	360 (AFT)				
	16,400	361 (AFT)				
	17,000	347 (FWD)	7000	45 to 125	Production	
	20,800	360 (AFT)	5000	60, 70, 80, 90		
External Load Operations	19,500	352 (MID)	2700 to 5000	Hover to 100	PAE 1	3700 lb sling load

NOTES:

[1]Normal utility external configuration, Automatic Flight Control System ON, 100% main rotor speed, doors and windows closed, lateral cg 0.0 (MID)
[2]Detailed configuration descriptions contained in appendix B
[3]Ship system indicated airspeed

were hand-recorded to supplement tape recording. Real time telemetry monitoring of selected critical data parameters was used during certain tests.

RESULTS AND DISCUSSION

GENERAL

6. Developmental flight tests were conducted to improve the takeoff pitch-over characteristic experienced by production configured aircraft and develop a pitot-static configuration which would minimize the large airspeed position errors observed on the ESSS aircraft. Upon establishing a candidate configuration, two separate PAEs were conducted to assess the takeoff, climbing, approach and landing characteristics and document the ship airspeed system position errors. Based on the two PAE pitot-static and stabilator program configurations tested, the takeoff handling characteristics of the clean UH-60A helicopter with the PAE 1 or PAE 2 pitot-static and stabilator system modifications installed were improved from the standard production aircraft installation and were acceptable for all gross weights and centers-of-gravity (cg) tested, although longitudinal control, stabilator angle, and indicated airspeed reversals were annoying. Pilot workload to maintain an airspeed in high power, low airspeed climbs was significantly reduced in the PAE 1 and PAE 2 configurations as compared to the production configuration. The ship airspeed position error for the PAE 1 and PAE 2 configurations was satisfactory, except during high power climbs. During a separate evaluation, the takeoff pitch-over characteristic was essentially eliminated with the installation of a nose pitot probe, although the system was not fully developed and program constraints prevented further testing. *Four shortcomings* applicable to both PAE configurations were identified: 1) the annoying longitudinal control, stabilator angle, and indicated airspeed reversals resulting in pitch attitude oscillations during takeoff (upgraded from a deficiency in production configuration); 2) the high pilot workload required to maintain precise airspeed during transitions to high power, low airspeed climbs; 3) the large, variable ship airspeed position errors, and (4) unreliable airspeed indications in low airspeed, high power climbs.

HANDLING QUALITIES

General

7. Takeoff, climbing, approach and landing handling characteristics of the UH-60A helicopter were assessed at the test conditions shown in table 2. A broad range of takeoff types (normal, intermediate rated power, simulated instrument departure, and level acceleration) were accomplished in accordance with the Aircrew Training Manual (ref 9, app A) and recorded on magnetic tape for time history analysis. Appropriate pilot comments were

also recorded. Climbing flight handling characteristics were observed in conjunction with the climbing flight position error tests. Slow approaches, fast approaches and low speed nap-of-the-earth flight were conducted. Based on the two PAE pitot-static and stabilator program configurations tested, the takeoff handling characteristics of the clean UH-60A helicopter with the PAE 1 or PAE 2 airspeed and stabilator system modifications installed were improved from the standard aircraft installations and were acceptable for all gross weights and cgs tested, although longitudinal control, stabilator angle, and indicated airspeed reversals were annoying. Pilot workload to maintain an airspeed in high power, low airspeed climbs was significantly reduced (PAE 1 or PAE 2) as compared with the production configuration. A separate evaluation of a nose mounted pitot probe, referenced to cabin static air, connected to the airspeed transducer, essentially eliminated the takeoff pitch over, although program constraints prevented full system development. Two shortcomings were identified relative to handling characteristics: 1) the annoying longitudinal control, stabilator angle and indicated airspeed reversals resulting in pitch attitude oscillations during takeoff; and 2) the high pilot workload required to maintain precise airspeed during transitions to high power, low airspeed climbs.

Production Pitot-Static System and Stabilator Schedule

8. Takeoff, climbing, approach, and landing handling characteristics of the UH-60A helicopter configured with the production pitot-static and stabilator systems were evaluated at a heavy gross weight and aft cg (table 2). Data from the previously conducted Airworthiness and Flight Characteristics (A&FC) (ref 10, app A) were also analyzed for comparison to data obtained during this program. The production pitot-static and stabilator configuration is discussed in detail in appendix B.

9. The takeoff handling characteristics of the UH-60A helicopter in the production pitot-static and stabilator program configuration were evaluated by accomplishing various types of takeoffs, including normal takeoffs (10 percent torque above hover power), slow acceleration takeoffs (minimum torque above hover power to accomplish the takeoff), level acceleration takeoffs (accelerating at a constant wheel height), simulated instrument takeoff (ITO) (15 percent torque above hover power) and intermediate rated power (IRP) takeoffs (maximum power available). Typical time histories of a slow acceleration takeoff and a normal takeoff (identical to an IRP takeoff at 22,000 lb gross weight) are shown in figures 1 and 2 of appendix E. These figures illustrate the airspeed reversals (approximately 15 knots), stabilator angle reversals (approximately 5 degrees), and longitudinal control

position reversals (approximately 1 inch) observed when accomplishing most types of takeoffs. The magnitude of these reversals was similar to that noted during the previously conducted A&FC (ref 10, app A). At the lighter gross weights, documented in the A&FC, the takeoff pitch over characteristics was most noted during slow acceleration takeoffs. During the current program all takeoffs that were accomplished with a minimal power margin resulted in slow acceleration takeoffs and the airspeed, stabilator and longitudinal control reversals occurred closer to the ground than at the lighter gross weights. Typical pilot comments to accomplishing a slow acceleration takeoff maneuver indicate an HQRS 7 both for these tests and the previously conducted A&FC. As previously noted in the A&FC, the takeoff characteristics of the UH-60A helicopter in the production pitot-static and stabilator program configuration are a deficiency.

10. The climbing flight handling characteristics of the UH-60A helicopter equipped with a production pitot-static system and stabilator schedule, were evaluated at the conditions noted in table 2. A typical time history of a heavy weight, aft cg IRP climb at a target airspeed of 65 knots calibrated airspeed (KCAS) is shown in figure 3, appendix E. Airspeed excursions of at least ±10 knots, stabilator excursions of ±4 degrees and longitudinal control excursions of ±1/2 inch were recorded. Similar pitch oscillation characteristics were noted during the A&FC (ref 10, app A). This characteristic could easily be encountered during sling load or maximum performance takeoffs from confined areas. As previously noted, the pitch oscillations experienced in low-speed flight (less than 70 KIAS) with high rates of climb (greater than 1500 feet per minute (fpm)) is a shortcoming.

11. The approach and landing characteristics of the UH-60A helicopter equipped with a production pitot-static system and stabilator schedule were evaluated at the test conditions noted in table 2. No pitot-static induced anomolies were observed during the approach and landing task, as shown in figure 4, appendix E. Airspeed indications appeared linear until passing through translational lift and, therefore, the stabilator exhibited a smoothly programmed trailing edge downward motion throughout the deceleration. Except as noted in the A&FC (ref 10, app A) (lateral trim change during the landing approach) the approach and landing characteristics of the UH-60A helicopter equipped with the production pitot-static system and stabilator schedule are satisfactory.

PAE of Pitot-Static and Stabilator System Modification 1 (PAE 1)

12. Takeoff, climb, approach, and landing handling characteristics of the UH-60A helicopter configured with a modified pitot-static system and stabilator program were evaluated at the test conditions shown in table 2. Pitot-static modifications included reorienting the overhead pitot-static probes 15 degrees inboard (about an axis normal to the mounting pad), providing approximately 0.4 second time constant pneumatic damping for the airspeed indicators, and venting the vertical speed indicators to cabin static air. Stabilator program changes involved introducing approximately 3.0 seconds time constant electrical damping to the airspeed signals inside the stabilator amplifiers and a reduced collective bias for collective positions above 50% between 30 and 90 KIAS. A more detailed description of the PAE 1 aircraft system modification is included in appendix B.

13. The takeoff handling characteristics of the UH-60A helicopter in the PAE 1 pitot-static and stabilator program configuration were evaluated by accomplishing various types of takeoffs, including normal takeoffs, slow acceleration takeoffs, level acceleration takeoffs, simulated ITO, and IRP takeoffs and recording time histories of these maneuvers as well as pilot comments. Two typical time histories are presented in figures 5 and 6, appendix E. Consistently throughout these tests, the most unfavorable pilot comments were associated with slow acceleration takeoffs. At light gross weights, where significant power margin was available, the pitchover was less critical in that the attitude change occurred at a higher altitude, the aircraft accelerated through this regime more rapidly, and additional power was available if necessary. At higher gross weights, the pitch-over was more critical since the attitude change occurred near the ground, the aircraft transitioned more slowly through the troubled regime, and frequently no additional power was available if difficulty was encountered. The most obvious difference between this configuration and the production configuration (para 8) was the electrical airspeed damping installed in the stabilator systems. This increased time constant damping to 3.0 seconds in lieu of 0.4 second time constant for production effectively reduced the sensitivity of the stabilator to large magnitude short duration airspeed discontinuities. The frequently observed stabilator response to an airspeed reversal was a flattening of the time history trace of stabilator angle (for example, fig. 5, app E). During the development phase of the testing as much as 4.0 seconds time constant damping was evaluated. The optimum damping for reducing the pitch-over tendency during takeoff yet still responsive enough to follow dynamic maneuvers was established as a 3.0 second time constant.

During certain types of maneuvers, such as a low airspeed pushover where airspeed increased rapidly, it was possible to accelerate so rapidly that with this damping, stabilator placard limits were exceeded by as much as 2 degrees trailing edge down for the indicated airspeed. No adverse handling characteristics were noted during these maneuvers (no tendency for the nose of the aircraft to tuck). The 3.0 second time constant damping applied to the airspeed signals to the stabilator system reduces the magnitude of the stabilator response to the airspeed reversal and was satisfactory although stabilator placard limits may be exceeded during rapid acceleration maneuvers. If a 3.0 second time constant damping is incorporated in the stabilator airspeed systems, the following CAUTION should be included in the operator's manual:

CAUTION

> When airspeed increases rapidly from below 40 KIAS through 100 KIAS, such as during a push-over maneuver to a dive, stabilator placard limits may be temporarily exceeded.

14. Another factor which appeared to help reduce the magnitude of the takeoff pitch-over tendency was the change to the stabilator program involving reduced collective bias (a full explanation is contained in app B). This stabilator program change effectively reduced the amount of trailing edge down stabilator angle for a given airspeed at collective positions above 50 percent for the airspeed ranges of 30 to 90 KIAS. The reduced incidence angle appears to be more suitable for the extreme heavy weight aircraft in that little pitch attitude change was noted with high collective inputs. Similar control inputs with the stabilator system in the production configuration produce noticeable collective to pitch attitude coupling. It should be noted that the development program made no attempt to optimize stabilator program modifications. The reduced stabilator trailing edge down with collective settings above 50% for airspeeds between 30 KIAS and 90 KIAS is satisfactory, reduces collective to pitch attitude coupling for this airspeed range and is an improvement over the production stabilator schedule configuration.

15. A slight amount of pneumatic damping (0.4 second time constant) was installed in the pilot and copilot airspeed indication systems. Prior to this damping installation, rapid airspeed oscillations of approximately 30 KIAS peak to peak were observed in the cockpit as the pitot-static tubes transitioned through the rotor wake (during takeoff or slow airspeed high power climbs).

The 0.4 second time constant damping greatly reduced this characteristic without making the indicators too sluggish to provide timely airspeed information. Incorporating a 0.4 second time constant damping to the ship airspeed indicators has significantly reduced the large fluctuations observed during takeoff and high power climbs. The following NOTE should be placed in the operator's manual if airspeed indicator damping is incorporated on the UH-60A helicopter:

NOTE

> During takeoff, in the airspeed range of 40 to 80 KIAS, 5 to 10 knot airspeed reversals may be observed on the pilot and copilot indicators.

16. Even with the aforementioned improvements, the pitch-over characteristic was still qualitatively noticeable. Comparison of time histories of various takeoff types and techniques indicates that an approximate 50 percent reduction in the magnitude of the pitch-over was achieved. The magnitude of the pitch attitude change has been reduced requiring less aft longitudinal stick compensation. Production aircraft configuration pitch-overs (para 9) frequently required approximately 1.0 inches aft longitudinal control to maintain the takeoff flight attitude. The airspeed and stabilator modifications incorporated in the PAE 1 configuration were apparently responsible for reducing this aft longitudinal control requirement to less than 0.6 inches to accomplish the same maneuver. The instrumented test aircraft prevented evaluation of the system modifications at extreme light gross weights. Testing on the ESSS aircraft indicated that the pitch-over characteristics and the position error was aggravated by the ESSS installation. Although the takeoff characteristics of the UH-60A helicopter equipped with the PAE 1 configuration pitot-static and stabilator program modifications were improved from the production configuration, the longitudinal control, stabilator angle, and indicated airspeed reversals resulting in pitch attitude oscillations during takeoff are a shortcoming (upgraded from a deficiency noted in the A&FC). If the PAE 1 pitot-static and stabilator program modification configuration is incorporated on aircraft in the field, that configuration should be evaluated on an extremely light gross weight aircraft and these modifications should also be evaluated on the ESSS aircraft.

17. The climbing flight handling characteristics of the UH-60A helicopter in the PAE 1 pitot-static and stabilator program configuration were evaluated at the test conditions shown in

table 2. Continuous climbs and transitions to low airspeed climbing flight were conducted throughout these tests. A time history of a transition from a 1000 fpm climb to an IRP climb 's presented in figure 7, appendix E. The ship indicated airspe. l was stable at approximately 52 KIAS in a 1000 fpm climb just prior to application of IRP. As power was increased, the airspeed position error discontinuity (para 34) resulted in a rapid increase in indicated airspeed to approximately 73 KIAS. This airspeed change caused the stabilator to program up from 24 degrees trailing edge down to 11 degrees trailing edge down requiring an approximate 1 inch forward longitudinal control application to maintain a steady boom airspeed. As much as a 30 knot airspeed change was noted on the pilot indicator. This airspeed discontinuity considerably increased the pilot workload required to precisely fly the aircraft in this flight regime. Following the transition to the high power, low airspeed climb, it should be noted that the control activity, stabilator oscillations, and airspeed changes were considerably less than the similar maneuver discussed in paragraph 10 and shown in the time history (fig. 3, app E) with the production aircraft configuration. Pilot workload to maintain an airspeed in a high power, low airspeed climb was significantly reduced in the PAE 1 configuration as compared to the production configuration. The high pilot workload required to maintain precise airspeed during transitions to high power, low airspeed climbs is a shortcoming.

18. Once established on airspeed in a steady state climb, power changes resulted in indicated airspeed variations of up to 30 knots resulting from local inflow effects from the rotor system. However, it should be noted that indicated airspeed changes accompanying large power changes also occurred in other flight conditions. In addition, in high power climbs at airspeeds below 50 KIAS, the pilot and copilot airspeed indicators frequently indicated a large difference in airspeed (as much as 30 knots) with the pilot system always indicating higher. The unreliable airspeed indication in low airspeed, high power climbs is a shortcoming. The following NOTEs should be included in the operator's manual, if those modifications are incorporated on aircraft in the field:

NOTE

> Power changes in high power, low airspeed climb may cause as much as 30 knots change in indicated airspeed. An increase in power causes an increase in indicated airspeed, and a decrease in power causes a decrease in indicated airspeed.

NOTE

The pilot and copilot airspeed indicators may be unreliable during high power climbs at low airspeed (less than 50 KIAS) with the copilot system reading as much as 30 knots lower than the pilot system.

19. The approach and landing handling characteristics of the UH-60A helicopter equipped with the PAE 1 pitot-static and stabilator program modifications were evaluated at the test conditions noted in table 2. A time history of an approach to a hover is shown in figure 8, appendix E. The satisfactory approach and landing characteristics observed with the production pitot-static and stabilator program configuration were also noted during this evaluation. The approach and landing handling characteristics of the UH-60A helicopter equipped with the PAE 1 pitot-static and stabilator program schedule modifications are satisfactory.

PAE of Pitot-Static and Stabilator System Modification 2 (PAE 2)

20. Takeoff, climb, approach, and landing handling characteristics of the UH-60A helicopter configured with a modified pitot-static system and stabilator program were evaluated at the test conditions shown in table 2. Pitot-static modifications included reorienting the overhead pitot-static probes 20 degrees rolled outboard (about the longitudinal axis) and 3 degrees down (about the lateral axis), providing approximately 0.4 second time constant pneumatic damping for the airspeed indicators, and venting the vertical speed indicators to cabin static air. Stabilator program changes were identical to PAE 1 modifications (para 12). A more detailed description of the PAE 2 aircraft system modifications is included in appendix B.

21. The takeoff handling characteristics of the UH-60A helicopter in the PAE 2 pitot-static and stabilator program configuration were evaluated by accomplishing various types of takeoffs, including normal takeoffs, slow acceleration takeoffs, level acceleration takeoffs, simulated ITO, and IRP takeoffs, and recording time histories of these maneuvers as well as pilot comments. Twelve typical time histories of varied types of takeoffs at different gross weights and cg are presented in figures 9 through 20, appendix E. The large number of time histories are presented to demonstrate the variability of the pitch-over characteristic. The airspeed, stabilator, and longitudinal control reversals exist and are similar in magnitude

to the PAE 1 system. The discussion, NOTEs, and CAUTION included in paragraphs 13 through 16 for the PAE 1 system are applicable to the PAE 2 system. Again, the most noticeable (and repeatable) pitch-overs occur during slow acceleration takeoffs. The pilot still perceives this characteristic as objectionable and typical comments indicate an HQRS 5 to accomplish the slow acceleration takeoff task. The annoying longitudinal control, stabilator angle, and indicated airspeed reversals resulting in pitch attitude oscillations during takeoff are a shortcoming. If the PAE 2 pitot-static and stabilator program modification is incorporated on aircraft in the field, that configuration should be evaluated on an extremely light gross weight aircraft and also on the ESSS aircraft.

22. The climbing flight handling characteristics of the UH-60A helicopter in the PAE 2 pitot-static and stabilator program configuration were evaluated at the test conditions shown in table 2. Continuous climbs and transitions to low airspeed climbing flight were conducted throughout these tests. The low airspeed climbing handling characteristics associated with the PAE 2 configuration were quantitatively and qualitatively identical to the PAE 1 configuration (paras 17 and 18). The two shortcomings and NOTEs are also applicable to this configuration.

23. The approach and landing handling characteristics of the UH-60A helicopter equipped with the PAE 2 pitot-static and stabilator program modifications were evaluated at the test conditions noted in table 2. No difference was observed between the approach and landing handling characteristics of the PAE 1 and 2 configurations (para 19). Airspeed indications, stabilator programming and longitudinal cyclic stick requirements were smooth and continuous throughout the approach and landing. The approach and landing handling characteristics of the UH-60A helicopter equipped with the PAE 2 pitot-static and stabilator program schedule modifications are satisfactory.

<u>Nose Mounted Pitot Probes (Nose Probe 1 and 2 Systems)</u>

24. Development efforts during this test program centered on achieving acceptable takeoff handling characteristics for the heavy weight production aircraft and also required improvement of the airspeed position error of the final installation on the ESSS aircraft. Airspeed damping, pitot-static probe reorientation and stabilator program changes were successful in reducing the magnitude of the airspeed reversals which are probably caused by main rotor wake impingement on the overhead mounted pitot-static probes. A limited number of flights were conducted utilizing a nose mounted pitot source to assess the possibility of providing

airspeed information less influenced by the rotor wake. One nose mounted pitot probe installation, referenced to cabin static air was flown with the airspeed input provided to the airspeed transducer of the AFCS. A full description of this configuration is contained in appendix B. Airspeed position error data were also collected for a second nose mounted pitot probe installation (app B) which was more consistent with a possible production installation (para 49), although this installation was never connected to the AFCS.

25. Takeoff, approach and landing handling characteristics were evaluated with the nose mounted pitot probe at the test conditions shown in table 2. Normal and IRP takeoff time histories are presented in figures 21 and 22, appendix E. The airspeed reversal for the nose mounted pitot probe occurred very early in the take off sequence (before aerodynamic forces increase on the stabilator thereby affecting aircraft attitude), and produces no adverse handling charcteristics. The stabilator progressed up smoothly and continuously resulting in a takeoff which was noticeably easier to accomplish. Nearly continuous forward cyclic application was required to accelerate unlike the discontinuities noted for previously discussed configurations. Program constraints prevented further development of this configuration. Based on limited nose pitot probe configuration testing, the takeoff, approach and landing handling characteristics of the clean UH-60A helicopter configured with a nose pitot probe (referenced to cabin static air) connected to the copilot's airspeed transducer were satisfactory at all gross weights and centers-of-gravity tested and essentially eliminated the longitudinal control, stabilator angle, and pitch attitude discontinuities previously reported.

26. High powered, low airspeed climbs were accomplished at the test conditions shown in table 2, with the nose pitot probe. A time history of one of these climbs is presented in figure 23, appendix E. Stabilator airspeed damping was the same as for the production configuration. A comparison of figures 3 and 23 graphically illustrates the reduced pilot workload to accomplish this maneuver. Maximum longitudinal control motion was approximately ±1/4 inch as the stabilator remained within a few degrees of the trim position. Pilot workload to maintain an airspeed in high power, low airspeed climbs was significantly reduced in the nose pitot probe configuration as compared to the production or PAE configurations.

VERTICAL SPEED INDICATORS

27. The production UH-60A helicopter vertical speed indicators are connected to the ship static system. Since the static sources of the UH-60A are located on the overhead pitot-static probes, these sources encounter the turbulent rotor wake in some flight regimes, such as during takeoff and during high power, low airspeed climbs. In the production configuration, the vertical speed indicators often display erroneous and/or unreliable information as the the main rotor wake transits the static sources. During this program, the vertical speed indicators were vented to the cabin static air and observations were made of their performance during takeoffs, climbs, level flight, descents, approaches, landings and hover. Venting the vertical speed systems to cabin static air, resulted in excellent indicator performance eliminating the previously noted erroneous and/or unreliable indications, although one problem was noted. During a steady state maneuver, i.e. level flight, if a cockpit window or gunner's window was opened a momentary vertical speed indicator fluctuation was observed (approximately 300 fpm). If the vertical speed indicators are vented to cabin static air, the following NOTE should be included in the operator's manual:

NOTE

> Inflight opening and closing of the cockpit and gunner's windows may cause momentary fluctuations of approximately 300 feet-per-minute on the vertical speed indicators.

AIRSPEED SYSTEM TESTS

General

28. Testing was conducted to obtain calibrations of the five pitot-static configurations (Production, PAE 1, PAE 2, Nose Probe 1, and Nose Probe 2 systems) at the conditions shown in table 3. Limited calibrations were performed on the production and nose probe systems. The PAE systems were evaluated throughout a wide gross weight and cg range in level flight, climbs, descents, and steady heading sideslips. The calibration of the nose probe systems were accomplished in conjunction with the PAE systems calibrations and recorded on magnetic tape for comparison and analysis. The two PAE pitot-static probe orientations offered minimal improvement in position error over the production system. The magnitude of PAE 2 system position error was slightly smaller

than the PAE 1 system in the level flight and descent regime. However, both PAE systems exhibited greater position error at similar conditions in the cruise airspeed range of level flight compared to the production system. Both nose probe systems exhibited greater than acceptable position error in various flight regimes (level flight in the Nose Probe 1 system, climbing flight in the Nose Probe 2 system), and each would require further development prior to incorporation on the UH-60A helicopter. One shortcoming was noted in both the PAE 1 and PAE 2 systems: the large, variable ship airspeed position error in low airspeed, high power climbs.

Production Configuration

29. The airspeed position error curves for the production configuration were extracted from the A&FC (ref 10, app A) and are shown to provide a limited baseline comparison for the modified airspeed systems. The production aircraft pitot-static system was calibrated over a ground speed course in level flight, and by use of a calibrated trailing bomb (finned pitot-static system) in climbs and autorotations. The same aircraft and instrumentation package was used in both the A&FC and this test. Test results for the pilot ship system are presented in figures 24 through 26, appendix E.

30. In level flight airspeed position error varied from approximately -12 knots at 25 KIAS, to nearly zero between 130 and 140 KIAS, to -1 knot at 160 KIAS. In autorotation, the position error varied from 0 at 67 KIAS to +5 knots at 129 KIAS. Below 60 KIAS position error was non-linear and varied from approximately +1 knot at 60 KIAS to approximatley -25 KIAS at 15 KIAS. In climbing flight between 72 and 120 KIAS position error varied approximately from -10 to -5 knots. Below 70 KIAS position error variation was as much as ±7 knots and was affected by power setting (increased collective caused a positive increase in position error). The large position error below 40 KIAS in autorotation and level flight, and the large, variable position error below 70 KIAS in climbs resulted in the pilot ship airspeed system being unuseable at these conditions. The large, variable position error in various flight regimes was a shortcoming previously reported (ref 10, app A).

PAE 1 System

General:

31. Various general steady state flight conditions, including level flight, climb, descent, and steady heading sideslip were

flown to determine the position error of the PAE 1 airspeed system in accordance with the conditions of table 3. The tests were performed on both pilot and copilot systems at heavy and design gross weights and extreme forward and aft cgs. The test boom airspeed system was used as a reference (app D). Test results are presented in figures 27 through 44, appendix E.

32. Th- PAE 1 pitot-static probe orientation offered minimal improvement in position error over the production configuration. In level flight, the pilot system position error below 40 KIAS was reduced approximately 3 knots compared to the production configuration, but above 60 KIAS position error was 1 to 3 knots greater. In descending flight the position error was improved 1 to 2 knots above 100 KIAS and similar in magnitude below 100 KIAS. In climbing flight, a large variable position error in low airspeed, high power climbs occurred which is a shortcoming.

Level Flight:

33. Airspeed calibration tests in level flight are presented in figures 27 through 30, appendix E. Pilot system position error at forward cg varied from -9 knots at 30 KIAS, to approximately -3 knots between 105 to 145 KIAS, to -6 knots in diving flight at 175 KIAS. Varying cg from forward to aft decreased position error approximately 2 knots throughout the airspeed range up to 155 KIAS. The copilot system position error at forward cg was similar to the pilot system, varying from -9 knots at 30 KIAS to approximately -1 knot between 110 and 140 KIAS to -4 knots at 177 KIAS in diving flight. The copilot system position error curve also decreased approximately 2 knots when cg was changed from forward to aft throughout the airspeed range up to 155 KIAS, and shifted approximately 3 knots from 155 to 180 KIAS in diving flight. When comparing the PAE 1 system with the production system, the PAE 1 pilot system position error was approximately 2 knots less than the production system at airspeeds below 50 KIAS. However, above 50 KIAS the PAE 1 system had greater position error by 1 to 3 knots. The PAE 1 position error in level flight is satisfactory and met the requirements of MIL-I-6115A (ref 4).

Climbing Flight:

34. Climbing flight airspeed calibration tests are presented in figures 31 through 38, appendix E. Position error generalized as a function of angle-of-attack and cg. For example, in figure 35, appendix E, change in position error remained relatively constant above approximately -15 degrees angle-of-attack at each airspeed. However, at approximately -15 degrees a discontinuity

in position error occurred probably caused by impingement of the rotor system pressure field and wake on the pitot-static probes. This discontinuity basically generated two different position error curves for each ship system depending on angle-of-attack and cg (figs. 31 through 34, app E). As a function of climb rate, the region of discontinuity corresponded to approximately 1400 to 1700 ft/min at 70 KIAS. Within this region small changes in climb rate or airspeed caused large, unpredictable variations in indicated airspeed. The discontinuity occurred at a slightly less negative angle-of-attack (approximately -10 degrees) (fig. 36) at an aft cg. The magnitude of position error variation was similar to the forward cg. The discontinuity was easily manifested by varying collective setting and noting indicated airspeed changes of up to $\pm$30 knots (an increase in power causes an increase in indicated airspeed, decrease in power causes a decrease in indicated airspeed). The copilot system exhibited similar characteristics. At 70 to 80 KIAS the large, variable position errors encountered in the region of discontinuity (above approximately 1700 ft/min in this speed range) will cause unpredictable, rapid changes in airspeed indications, making the ship airspeed system difficult to use. This will negate the effective use of the high powered, low airspeed climb regime required during evasive maneuvering, rejected landings, and missed instrument approaches due to increased pilot workload to maintain precise airspeed control. The large, variable position error in the PAE 1 system at high negative angles-of-attack offer minimal improvement over the production configuration and is a shortcoming. The NOTEs in paragraph 18 should be placed in the operator's manual if this sytem is incorporated on the UH-60A.

Descending Flight:

35. Descents were conducted from 500 ft/min to autorotation and are presented in figures 39 through 42, appendix E. Position error ranged from approximately 0 knots at 120 KIAS to approximately -4 knots at 50 KIAS for both pilot and copilot systems throughout the cg range. Below 50 KIAS, the position error varied widely from -5 to over -20 knots. During autorotation at airspeeds below 50 KIAS, large indicated airspeed differences of up to 30 knots occurred between the pilot and copilot systems. The position error in descending flight is satisfactory. The

following NOTE should be placed in the operator's manual if this system is incorporated in the UH-60A:

NOTE

> Airspeed indicators are unreliable in autorotative flight below 50 KIAS (exhibited up to 30 knots difference between pilot and copilot systems).

Steady Heading Sideslip:

36. Steady heading sideslips up to 31 degrees right and 26 degrees left were performed at 80 KCAS in level flight. Position error variation with angle of sideslip is presented in figures 43 and 44, appendix E. Pilot system position error remained relatively unchanged at approximately -5 knots, from 0 to 12 degrees left sideslip. As sideslip angle was incresed, both left and right, the position error decreases to approximatley 0 at 20 degrees left and approximately 12 degrees right sideslip throughout the cg envelope for the pilot system. The copilot system showed similar characteristics. Position error as a function of angle of sideslip did not change significantly with cg. The position error in steady heading sideslip is satisfactory.

Nose Probe 1 System

General:

37. The Nose Probe 1 System was developed to eliminate the pitch over characteristics noted during takeoffs, and no comprehensive program was pursued to minimize position error. The nose probe airspeed system was calibrated simultaneously with the PAE 1 system tests in accordance with the conditions of table 3. Test results are presented in figures 45 through 48, appendix E.

38. The Nose Probe 1 System manifested a larger than acceptable position error in the level flight cruise regime and would require further development in this configuration if incorporated on the UH-60A. The position error in climbing flight is satisfactory and an improvement over the overhead probe configuration. The error in descending flight offered no improvement over the PAE 1 and PAE 2 systems and only a small improvement over the production system. The effects of sideslip on position error were minimal in this configuration. The variation of position error throughout all tested flight regimes was less than the overhead probe configurations.

Level Flight:

39. Airspeed calibration tests in level flight were performed at an aft cg and are presented in figure 45, appendix E. Position error varied from approximately 0 at 40 KIAS to +1 knot at 70 KIAS. Above 70 KIAS position error varied linearly from +1 knot at 70 to +9 knots in diving flight at 187 KIAS. Between 115 and 160 KIAS position error varied from approximatley 5 to 8 knots. The Nose Probe 1 system generated lower absolute position errors than the production system at airspeeds less than 90 KIAS, but ranged from 1 to 7 knots worse at higher speeds. The 5 to 8 knot position error in the cruise airspeed range exceeded acceptable limits and failed the requirements of paragraph 4.2.6.3, MIL-I-6115A by exceeding the maximum allowable tolerance of 4 knots.

Climbing Flight:

40. Climbing flight airspeed calibration tests are presented in figures 46 and 47, appendix E. The discontinuities as a function of angle-of-attack noted in the overhead probe configurations (PAE 1 and 2) were minimal in this system in the climbing flight regime. The variation of airspeed with climb rate was less than 3 knots at airspeeds above 70 KIAS. At less than 70 KIAS the variation could be larger. Position error varied from approximately -12 knots at 30 KIAS to +8 knots at 130 KIAS. The position error in climbing flight is satisfactory and represents an improvement over the overhead probe configurations.

Descending Flight:

41. Descents were conducted from 500 ft/min to autorotation and are presented in figure 48, appendix E. From 60 to 120 KIAS position error variation was small, ranging from +1 to +4 KIAS. Below 60 KIAS, the variation of airspeed with descent rate was approximately 8 knots. The Nose Probe 1 System position error was slightly greater than the overhead probe systems above 50 KIAS, but below 50 KIAS position error was similar to the modified overhead probe systems, and a small improvement over the production system. The position error in descending flight is satisfactory.

Steady Heading Sideslip:

42. Steady heading sideslips were performed at 80 KCAS in level flight at an aft cg out to the sideslip limits. Position error variation with angle of sideslip is presented in figure 44, appendix E. From 20 degrees left to 0 degrees sideslip, essentially no change in position error occurred. As sideslip angle

was increased to 20 degrees right, the position error changed approximately 3 knots. The position error in steady heading sideslip is satisfactory.

PAE 2 System

General:

43. Various steady state maneuvers including level flight, climbs, descents, and steady heading sideslips were conducted to determine the position error of the PAE airspeed system at the conditions shown in table 3. The tests were performed on both pilot and copilot systems at heavy and design gross weights, at extreme forward and aft cg. Test results are presented in figures 49 through 66, appendix E.

44. The PAE 2 pitot-static probe orientation offered minimal improvement in position error over the production configuration. In level flight absolute position error was improved slightly over the PAE 1 system, but was 1 to 4 knots higher than the production system in the cruise airspeed range (100 to 160 KIAS). In descending flight the PAE 2 system was an improvement over the production and PAE 1 systems by reducing position error in the low airspeed regime (below 50 KIAS). In climbing flight, a large, variable position error occurred in low airspeed, high power climbs, which is a shortcoming.

Level Flight:

45. Airspeed calibration tests in level flight are presented in figures 49 through 52, appendix E. Pilot system position error at forward cg varied linearly from -9 knots at 33 KIAS to +4 knots in diving flight at 184 KIAS. Between 100 and 150 KIAS absolute position error was 2 knots or less. Varying cg from extreme forward to extreme aft caused an approximate +2 knot increase in position error, shifting the curve from -7 knots at 33 KIAS to +5 knots in diving flight at 170 KIAS. The position error in the copilot system was essentially the same as the pilot system above 40 KIAS. Below 40 KIAS the copilot system error was approximately 1 knot larger (-10 knots at extreme forward cg at 32 KIAS). The PAE 2 system exhibited a wider variation of position error throughout the entire airspeed range compared to the production or PAE 1 system. However, the absolute position error was lower in the cruise airspeed range (100 to 160 KIAS) than the PAE 1 system and 1 to 4 knots higher than the production configuration. At airspeeds lower than 70 KIAS the PAE 2 system error was approximately 1 knot higher than the PAE 1 system but 1 to 3 knots lower than the production system. The

position error of the PAE 2 system in level flight is satisfactory and met the requirements of MIL-I-6115A (ref 4).

Climbing Flight:

46. Climbing flight airspeed calibration tests are presented in figures 53 through 60, appendix E. Pilot airspeed position error generalized as a function of angle-of-attack and cg. For example, in figure 58, appendix E, position error remained relatively constant greater than approximately -10 degrees angle-of-attack at 70 KIAS or above. However, between -10 and -15 degrees, a discontinuity in position error occurred probably caused by impingement of the rotor system pressure field and wake on the pitot-static probes. This discontinuity basically resulted in two different position error curves for each ship system depending on angle-of-attack and cg (figs. 53 through 56, app E). When expressed as a function of climb rate, the region of discontinuity corresponds to climb rates varying from 220 ft/min at 30 KIAS to approximately 2320 ft/min at 100 KIAS. Within this region small changes in climb rate or airspeed caused large, unpredictable variations in indicated airspeed. The discontinuity occurred at a slightly higher negative angle-of-attack (approximately -15 degrees) at a forward cg. The magnitude of position error variation was independent of cg loading. The discontinuity was easily manifested by varying collective setting and noting indicated airspeed changes of up to $\pm$30 knots (an increase in power caused an increase in indicated airspeed, a decrease in power caused a decrease in indicated airspeed). The copilot system exhibited similar characteristics, except that at airspeeds below 50 KIAS in climbs the position error variation was greater than the pilot system by 20 to 35 knots causing larger airspeed indicator discrepancies (up to 40 knots) between pilot and copilot indicators. At 70 to 80 KIAS the large, variable position error encountered in the region of discontinuity (approximately 1750 ft/min in this speed range) will cause unpredictable, rapid changes in airspeed indications making the ship airspeed system difficult to use. This will negate the effective use of the high powered, low airspeed climb regime required during evasive maneuvering, rejected landings, and missed instrument approaches due to increased pilot workload to maintain precise airspeed control. The large, variable position error in the PAE 2 system at high negative angles-of-attack offer minimal improvement over the production configuration and is a shortcoming. The NOTEs referred to in paragraph 22 should be placed in the operator's manual if this system is incorporated on the UH-60A.

Descending Flight:

47. Descents were conducted from 500 ft/min to autorotation and are presented in figures 61 through 64, appendix E. Pilot system position error ranged from approximately -5 knots at 34 KIAS to approximately 0 at 120 KIAS. Variation of cg from extreme forward to extreme aft had negligible effect on position error. The copilot system exhibited similar characteristics. However, below 30 KIAS (copilot) the position error became large (approximately 20 knots). The PAE 2 system was a slight improvement over the production and PAE 1 systems by reducing the position error in the low airspeed regime (less than 50 KIAS). The position error in the PAE 2 system in descending flight is satisfactory.

Steady Heading Sideslip:

48. Steady heading sideslips were performed at 80 KCAS in level flight out to the sideslip limits. Position error variation with angle of sideslip is presented in figures 65 and 66, appendix E. Pilot system position error was essentially constant in magnitude, approximately -4 knots, from 10 degrees left to 10 degrees right sideslip. For changes in sideslip up to 20 degrees left and right the position error change was minimal (approximately 2 knots). The copilot system exhibited similar characteristics. The effect of cg on position error was negligible. PAE 2 system position error as a function of angle of sideslip was improved over the PAE 1 system and is satisfactory.

Nose Probe 2 System

General:

49. The Nose Probe 2 System was an interim design to investigate the suitability of a dual nose probe configuration. In this configuration analysis of position error and dynamic effects was conducted with the system connected to instrumentation only. Possible successive iterations would have involved incorporation of a second probe, a different static source location, and if appropriate, interface with the ship airspeed indicators and AFCS. This nose probe system was tested simultaneously with the PAE 2 system at the conditions shown in table 3. The test results are presented in figures 67 through 74, appendix E.

50. The Nose Probe 2 System manifested acceptable positon error in level flight. The magnitude of position error below 70 KIAS in the climbing flight regime was larger than the overhead probe systems and exceeded useful limits. Further development in this configuration would be required before incorporation of this

configuration on the UH-60A. The error in descending flight was slightly greater than the modified overhead systems, but lower than the production system below 50 KIAS.

Level Flight:

51. Airspeed calibration tests in level flight are presented in figures 67 and 68, appendix E. The position error varied from approximately -11 knots at 30 KIAS to approximately +4 knots in diving flight at 184 KIAS. Between 100 to 160 KIAS position error varied less than ±3 knots. Position error was similar to the PAE 2 system througout the airspeed range and slightly worse than the production system in the cruise airspeed range. The position error in level flight for the Nose Probe 2 System is satisfactory and met the requirements of MIL-I-6115A (ref 4).

Climbing Flight:

52. Climbing flight airspeed calibration tests are presented in figures 69 through 72, appendix E. The position error varied from approximately +1 knot at 120 KIAS to -15 ±2 knots at 50 KIAS. The change in position error with angle-of-attack showed a discontinuity in the opposite direction from the other systems tested resulting in larger position error. This system generated a much larger position error in the climbing flight regime than the Nose Probe 1 and overhead probe systems. The excessive error in climbs below 70 KIAS will prevent the pilot from maintaining optimum and precise airspeed control during tactical instrument flight conditions and during evasive maneuvering. The magnitude of position error below 70 KIAS in the climbing flight regime exceeded useful limits.

Descending Flight:

53. Descents were conducted from 500 ft/min to autorotation and are presented in figures 73 and 74, appendix E. Position error varied linearly from approximatley 0 at 120 KIAS to approximately -7 knots at 34 KIAS. Position error variation was ±3 knots as a function of rate of descent below 50 KIAS, but indicated airspeed changes were not noticeable to the pilot during changing descent rates. The Nose Probe 2 System error was slightly greater than the modified overhead probe systems, but the magnitude of the position error was lower than the production configuration below 50 KIAS and above 100 KIAS. The position error of the Nose Probe 2 System in descending flight is satisfactory.

Steady Heading Sideslip:

54. Steady heading sideslips were performed at 80 KCAS in level flight out to the sideslip limits. Position error variation with angle of sideslip is presented in figures 65 and 66, appendix E. Position error was essentially constant from 5 degrees left to 13 degrees right sideslip at a forward cg. Position error at this cg increased in magnitude with increasing left sideslip to -17 knots error at 25 degrees left sideslip; and with increasing right sideslip to -14 knots error at 36 degrees right sideslip. The effects of cg were minimal on position error. However, at an extreme aft cg, position error was lower above approximately ±20 degrees of sideslip. The position error in this system was comparable to the PAE 1 and PAE 2 systems within ±10 degrees sideslip. However, error was 5 to 10 knots larger in magnitude than the modified overhead systems at the sideslip limits. The position error in steady heading sideslip is satisfactory.

CONCLUSIONS

GENERAL

55. Based on the two PAE pitot-static and stabilator program configurations tested, the following general conclusions were reached:

a. The take-off handling characteristics of the clean UH-60A helicopter with the PAE 1 or PAE 2 airspeed and stabilator system modifications installed were improved from the standard aircraft installations and were acceptable for all gross weights and centers-of-gravity tested, although longitudinal control, stabilator angle, and indicated airspeed reversals were annoying (paras 16 and 21).

b. Pilot workload to maintain an airspeed in high power, low airspeed climbs was significantly reduced in the PAE 1 and PAE 2 configurations as compared to the production configurations (paras 17 and 22).

c. The ship airspeed position error for the PAE 1 and PAE 2 configuration was satisfactory for all gross weights and centers-of-gravity tested, except during high power climbs (paras 33, 35, 36, 45, 47, and 48).

56. Based on limited nose pitot probe configuration testing, the following general conclusions were reached:

a. The take-off, approach and landing handling characteristics of the clean UH-60A helicopter configured with a nose pitot probe (referred to cabin static air) connected to the copilot's airspeed transducer were satisfactory at all gross weights and centers-of-gravity tested and essentially eliminated the longitudinal stick, stabilator angle, and pitch attitude discontinuities previously reported. Program constraints prevented ull development of this airspeed system (para 25).

b. Pilot workload to maintain an airspeed in high power, low airspeed climbs was significantly reduced in the Nose Probe 1 System configuration as compared to the production configuation (para 26).

c. The nose pitot probe referenced to cabin static air, (Nose Probe 1 System), airspeed position errors exceeded acceptable limits at cruise airspeeds although no comprehensive program was pursued to minimize these errors (para 39).

d. The position error in climbing flight represents an improvement over the overhead probe configurations (para 40).

57. Four shortcomings and one item that did not comply with the MILSPEC (ref 4, app A) were noted.

SPECIFIC

58. Based on the two PAE pitot-static configurations tested the following specific conclusions were reached:

a. The reduced stabilator trailing edge down with collective settings above 50% for airspeeds between approximately 30 KIAS and 90 KIAS is satisfactory, reduces collective to pitch attitude coupling for this airspeed range and is an improvement over the standard stabilator schedule configuration (paras 14 and 21).

b. The 3 second time constant damping (PAE 1 and 2 configurations) applied to the airspeed signals in the stabilator system reduces the magnitude of the stabilator response to the airspeed reversals and was satisfactory although stabilator placard limits may be exceeded during rapid acceleration maneuvers (paras 13 and 21).

c. Venting the vertical speed indicators to the cabin static air eliminated erroneous indications although momentary fluctuations of up to 300 fpm were observed when opening or closing the cockpit or gunner's windows (para 27).

d. Incorporating a 0.4 second time constant damping to the ship airspeed indicators has significantly reduced the large fluctuations observed during take-off and high power climbs (paras 15 and 21).

SHORTCOMINGS

59. The following shortcomings were identified and are applicable to the PAE 1 and 2 configuration tests:

a. The annoying longitudinal control, stabilator angle, and indicated airspeed reversals resulting in pitch attitude oscillations during take-off (paras 16 and 21).

b. The high pilot workload required to maintain precise airspeed during transitions to high power, low airspeed climbs (paras 17 and 22).

c. The large, variable ship airspeed position error in low airspeed, high power climbs (paras 34 and 46).

d. The unreliable airspeed indication in low airspeed, high power climbs (paras 18 and 22).

SPECIFICATION COMPLIANCE

60. The Nose Probe 1 System failed to meet the requirements of paragraph 4.2.6.3, MIL-L-6115A by exceeding the maximum tolerance of 4 knots (para 39).

RECOMMENDATIONS

61. The following recommendations are made relative to the two PAE pitot-static and stabilator progam configurations:

a. Evaluate the proposed PAE installation on the ESSS UH-60 helicopter (paras 16 and 21).

b. Evaluate the proposed PAE installation on an extremely light gross weight UH-60 helicopter (paras 16 and 21).

62. If 3.0 seconds time constant damping is incorporated in the stabilator airspeed systems, the following CAUTION should be included in the operator's manual (paras 13 and 21):

CAUTION

When airspeed increases rapidly from below 40 KIAS through 100 KIAS, such as during a push-over maneuver to a dive, stabilator placard limits may be temporarily exceeded.

63. The following NOTEs should be placed in the operator's manual if either PAE airspeed configuration is incorporated on the UH-60 helicopter (paras 15, 18, 21, and 22):

NOTE

During take-off, in the airspeed range of 40 to 80 KIAS, 5 to 10 knot airspeed reversals may be observed on the pilot and copilot airspeed indicators.

NOTE

Power changes in high power, low airspeed climb may cause as much as 30 knots change in indicated airspeed. An increase in power causes an increase in indicated airspeed, and a decrease in power causes a decrease in indicated airspeed.

NOTE

The pilot and copilot airspeed indicators may be unreliable during high power climbs at low airspeeds (less than 50 KIAS) with the copilot system reading as much as 30 knots lower than the pilot system.

64. If the vertical speed indicators are vented to cabin static air, the following NOTE should be included in the operator's manual (para 27):

NOTE

> Inflight opening and closing of cockpit and gunner's windows may cause momentary fluctuations of approximately 300 feet-per-minute on the vertical speed indicators.

65. The following NOTE should be placed in the operator's manual if the PAE 1 system is incorporated on the UH-60A (para 35):

NOTE

> Airspeed indicators are unreliable in autorotative flight below 50 KIAS (exhibits up to 30 knots difference between copilot and pilot systems).

APPENDIX A. REFERENCES

1. Letter, AVRADCOM, DRDAV-DI, 27 August 1982, subject: Preliminary Airworthiness Evaluation of the UH-60A with an Improved Airspeed System.

2. Technical Manual, Headquarters, Department of the Army, TM 55-1520-237-10, *Operator's Manual, UH-60A Helicopter* 21 May 1979, through change 19, 14 February 1983.

3. Letter, AVRADCOM, DRDAV-D, 13 October 1982 through revision 6, 25 January 1983, subject: Airworthiness Release for UH-60A Helicopter S/N 77-22716 to Conduct Airspeed Development Testing, Project No. 82-09.

4. Military Specification, MIL-I-6115A, *Instrument Systems, Pitot Tube and Flush Static Port Operated,* 29 March 1951 with amendment 3, dated 31 December 1960.

5. Letter, USAAEFA, DAVTE-TB, 10 September 1983, subject: Test Plan, Preliminary Airworthiness Evaluation of the UH-60A with an Improved Airspeed System, USAAEFA Project No. 82-09.

6. Test Plan, Sikorsky Aircraft, SER-70403-1, *UH-60A Post Maturity Phase Flight Test Plan,* 18 February 1981, with revision 5, 1 October 1982.

7. Engineering Design Handbook, Army Material Command, AMC Pamphlet 706-204, *Helicopter Performance Testing,* 1 August 1974.

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

9. Aircrew Training Manual, Headquarters, Department of the Army, Training Circular No. 1-138, *Utility Helicopter, UH-60,* 31 July 1981, with change 1, 27 July 1982.

10. Final Report, USAAEFA Project No. 77-17, *Airworthiness and Flight Characteristics Evaluation UH-60A (Black Hawk) Helicopter,* September 1981. (not published)

11. Technical Manual, Headquarters, Department of the Army, TM 55-1520-237-23-2, *Aircraft General Information Manual, UH-60A Helicopter,* 29 December 1978.

APPENDIX B. AIRCRAFT DESCRIPTION

TABLE OF CONTENTS

GENERAL

1. The Sikorsky UH-60A (Black Hawk) is a twin turbine engine, single main rotor helicopter capable of transporting 11 combat troops plus a crew of three, cargo, and weapons during day, night, and all-weather conditions. A complete description of the Sikorsky UH-60A Black Hawk helicopter (photo 1) is contained in the operator's manual (ref 2, app A) and the aircraft general information manual (ref 11, app A). Major features of the production helicopter including the airspeed and stabilator systems are included in appendix B of the Airworthiness and Flight Characteristics Evaluation UH-60A (Black Hawk) Helicopter (ref 10, app A). Major features of the four different pitot-static/stabilator configurations tested and their differences from the production aircraft are described below.

PAE 1 SYSTEM

General

2. The PAE 1 airspeed system modifications included five changes from the original production aircraft. Three changes were incorporated in the pitot-static pressure system and two changes were electrical circuit modifications to the stabilator amplifiers in the stabilator system. Major features of the PAE 1 modifications to the production aircraft are described below and summarized in table 1.

Pitot-Static System

3. The UH-60A dual pitot-static system with the installed modifications was electrically heated and provided ram pressure to the pilot airspeed indicator from the right (No. 2) probe and the copilot airspeed indicator from the left (No. 1) probe. Both airspeed sytems provide electrical airspeed information to the Automatic Flight Control System (AFCS) from the airspeed transducer (copilot system) and the air data transducer (pilot system). The orientation of the probes was changed from straight ahead to 15 degrees inboard (rotated about an axis normal to the mounting pad) as indicated in photos 2 and 3.

4. The two static sources for each of the two systems remained interconnected and provide static pressure to the ship airspeed indicators and altimeters. However, the vertical velocity indicators were vented to the cabin area in an attempt to reduce needle oscillation and to prevent climb rate reversals during pullups or pushovers.

Photo 1. Right Three-Quarter View, Production UH-60A Helicopter

Table 1. PAE 1 Configuration

Item	Production	PAE 1
Stabilator Damping	0.4 sec	3.0 sec (electrical)
Pitot-Tube Orientation	Straight	15 deg inboard
Stabilator Program	--	Collective gain reduced
Airspeed Indicator Damping	0.0 sec	0.35 (pilot) 0.4 (copilot)
VSI Static Source Location	S1, S2	Vented to cabin

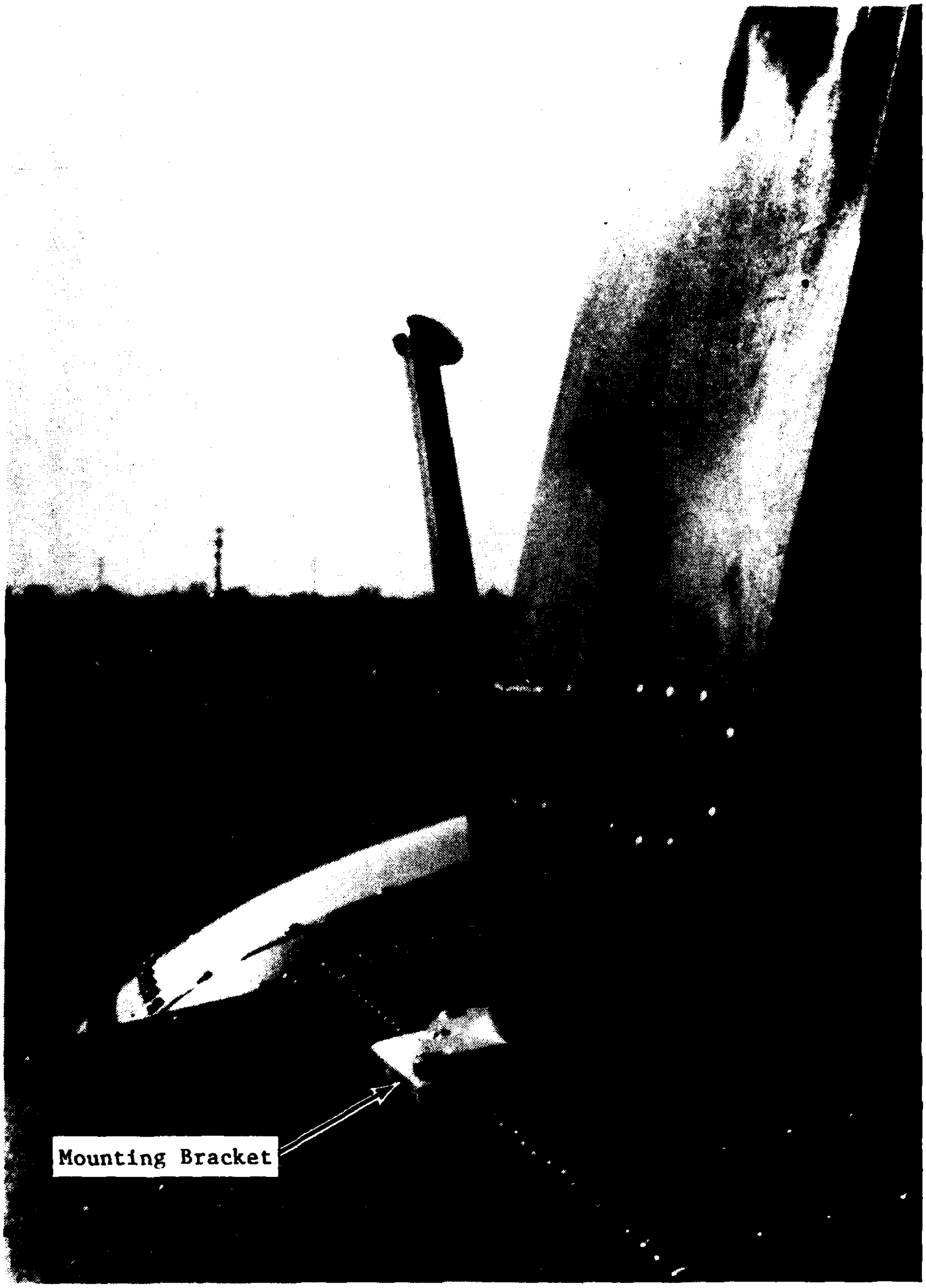


Photo 2. Rear View of Pitot-Static Probe
(PAE 1 Configuration)

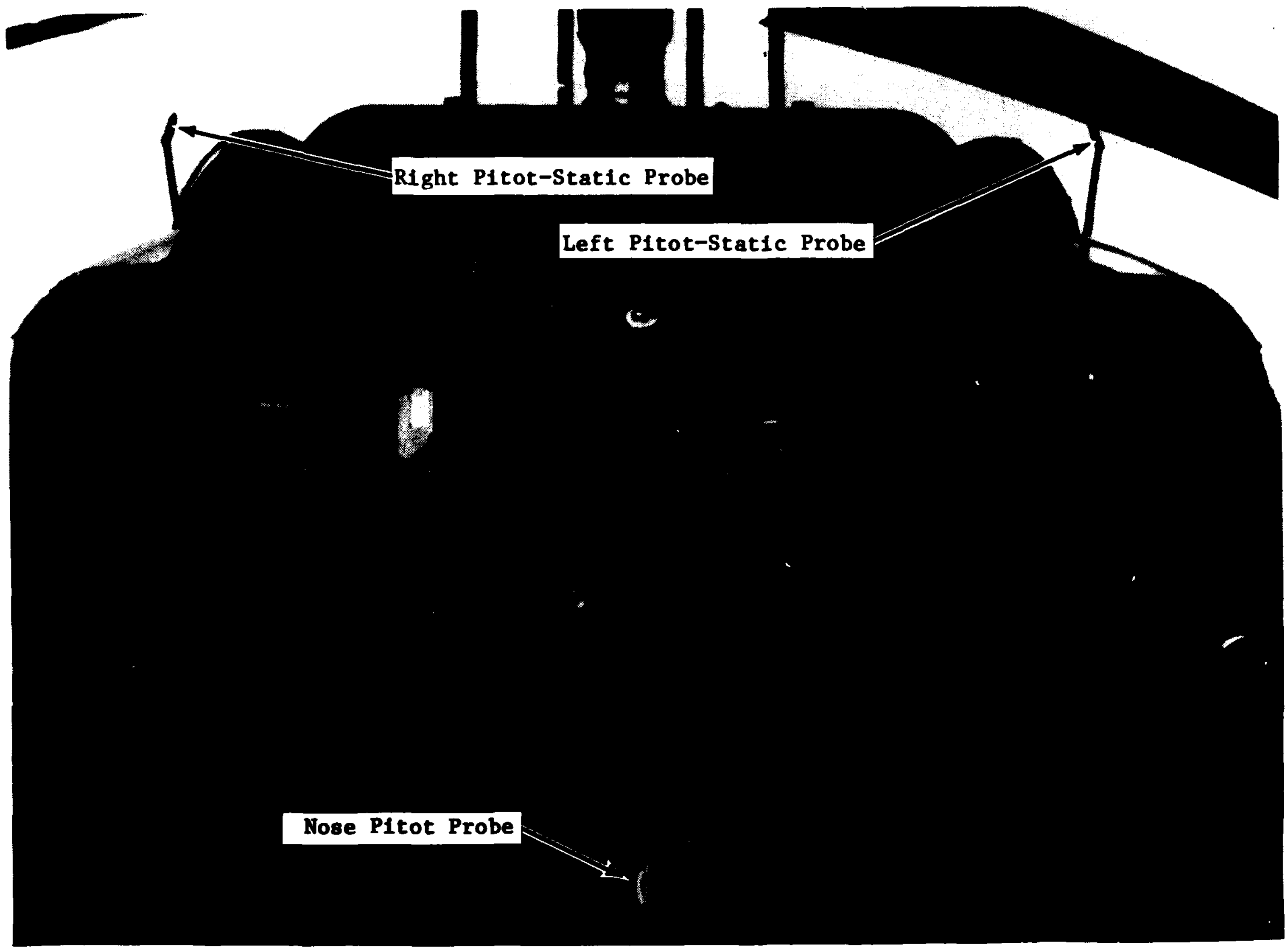


Photo 3. Front View of Pitot-Static Probes
(PAE 1 Configuration)

5. The damping time constant of both ship airspeed indicators was increased from essentially 0 to approximately 0.35 seconds for the pilot and 0.4 sec for the copilot by incorporating a 4.25 cubic inch and a 2.6 cubic inch accumulator in the pilot system, and one 4.25 cubic inch accumulator in the copilot sytem (photo 4). In addition a 0.001 inch restrictor in each pitot line and a 0.0012 inch restrictor in each static line were incorporated at the junction of each line and airspeed indicator. The intended purpose of increased damping was to improve readability and reduce needle oscillation from hover to 60 KIAS. A simplified pitot-static block diagram is presented in figure 1.

Stabilator Control System

6. The stabilator control system is an electrically controlled and activated system. The stabilator incidence angle is programmed between -5 degrees trailing edge up and 38 ± 4 degrees trailing edge down as a function of four variables: airspeed, collective control position, aircraft pitch rate, and lateral acceleration. The Preliminary Airworthiness Evaluation (PAE) 1 configuration modified the inputs of two of these variables: airspeed and collective control position by changing the electrical circuitry in the gain control module in each stabilator amplifier (fig. 2). In the first change the airspeed time constant damping into the stabilator amplifiers was increased electrically from 0.4 seconds to 3.0 seconds in an attempt to reduce stabilator movement in response to short, sharp airspeed reversals accompanying normal takeoffs. In the second change the collective bias as a function of airspeed was reduced above the 50% collective position in the airspeed range of 30 to 90 KIAS (fig. 3). The reduced bias at high power settings should cause the stabilator to program up faster during the initial portion of the takeoff, in an attempt to reduce stabilator incidence angle change in the event of an airspeed reversal.

NOSE PROBE 1 SYSTEM

General

7. The nose probe airspeed system modifications included three changes in the existing pitot-static and stabilator systems from the original production aircraft and the addition of a third pitot source located on the nose of the aircraft to replace the copilot pitot source to the stabilator system. Major features of the nose probe system modifications to the production aircraft are described below and summarized in table 2.

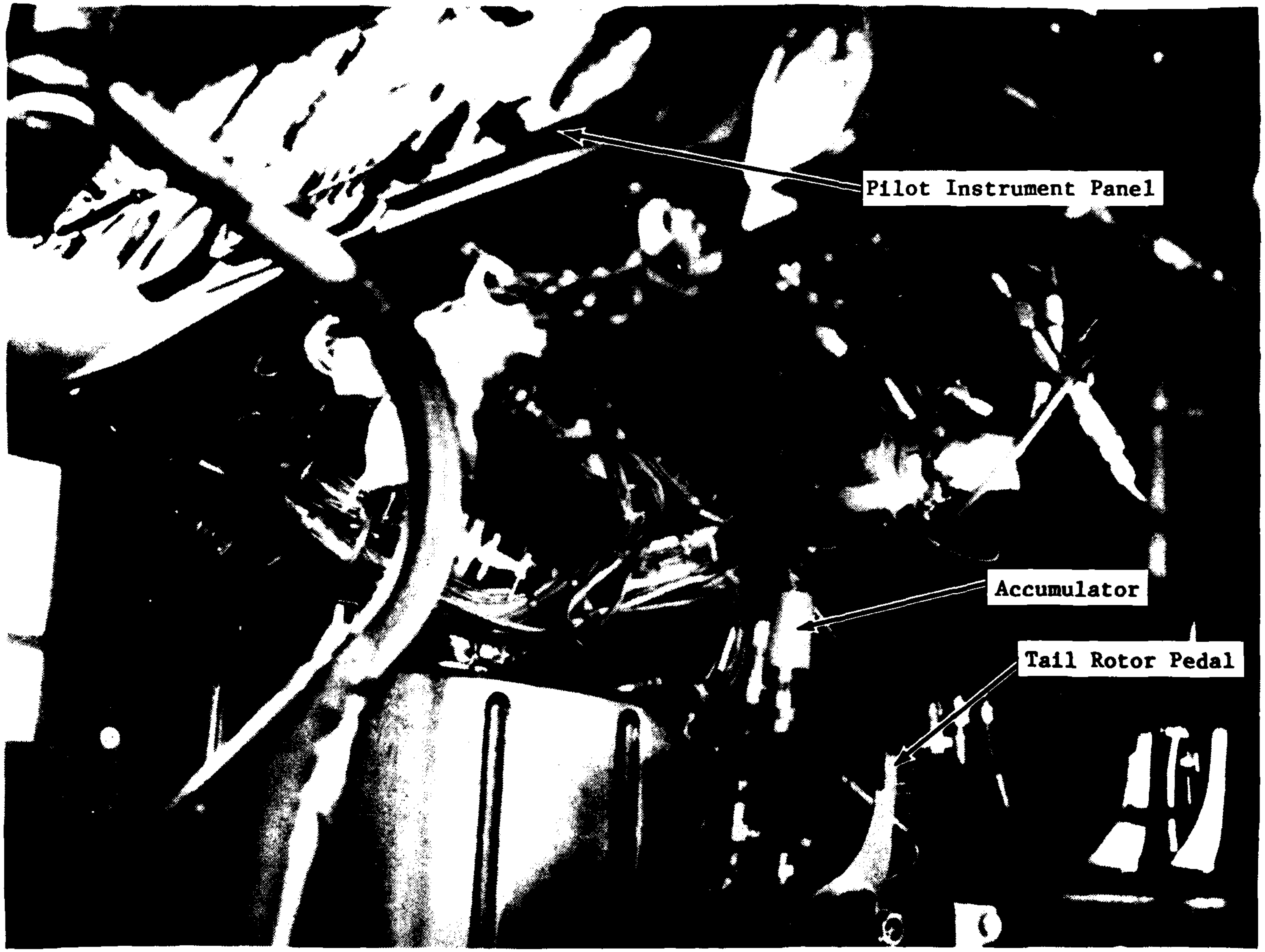


Photo 4. View of Pilot System Accumulator
(PAE 1 Configuration)

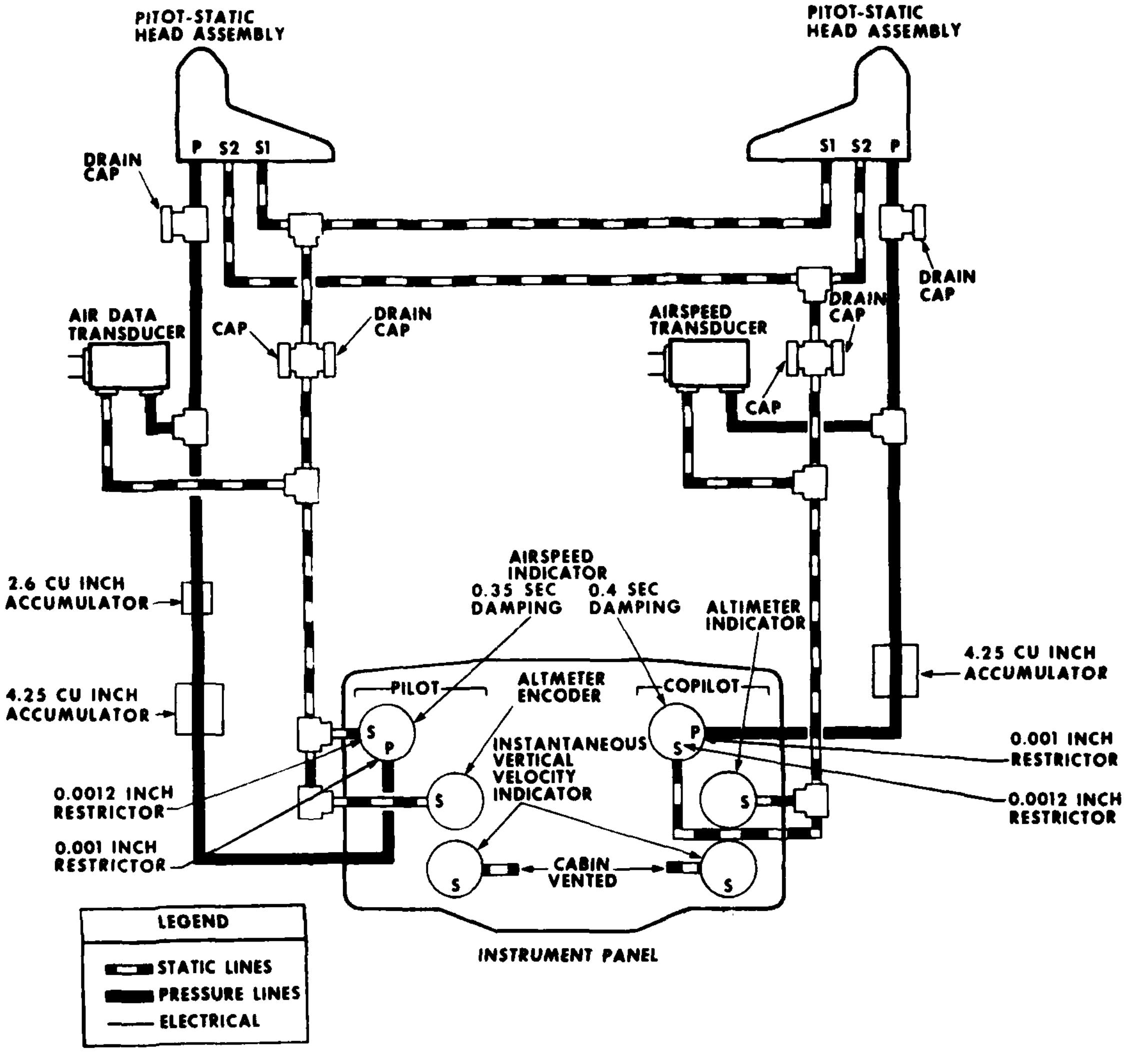


Figure 1. Pitot-Static Pressure System Block Diagram (PAE 1 Configuration)

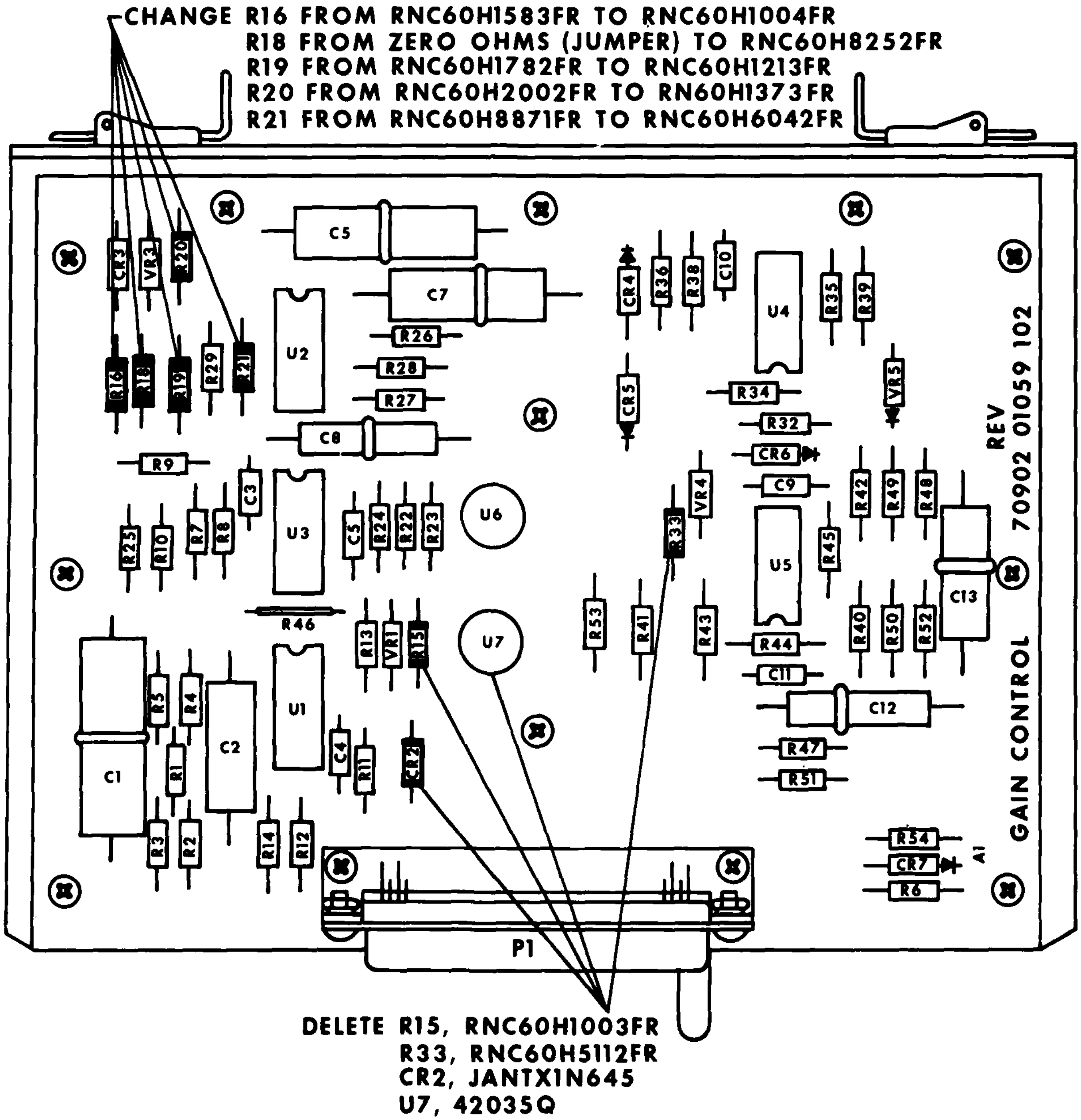


Figure 2. Stabilator Gain Control Module Modifications

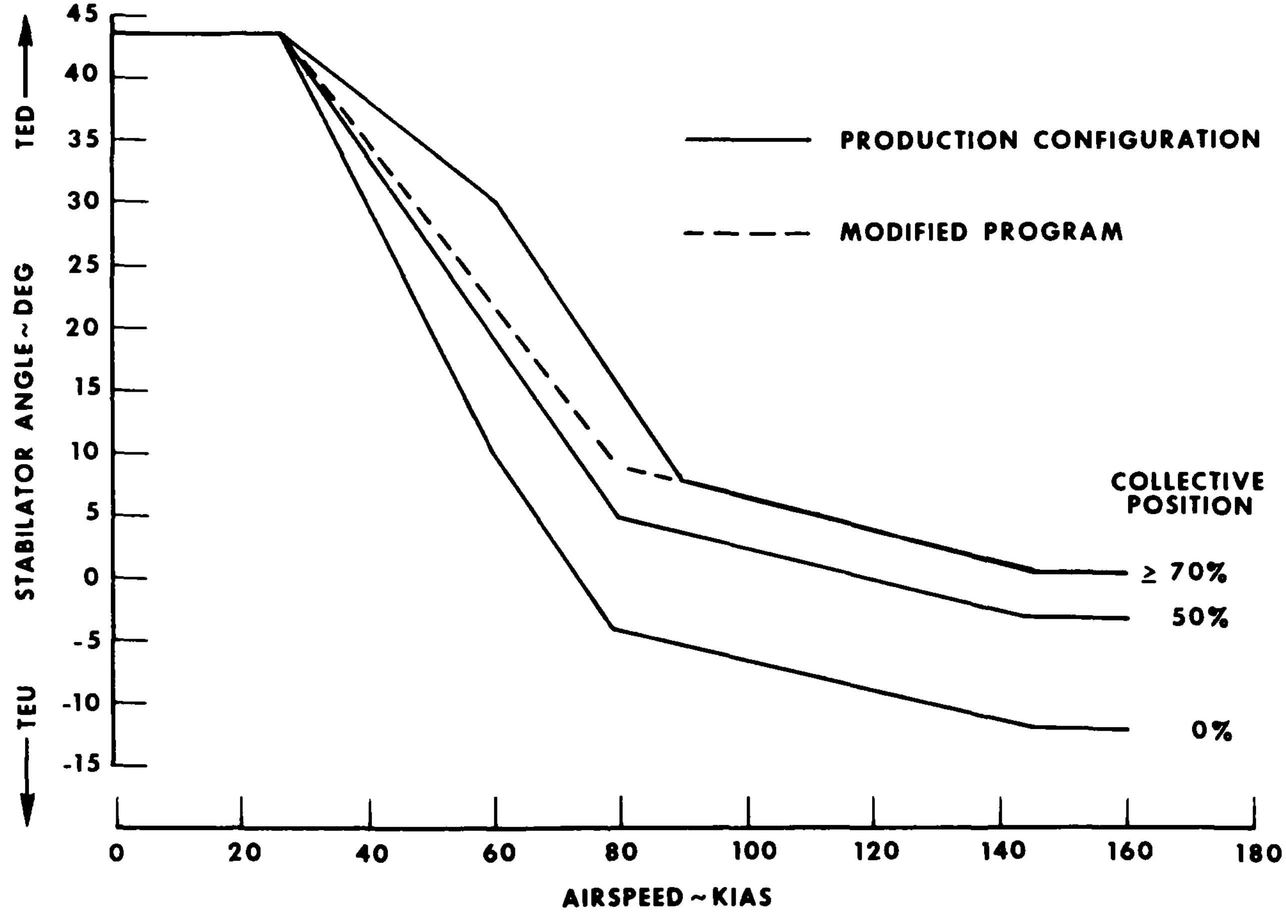


Figure 3. Stabilator Angle Versus Airspeed

Table 2. Nose Probe 1 Configuration

Item	Production	Nose Probe 1
Stabilator Damping	0.4 sec	0.4 sec
Pitot-Tube Orientation	Straight	Straight
Stabilator Program	--	Collective gain reduced
Airspeed Ship Indicator Damping	0.0 sec	0.35 (pilot) 0.4 (copilot)
Nose Probe Airspeed Indicator Damping	None	0.0 sec
VSI Static Source Location	S1, S2	Vented to cabin
Nose Probe	None	1) Pitot mounted on avionics bay door 2) Static vented to cabin 3) Replaced copilot airspeed source in stabilator system 4) Left pitot tube drives copilot airspeed indicator only 5) Nose probe airspeed indicator mounted on copilot instrument panel

Pitot-Static System

8. The UH-60A with the nose probe system consists of two electrically heated unmodified overhead pitot-static tubes and a nose pitot probe installed on the center of the avionics compartment door 14.2 inches down from the rear edge and rotated 1.2 degrees left about the vertical axis of the mount (photos 5 and 6). The unheated pitot probe was connected to the pitot-static pressure system by flexible and fixed pneumatic lines. The right overhead probe (No. 2) provided ram pressure to the pilot airspeed indicator and the air data transducer. The left overhead probe (No. 1) drove the copilot airspeed indicator only. The nose probe system replaced the copilot pitot input to the airspeed transducer and was referenced to a cabin-vented static source. The nose probe airspeed was displayed on a third indicator referenced to cabin static and mounted on the copilot instrument panel. The purpose of installing a nose probe system was an attempt to eliminate the stabilator reversals observed during takeoffs by allowing nose probe airspeed to drive the stabilator system during the reversal region of the overhead probes (50-80 knots indicated airspeed (KIAS)).

9. As with the PAE 1 system (para 4), the static sources for the overhead probes remained interconnected and provided static pressure to the ship airspeed indicators and altimeters. The vertical velocity indicators were vented to the cabin area behind the instrument panel.

10. The damping time constant of both ship airspeed indicators was approximately 0.35 sec (pilot) and 0.4 sec (copilot) as described in paragraph 5. A simplified pitot-static block diagram is presented in figure 4.

Stabilator Control System

11. The stabilator control system was modified as follows: (1) The pneumatic copilot airspeed input into the airspeed transducer was disconnected and replaced with the nose probe system. The stabilator system compared pilot system airspeed with nose probe airspeed and programmed the stabilator with the highest of the two airspeeds. The time constant damping of airspeed within each stabilator amplifier remained unchanged from production (0.4 sec); (2) The collective bias as a function of airspeed was reduced above the 50% collective position (fig. 3).

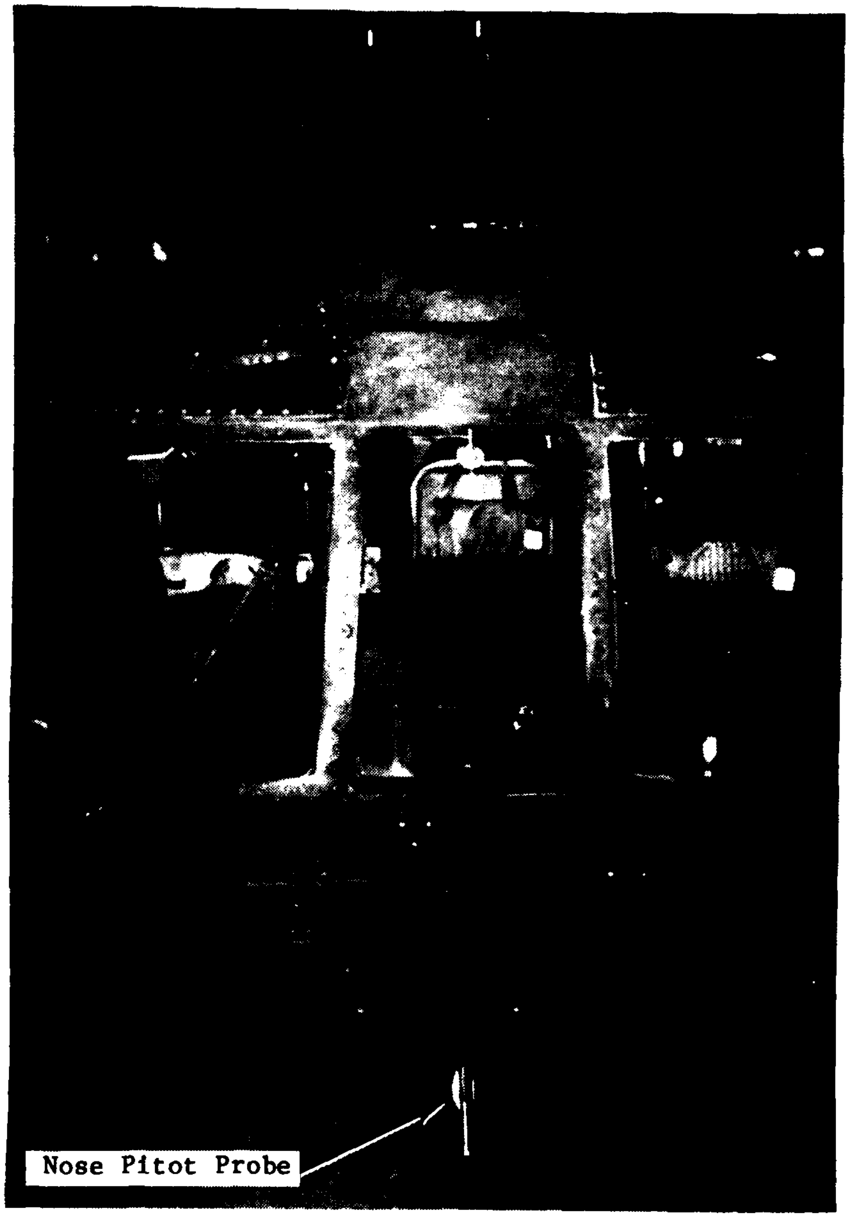


Photo 5. Front View of Nose Pitot Probe
(Nose Probe 1 Configuration)

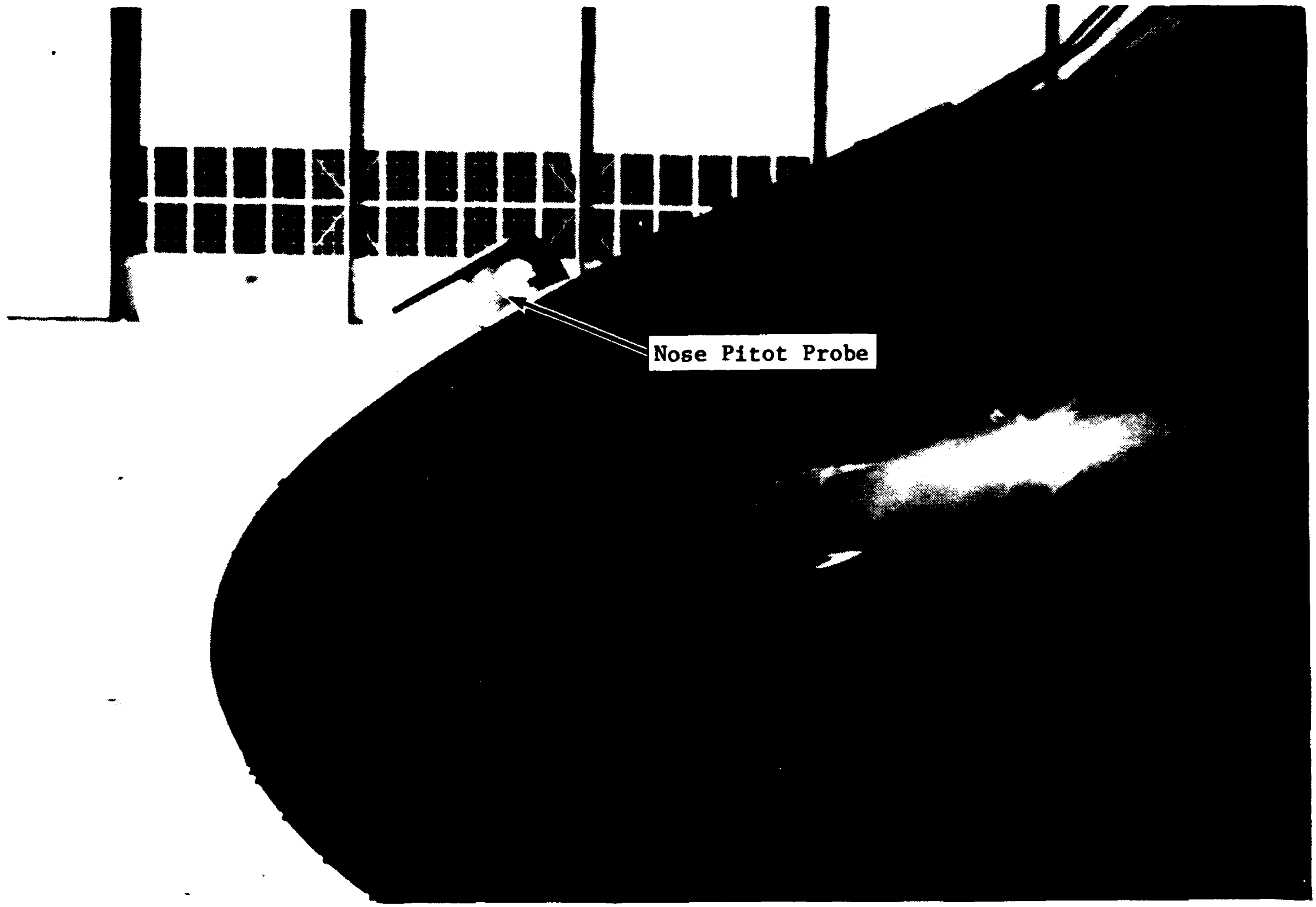


Photo 6. Left Side View of Nose Pitot Probe
(Nose Probe 1 Configuration)

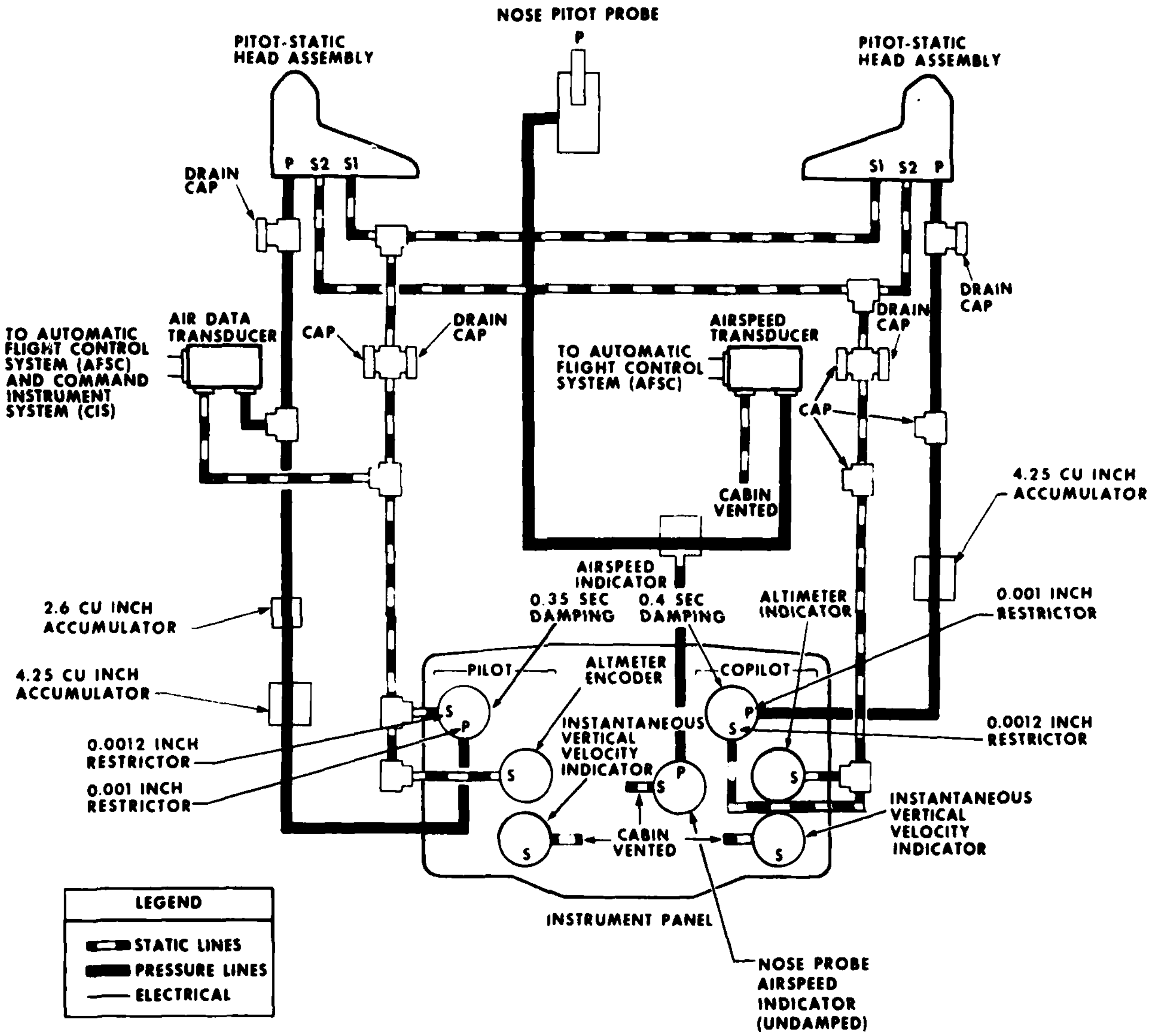


Figure 4. Pitot-Static Pressure System Block Diagram (Nose Probe 1 Configuration)

PAE 2 SYSTEM

General

12. The PAE 2 airspeed system modifications included five changes from the original production aircraft. Three changes were incorporated in the pitot-static pressure system and two changes were electrical circuit modifications to the stabilator amplifiers in the stabilator system. Major features of the PAE 2 modifications to the production aircraft are described below and summarized in table 3.

Table 3. PAE 2 Configuration

Item	Production	PAE 2
Stabilator Damping	0.4 sec	3.0 sec (electrical)
Pitot-Tube Orientation	Straight	Rolled 20 deg outboard 3 deg down
Stabilator Program	--	Collective gain reduced
Airspeed Indicator Damping	0.0 sec	0.4 sec
VSI Static Source Location	S1, S2	Vented to cabin

Pitot-Static System

13. The UH-60A dual pitot-static system with the installed modifications was electrically heated and provides ram pressure to the pilot airspeed indicator from the right (No. 2) probe and the copilot airspeed indicator from the left (No. 1) probe. Both airspeed systems provided electrical airspeed information to the AFCS from the airspeed transducer (copilot system) and the air data transducer (pilot system). The orientation of the probes with respect to the production orientation was 20 degrees outboard

(rolled about the longitudinal axis of the mounting pad) and rotated 3 degrees down about the lateral axis of the mounting pad as indicated in photos 7 through 11. The test configuration angular measurements are presented in table 4.

Table 4. Pitot-Static Probe Angular Measurements[1]

Probe	Rolled Outboard (deg from vertical)	Rotation Down (deg from horizontal)
#1 (Left)	33.53	3.87
#2 (Right)	33.43	3.12

NOTE:

[1]Aircraft leveled, measurements in degrees relative to horizontal and vertical earth references.

14. As with the PAE 1 system (para 4), the static sources for the two systems remained interconnected and provide static pressure to the ship airspeed indicators and altimeters. The vertical velocity indicators were vented to the cabin area.

15. The damping time constant of both ship airspeed indicators was increased from essentially zero to approximately 0.4 second by incorporating one 4.25 cubic inch accumulator in the copilot pitot line and two 4.25 cubic inch accumulators in the pilot pitot line (photo 12). The restrictors remained as per the PAE 1 configuration (para 5). A simplified pitot-static block diagram is presented in figure 5.

Stabilator Control System

16. The modified stabilator control system was identical to the PAE 1 system as described in paragraph 6.

NOSE PROBE 2 SYSTEM

General

17. The Nose Probe 2 System consisted of a third pitot probe located on the nose of the aircraft. The system was connected only to an airspeed indicator mounted on the copilot instrument

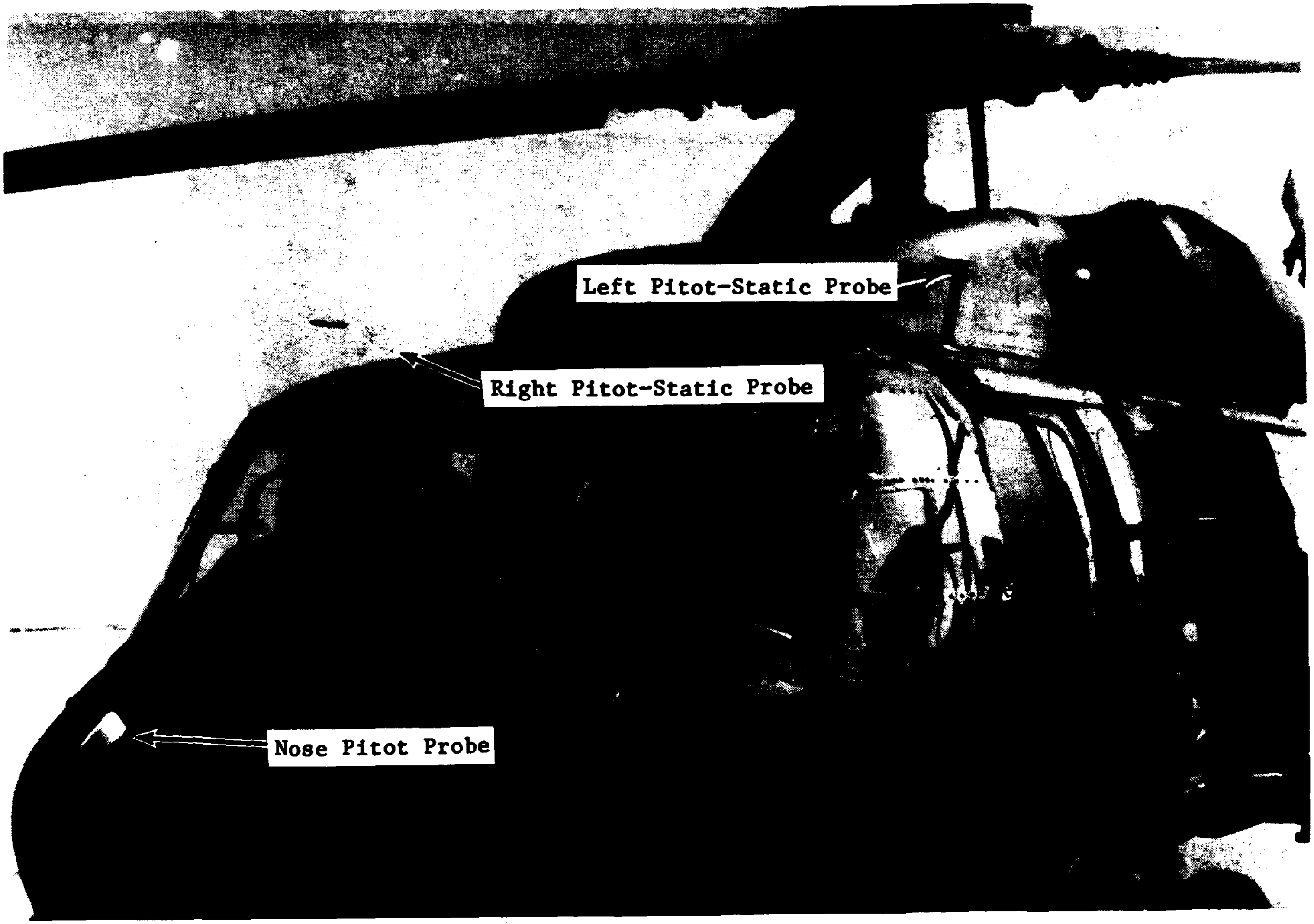


Photo 7. Left Quartering View of Pitot-Static Probes
(PAE 2/Nose Probe 2 Configurations)

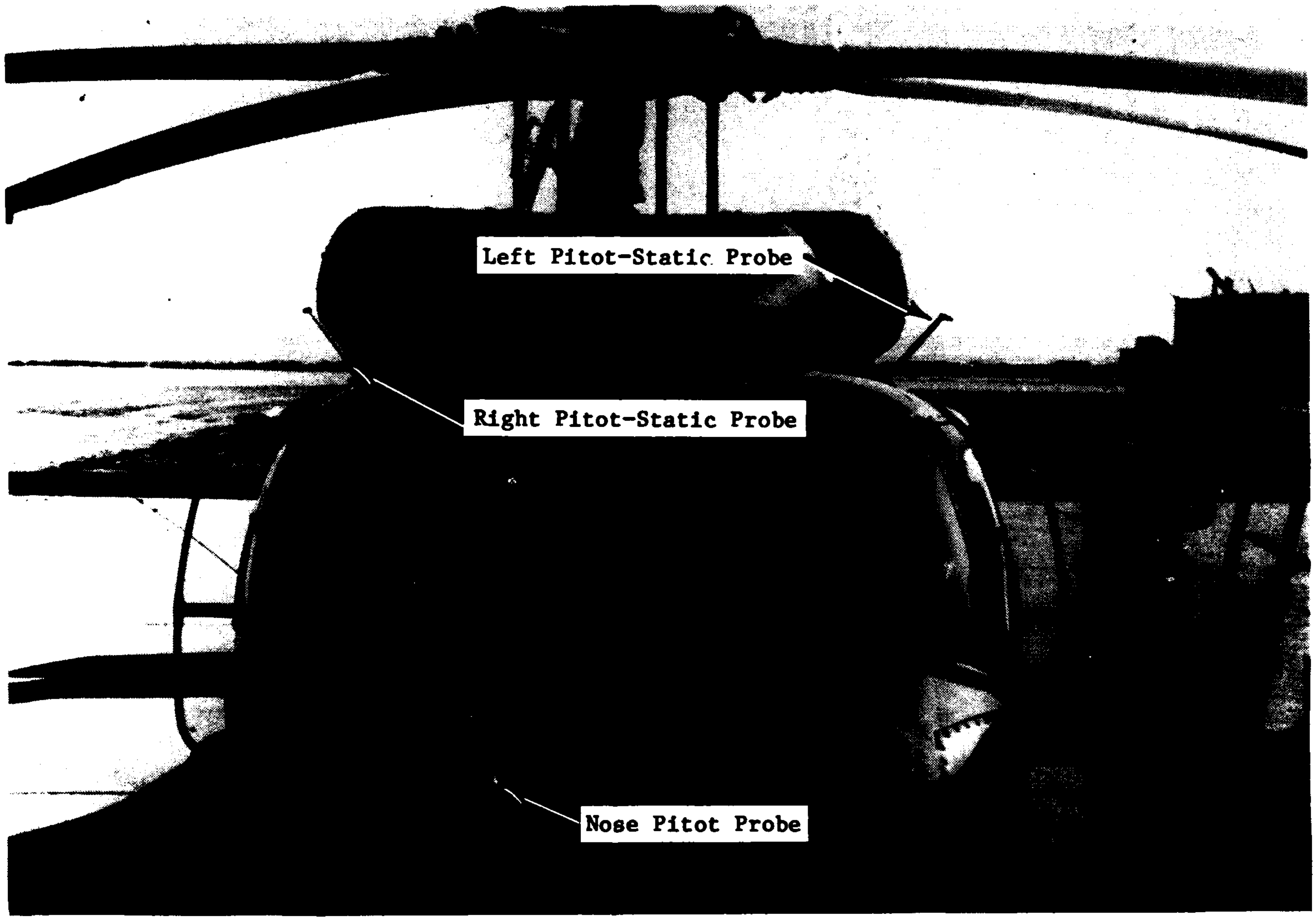


Photo 8. Elevated Front View of Pitot-Static Probes
(PAE 2/Nose Probe 2 Configurations)

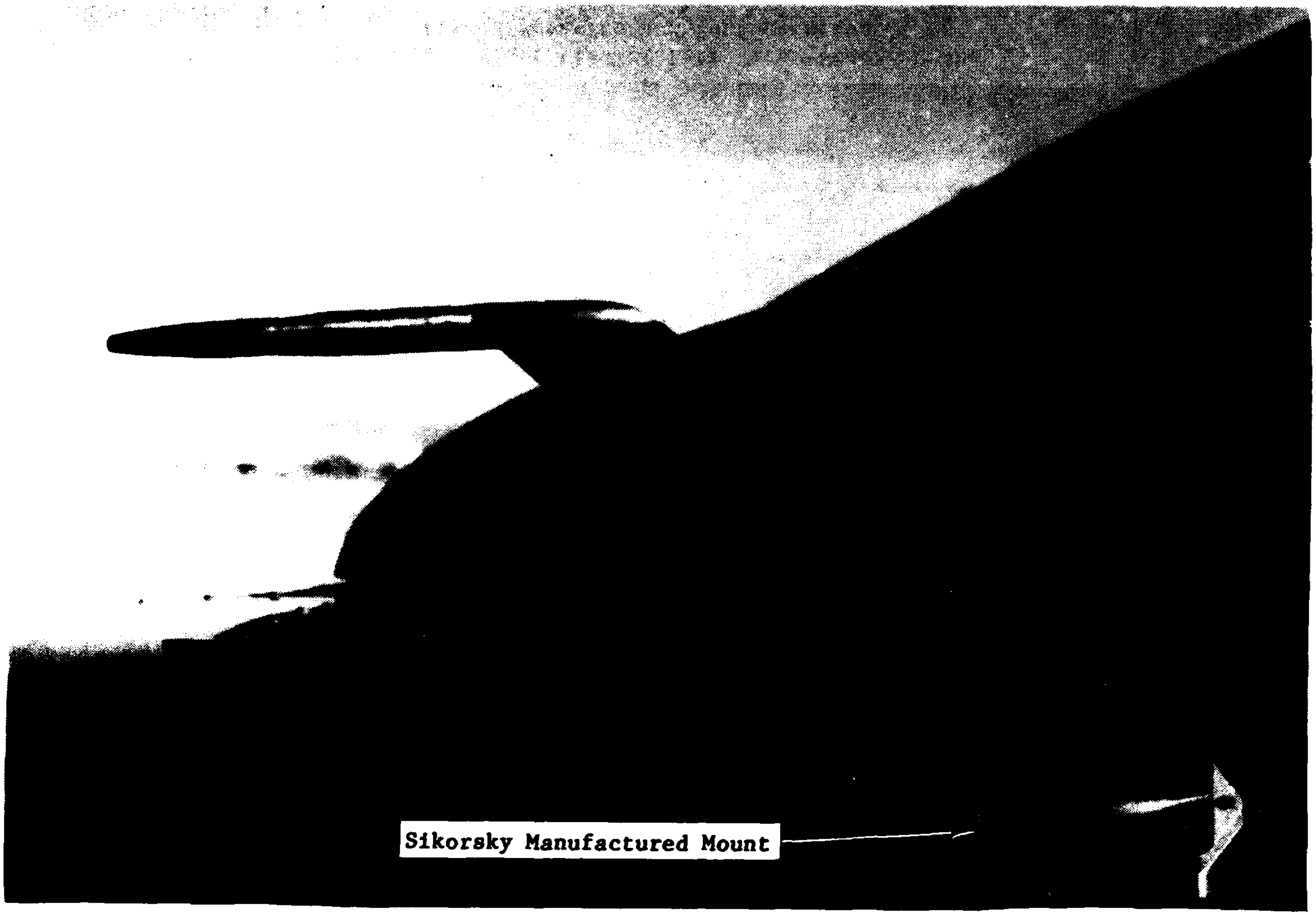


Photo 9. Left View of Left Pitot-Static Probe
(PAE 2/Nose Probe 2 Configurations)

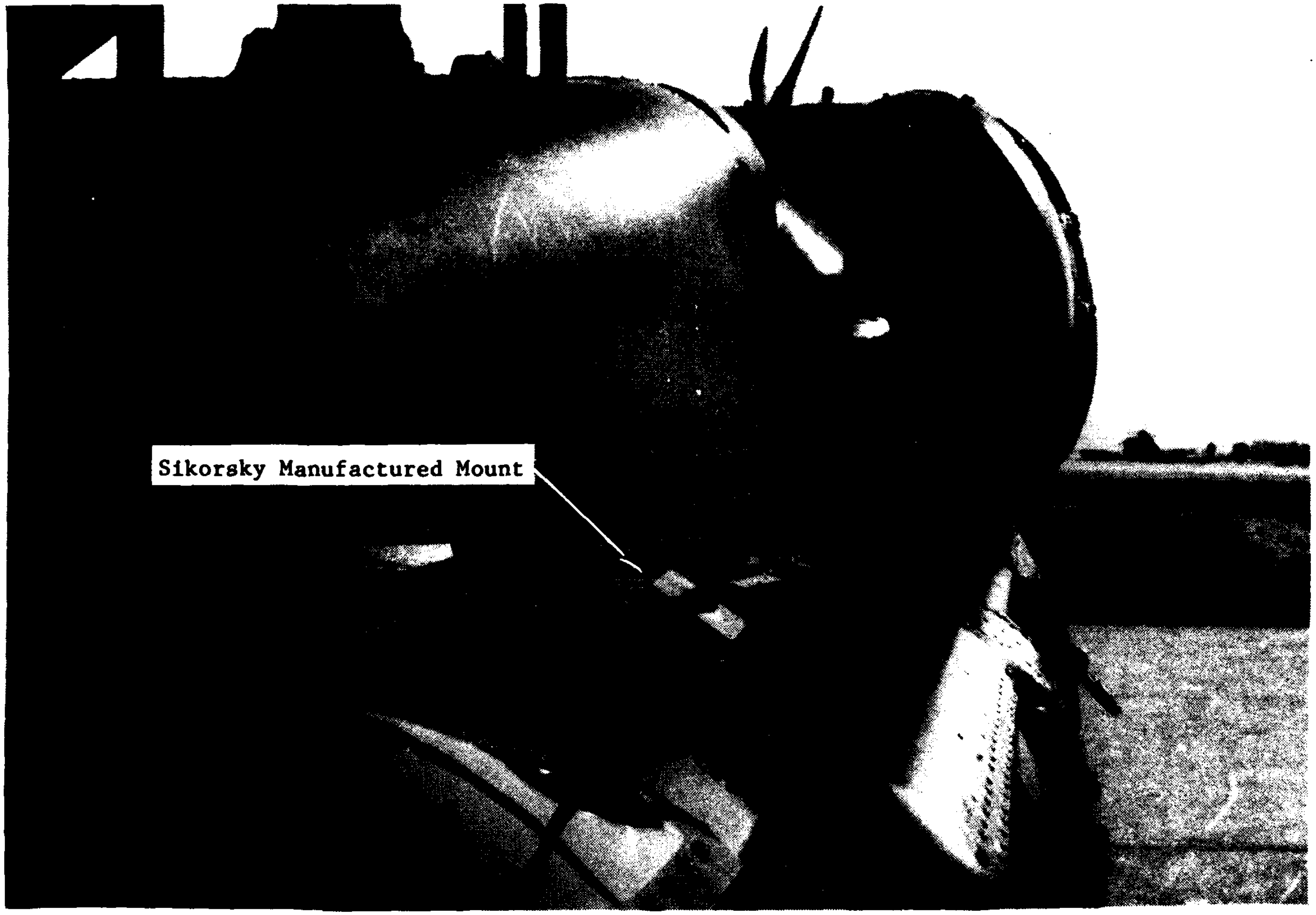


Photo 10. Front View of Left Pitot-Static Probe
(PAE 2/Nose Probe 2 Configurations)

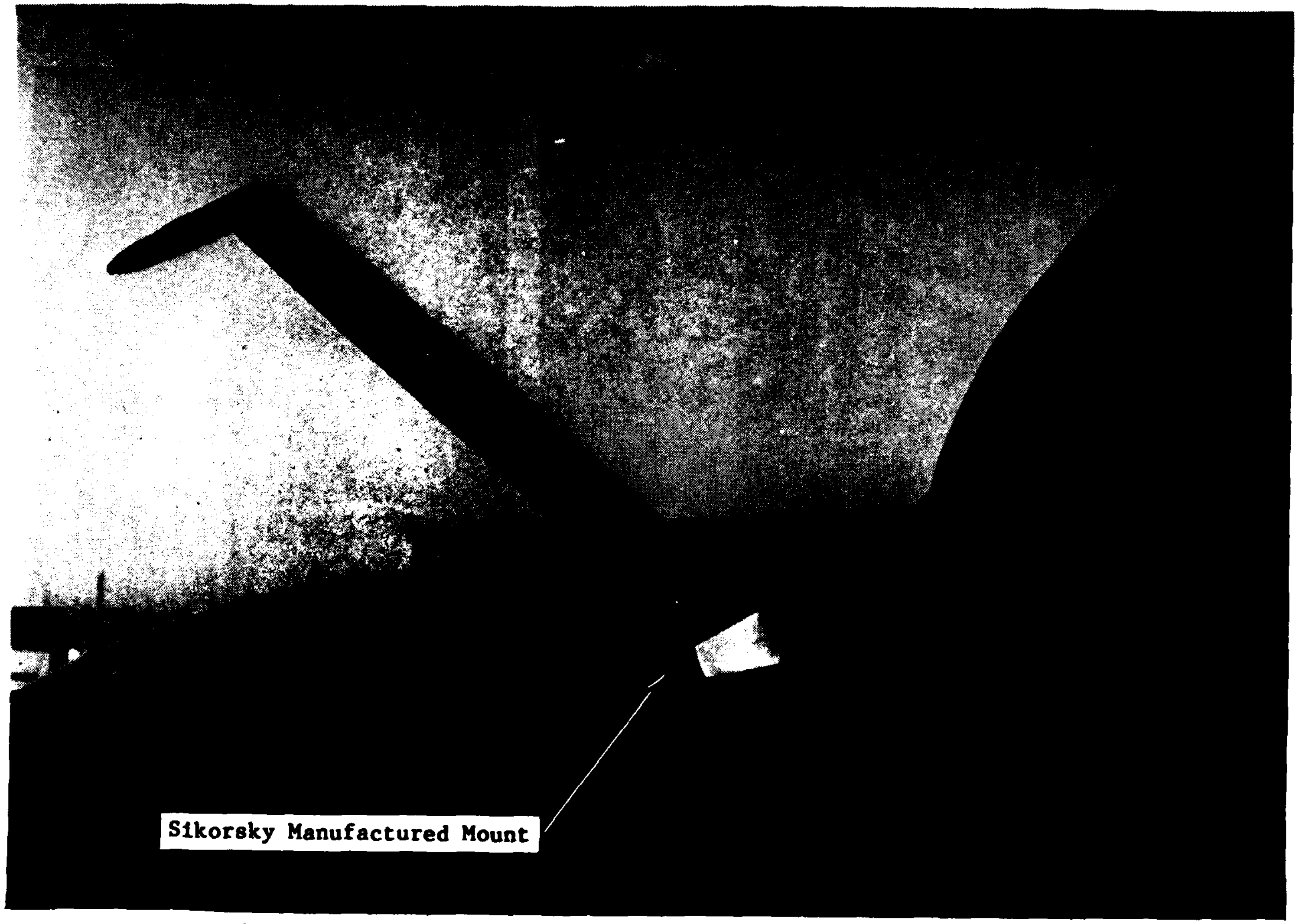


Photo 11. Left Quartering Rear View of Left Pitot-Static Probe
(PAE 2/Nose Probe 2 Configurations)

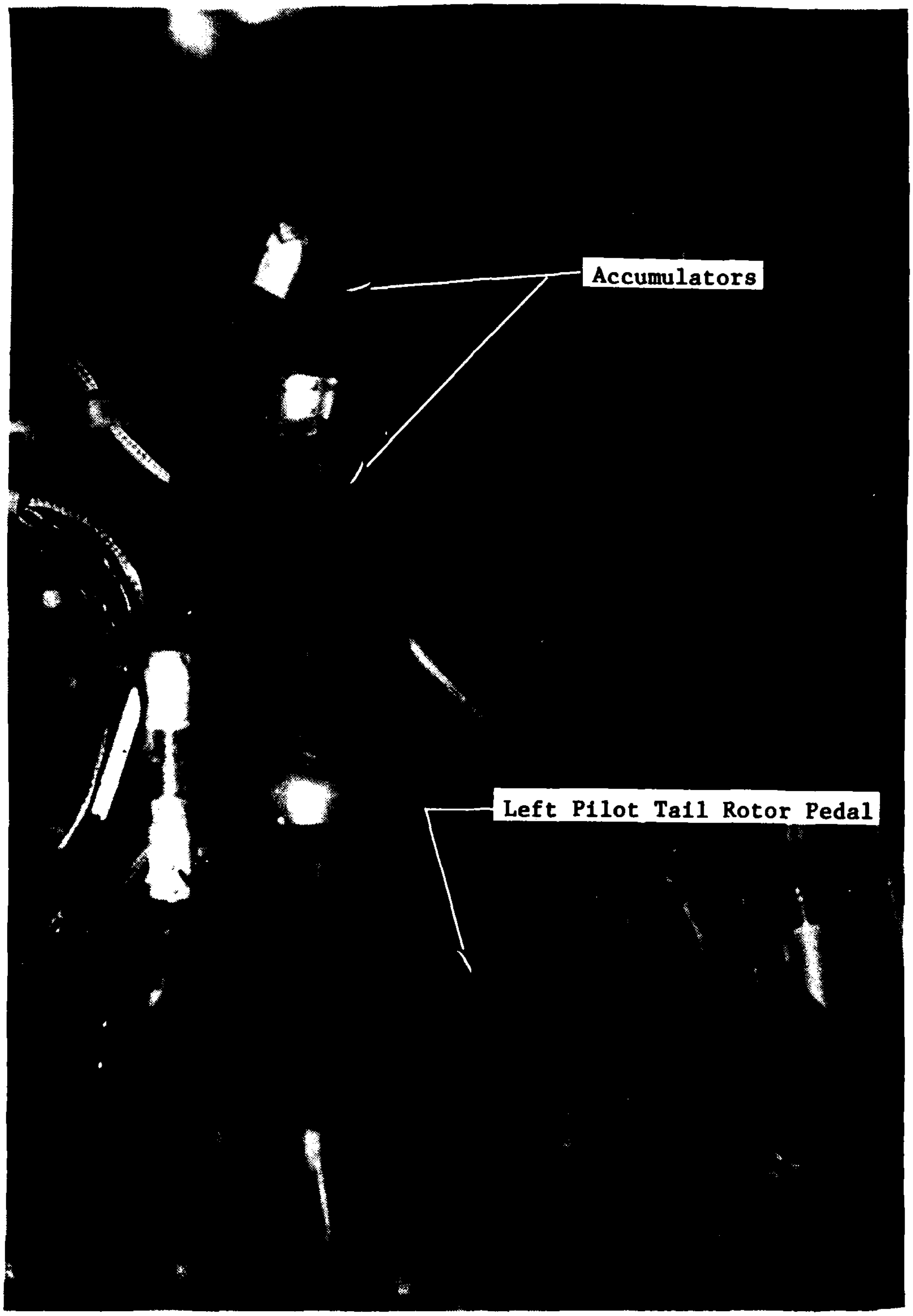


Photo 12. Right View of Pilot Airspeed System Accumulators
(PAE 2/Nose Probe 2 Configurations)

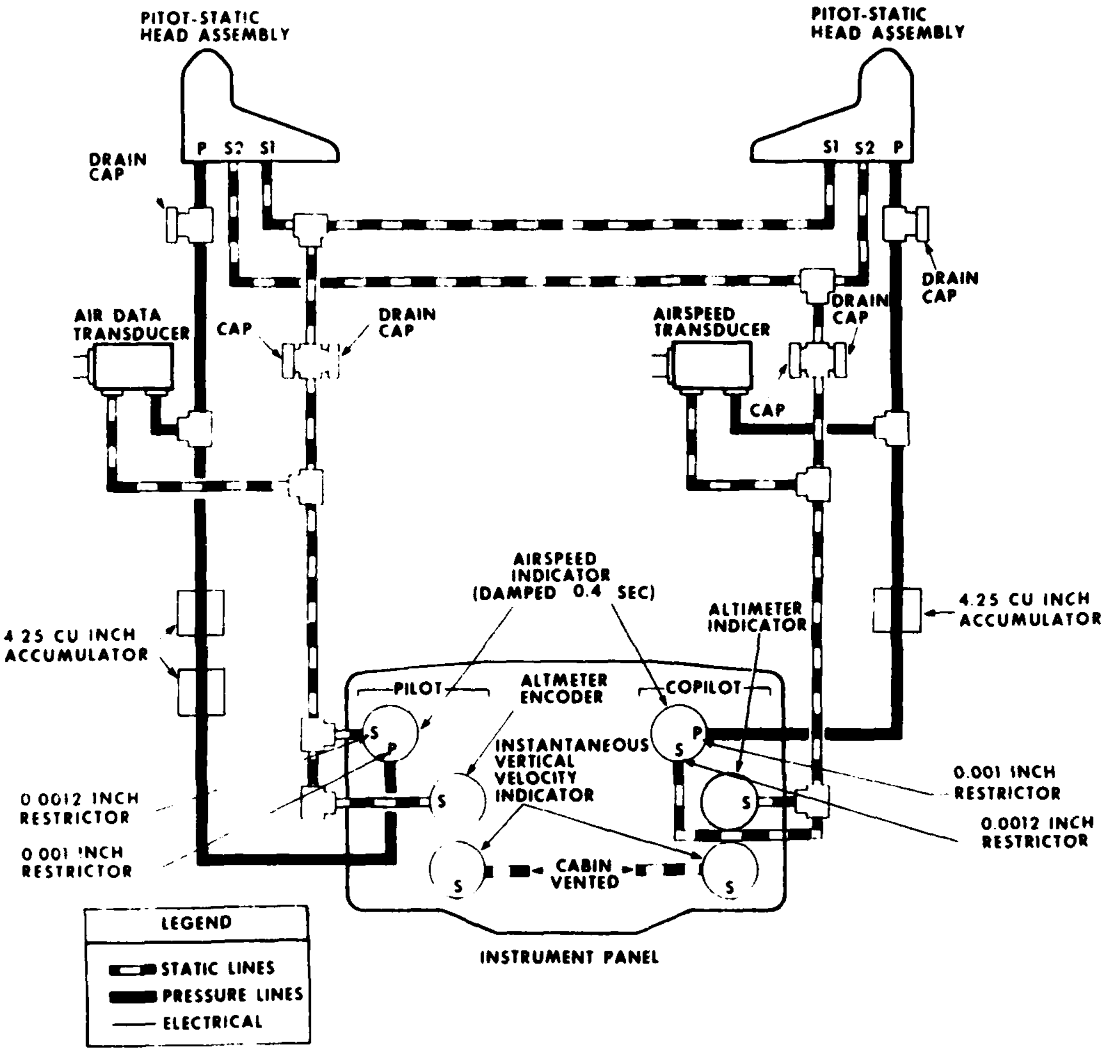


Figure 5. Pitot-Static Pressure System Block Diagram (PAE 2 Configuration)

panel. Airspeed information was recorded on magnetic tape through a separate transducer. Major features of the Nose Probe 2 System modifications are described below and summarized in table 5.

Pitot-Static System

18. The UH-60A with the Nose Probe 2 System consists of two electrically heated unmodified overhead pitot-static tubes and a nose pitot probe installed on the avionics bay compartment door, 13.5 inches from the rear edge, 14.0 inches right of centerline, and parallel to the aircraft longitudinal axis (photos 7 and 8). The unheated nose pitot probe was connected to a separate airspeed indicator with both flexible and fixed pneumatic lines. The right overhead probe (No. 2) provided ram pressure to the pilot airspeed indicator and the air data transducer. The left overhead probe (No. 1) provided ram pressure to the copilot airspeed indicator and the airspeed transducer. The overhead probe orientation was in the PAE 2 configuration (photos 7 through 11).

19. The static sources for the two overhead systems remained interconnected and provided static pressure to the ship airspeed indicators and altimeters. The nose probe static system was referenced to the pilot ship static system. The vertical velocity indicators were vented to the cabin area.

20. The time constant damping of both ship airspeed indicators was increased to 0.4 seconds as in the PAE 2 system. The nose probe airspeed indicator was undamped. A simplified pitot-static block diagram is presented in figure 6.

Stabilator Control System

21. The stabilator control system was modified as per the PAE 1 and PAE 2 configurations (para 6).

Table 5. Nose Probe 2 Configuration

Item	Production	Nose Probe 2
Stabilator Damping	0.4 sec	3.0 sec (electrical)
Pitot-Tube Orientation	Straight	20 deg outboard 3 deg down
Stabilator Program	--	Collective gain reduced
Ship Airspeed Indicator Damping	0.0 sec	0.4 sec
Nose Probe Airspeed Indicator Damping	None	0.0 sec
VSI Static Source Location	S1, S2	Vented to cabin
Nose Probe	None	1) Pitot mounted 13.5" down, 14" right of centerline on avionics door 2) Static referenced to pilot ship system 3) Connected only to nose probe airspeed indicator located on copilot instrument panel

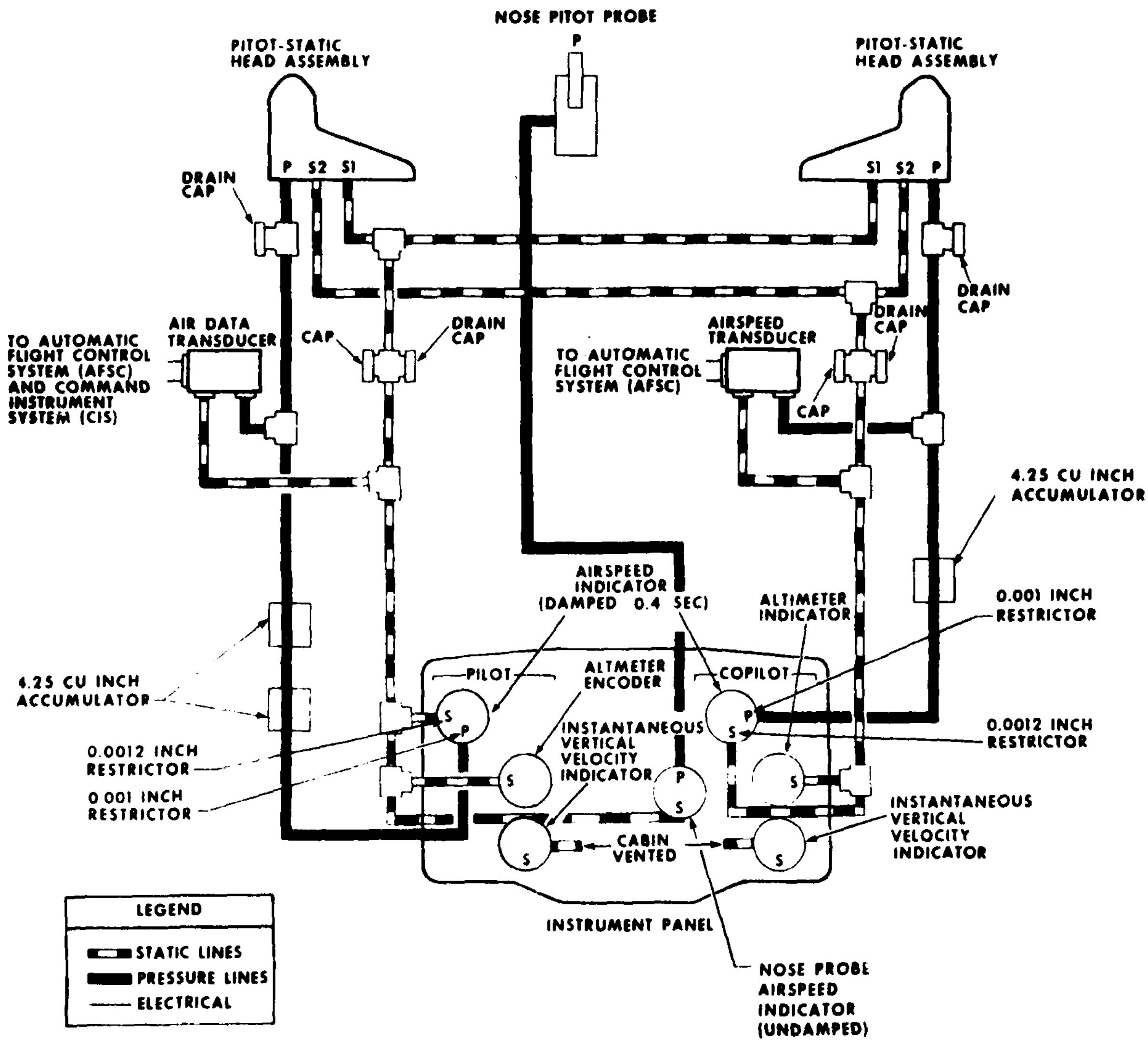


Figure 6. Pitot-Static Pressure System Block Diagram (Nose Probe 2 Configuration)

APPENDIX C. INSTRUMENTATION

GENERAL

1. The test instrumentation was installed, calibrated, and maintained by the US Army Aviation Engineering Flight Activity (USAAEFA) personnel, with guidance and additional instrumentation supplied by Sikorsky Aircraft personnel during airspeed system modification phases. A test boom with a swiveling pitot-static tube and angle of attack and sideslip vanes was installed at the nose of the aircraft. Data was obtained from calibrated instrumentation and displayed or recorded as indicated below.

Pilot Station

Airspeed (boom)
Airspeed (ship)*
Altitude (boom)
Altitude (ship)*
Altitude (radar-dual range)*
Rate of climb (boom)
Rate of climb (ship)
Rotor speed (digital)
Control positions
   Longitudinal
   Lateral
   Pedal
   Collective
Angle of sideslip
Sensitive bank angle (cg lateral acceleration)

Copilot Station

Airspeed (ship)*
Airspeed (nose probe)
Altitude (ship)*
Altitude (dual range)*
Rate of climb (ship)
Ballast cart position
Event switch/tape control head

Engineer Station

Total air temperature
Fuel used (both engines)
Fuel used (APU)
Event switch/tape control head
Time code/run number display

*Calibrated - production system indicator

Digital (PCM) Data Paramters

Airspeed (boom)
Airspeed (ship - pilot system)
Airspeed (ship - copilot system)
Airspeed (nose probe)
Airspeed (trailing pitot-static bomb system)
Airspeed (air data transducer - pilot system)
Airspeed (airspeed transducer - copilot system)
Airspeed (stabilator amplifier output - pilot system)
Airspeed (stabilator amplifier output - copilot system)
Altitude (boom) (Garrett transducer)
Altitude (ship - pilot system)
Altitude (ship - copilot system)
Altitude (trailing pitot-static bomb system)
Altitude (air data transducer - pilot system)
Altitude (radar)
Rate of climb (boom)
Rate of climb (ship - pilot system)
Rate of climb (ship - copilot system)
Static differential pressure (ship - pilot system)
Static differential pressure (ship - copilot system)
Rotor speed
Control positions
- Longitudinal
- Lateral
- Pedal
- Collective

Angle-of-sideslip
Angle-of-attack
Fuel used (both engines)
Fuel used (APU)
Fuel temperature (both engines)
Fuel temperature (APU)
Main rotor shaft bending (2)
Engine torque (both engines)
Tail rotor impress pitch
Stability augmentation system output position
- Longitudinal
- Lateral
- Directional

Stabilator position
Ballast cart position
Total air temperature
Aircraft attitude
- Pitch
- Roll
- Yaw

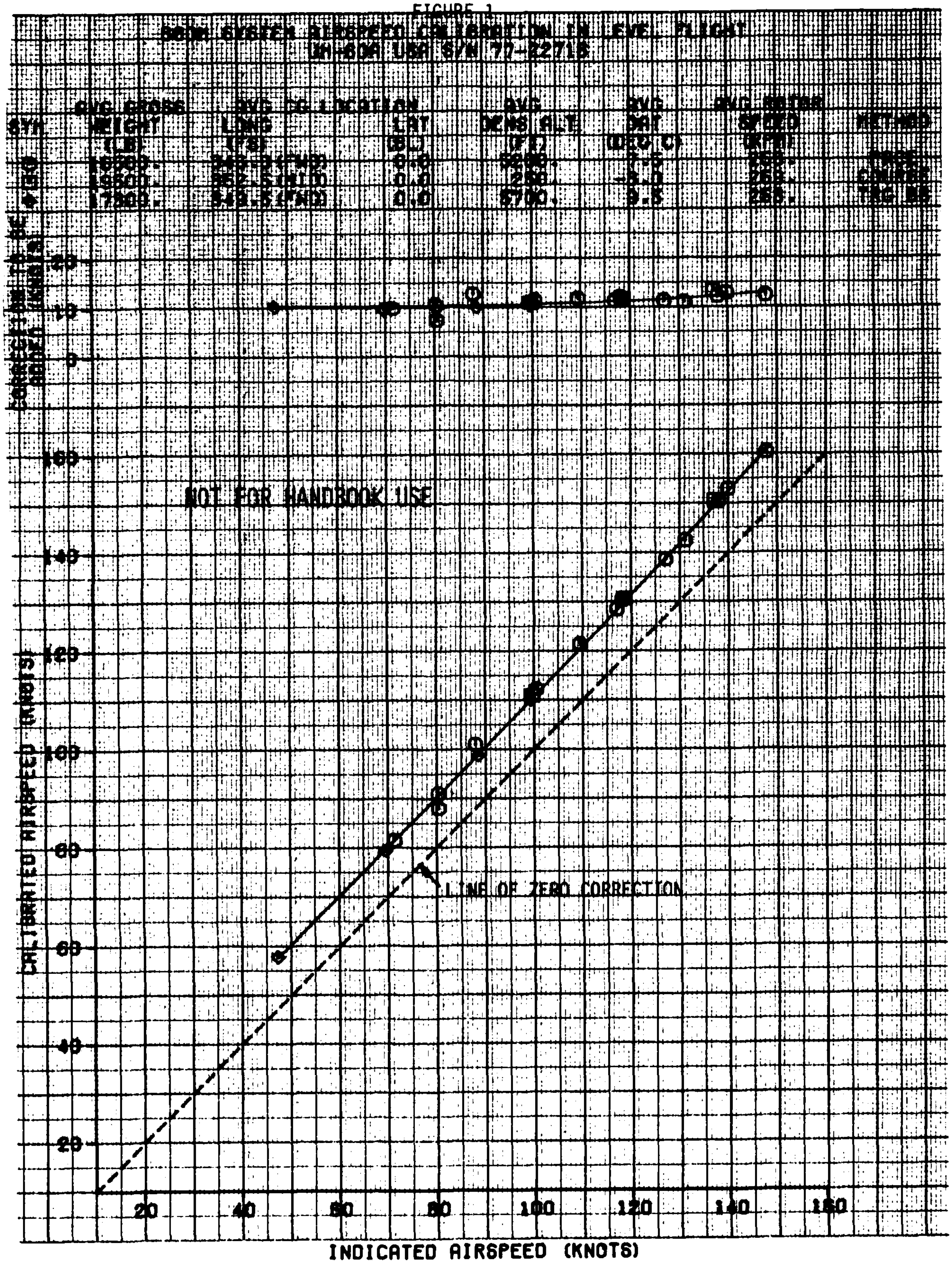
Aircraft angular rate
   Pitch
   Roll
   Yaw
Linear acceleration
   Center-of-gravity vertical (normal)
   Center-of-gravity lateral
   Center-of-gravity longitudinal

2. Provision was made for telemetry transmission of parameters.

AIRSPEED CALIBRATION

3. The test boom airspeed system was calibrated during level flight, climb, and autorotation. The T-28 pace aircraft, trailing bomb pitot-static system, and ground speed course were all used in determining position error in level flight. The altitude depression method was utilized to check the accuracy of the level flight position error calibration. The calibrated trailing bomb was used during climb and descent. The position error of the boom airspeed system is presented in figures 1 and 2.

FIGURE 1


UH-60A USA S/N 77-22716
SYM
METHOD
NOT FOR HANDBOOK USE
LINE OF ZERO CORRECTION
CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
20
40
60
80
100
120
140
160

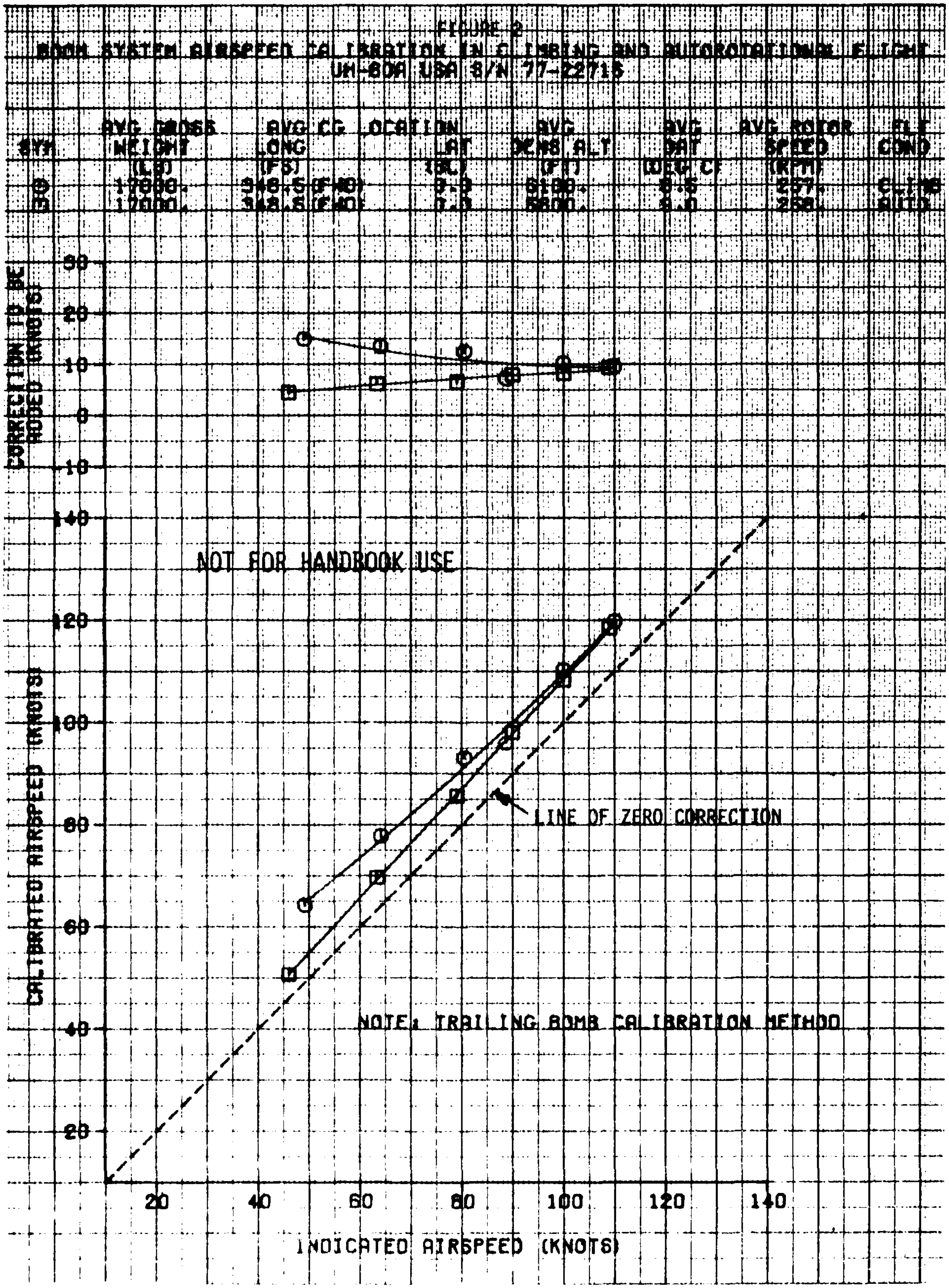


FIGURE 2
BOOM SYSTEM AIRSPEED CALIBRATION IN CLIMBING AND AUTOROTATIONAL FLIGHT
UH-60A USA S/N 77-22716

APPENDIX D. TEST TECHNIQUES AND DATA ANALYSIS METHODS

AIRCRAFT WEIGHT AND BALANCE

1. The aircraft was weighed in the instrumented configuration with full oil and all fuel drained prior to the start of the program. The initial weight of the aircraft was 12,280 pounds with the longitudinal center-of-gravity (cg) located at FS 352.8 with the cg of the empty ballast cart located at FS 301. The fuel cells and an external sight gage were also calibrated. The measured fuel capacity using the gravity fueling method was 364 gallons. The fuel weight for each test flight was determined prior to engine start and after engine shutdown by using the external sight gage to determine the volume and measuring the specific gravity of the fuel. The calibrated cockpit fuel totalizer indicator was used during the test and at the end of each test was compared with the sight gage readings. Aircraft cg was controlled by a moveable ballast system which was manually positioned to maintain a constant cg while fuel was burned. The moveable ballast system was a cart (2000-pound capacity) attached to the cabin floor by rails and driven by an electric screw jack with a total longitudinal travel of 72.3 inches.

AIRCRAFT PITOT-STATIC SYSTEM CALIBRATION

2. A test boom incorporating a swiveling pitot-static tube was the reference used for determining airspeed position error of the pilot and copilot ship systems, and the nose mounted pitot probe.

3. Altitude position error of the pilot and copilot ship systems was determined by flying at a constant radar altitude over a ground speed course from hover to maxium level flight airspeed. The radar altitude height added to the boom system altitude measurement with the aircraft positioned on the ground, provided the reference altitude.

ANGLE-OF-ATTACK

4. Angle-of-attack was measured as the angle between the relative wind and the aircraft longitudinal axis. Photo 1 shows the position of the angle-of-attack vane on the nose mounted test boom as installed on the UH-60A. Sign convention used is depicted in figure 1. Arrows indicate the direction of the relative wind. Climbing flight, downward flow of air in relation to the longitudinal axis, would be represented by a downward pointing arrow (vane pointing upward) and assigned a negative value.

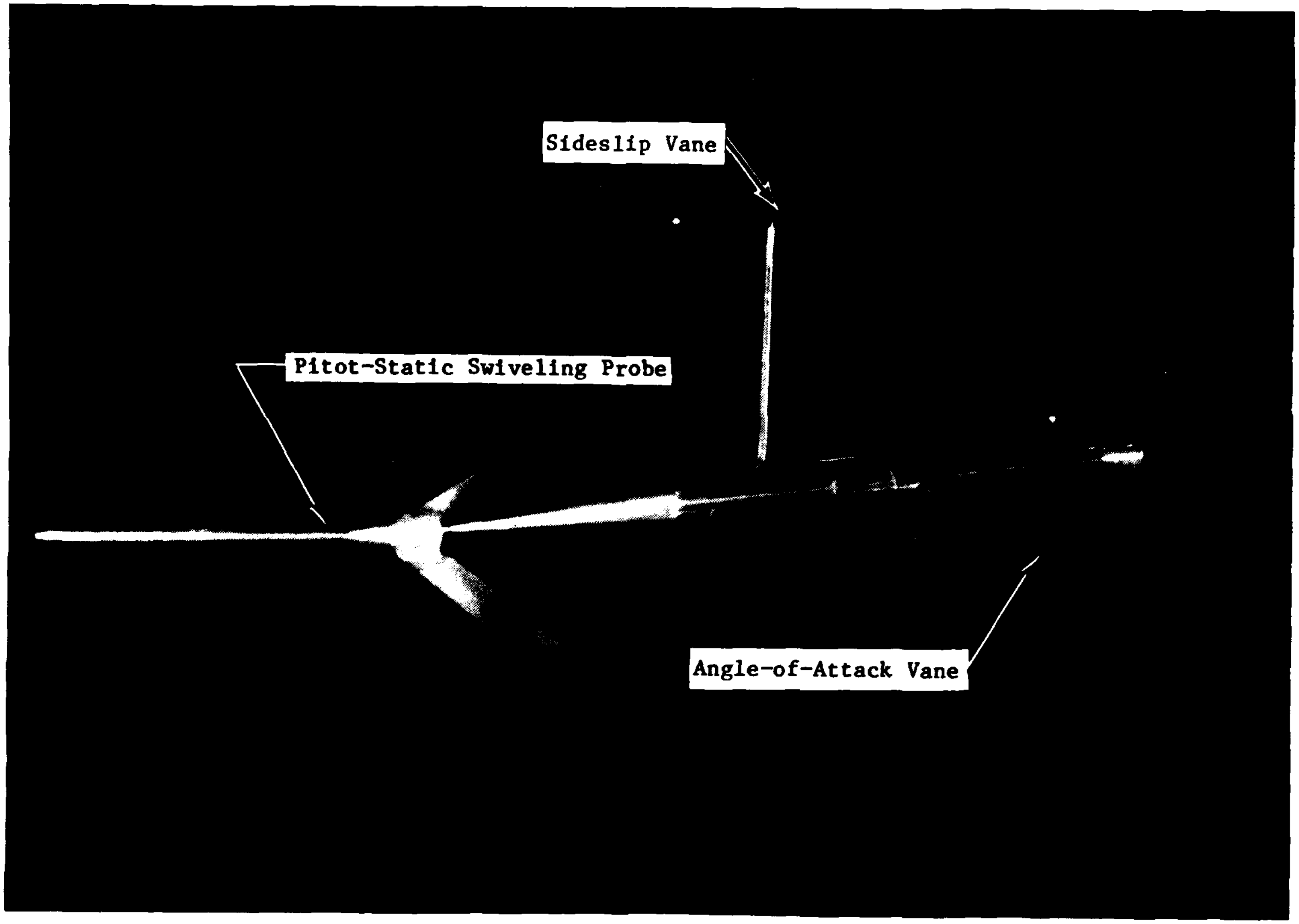


Photo 1. Boom Sensors

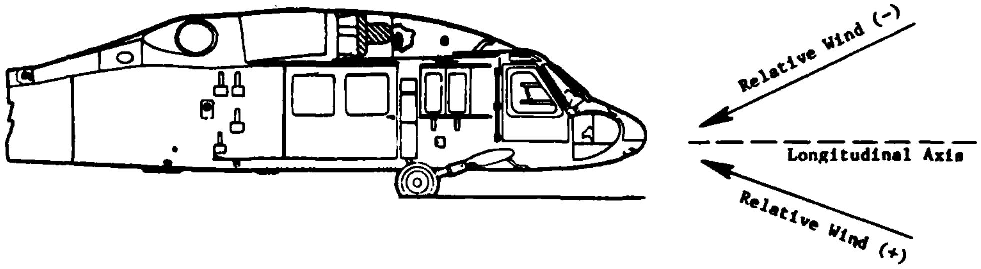
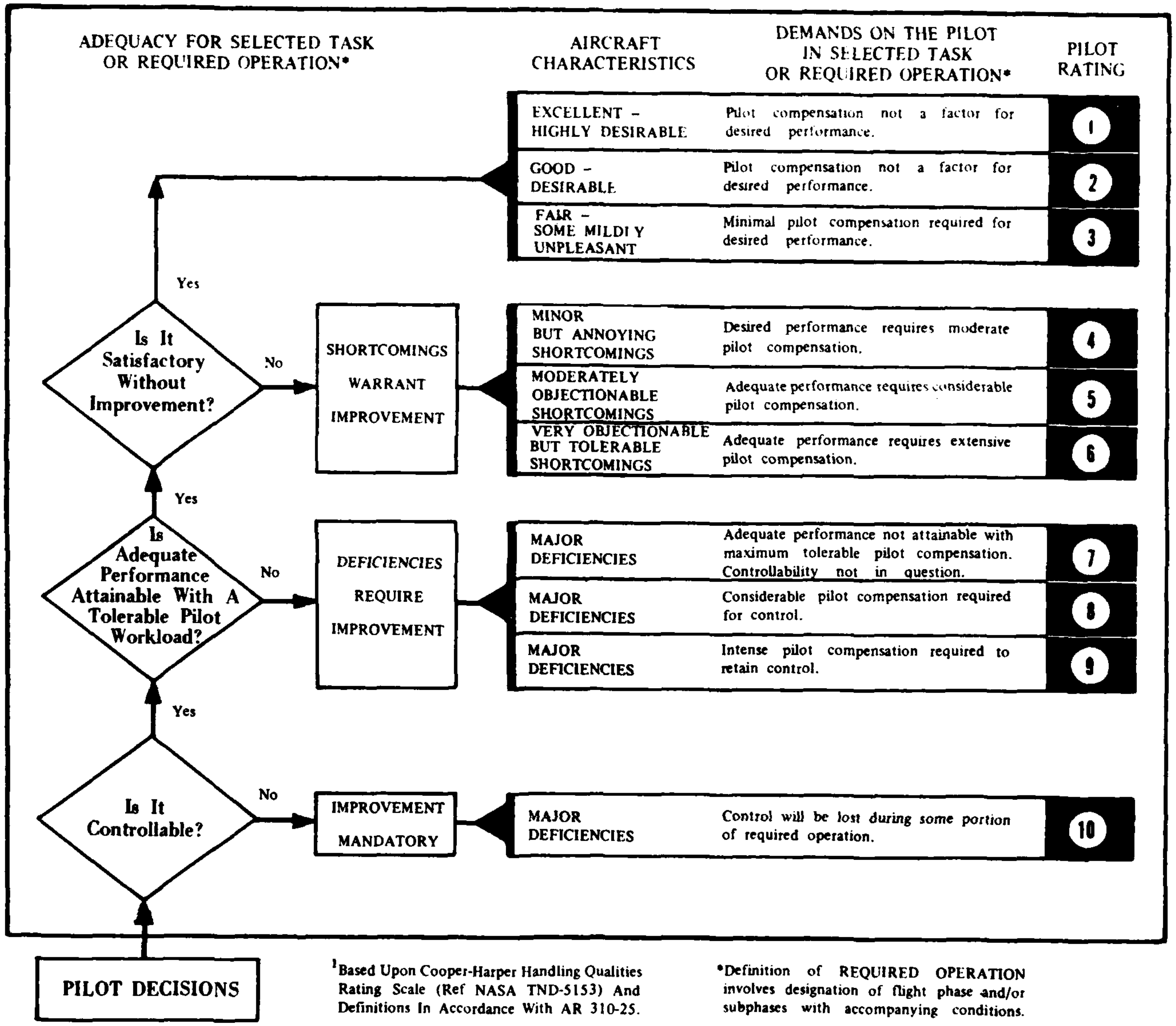


Figure 1. Angle-of-Attack Sign Convention

HANDLING QUALITIES EVALUATION

5. Handling qualities were evaluated during all phases/types of testing. The basis for evaluation was the Handling Qualities Rating Scale shown in figure 2.



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

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

Figure 2. Handling Qualities Rating Scale

APPENDIX E. TEST DATA

INDEX

FIGURE 1
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PRODUCTION SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
21840.	360.3(AFT)	0.0(MID)	1600.	6.6	258.	12.	ON

NOTES: 1. SLOW ACCELERATION TAKEOFF
2. PRODUCTION STABILATOR SCHEDULE
3. PRODUCTION DAMPED STABILATOR
4. PITOT-STATIC PROBES IN STANDARD CONFIGURATION

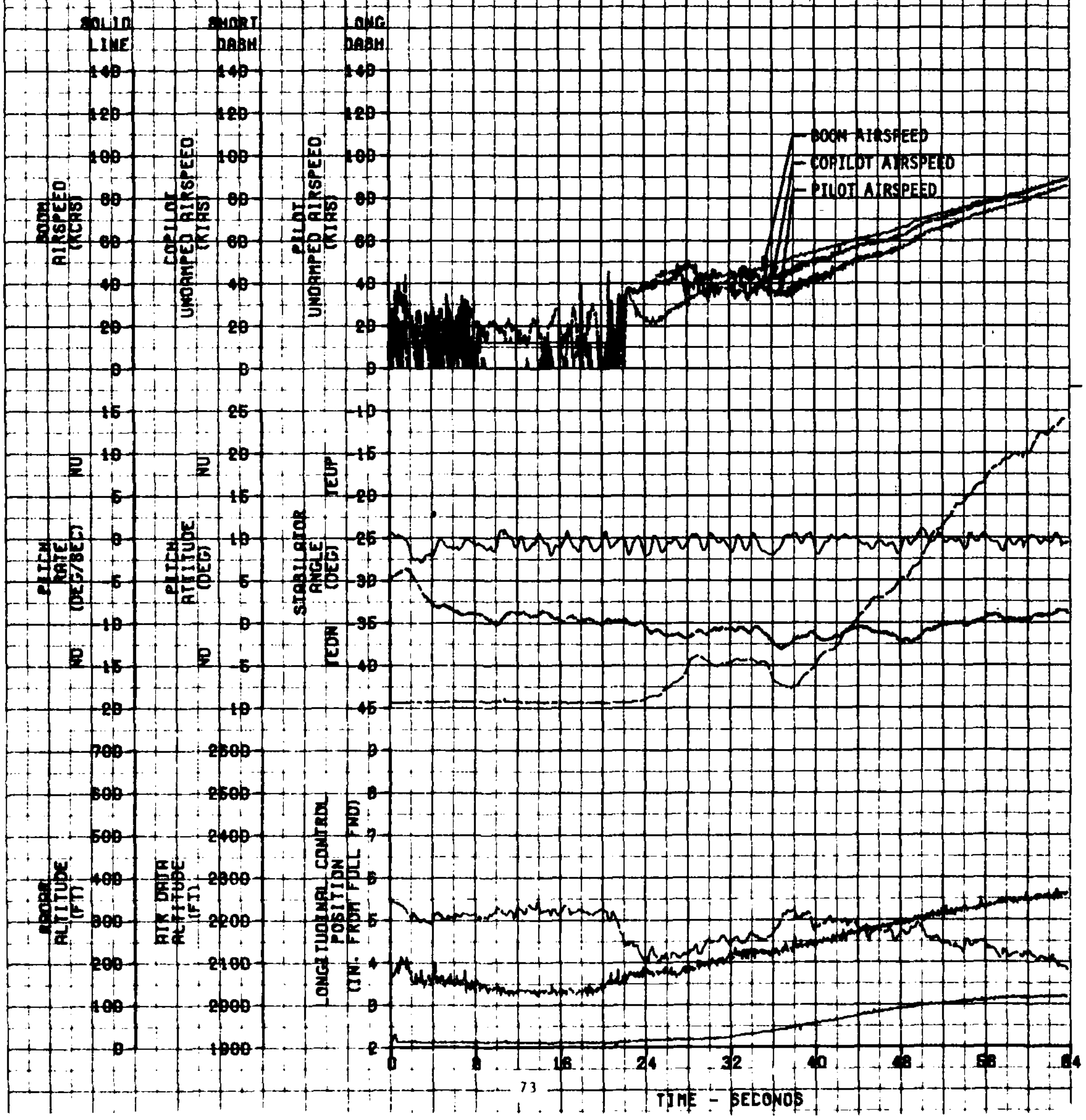


FIGURE 2
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PRODUCTION SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
21520.	360.1(AFT)	0.0(MID)	1540.	6.0	258.	12.	ON

NOTES: 1. IRP TAKEOFF
2. PRODUCTION STABILATOR SCHEDULE
3. PRODUCTION DAMPED STABILATOR
4. PITOT-STATIC PROBES IN STANDARD CONFIGURATION

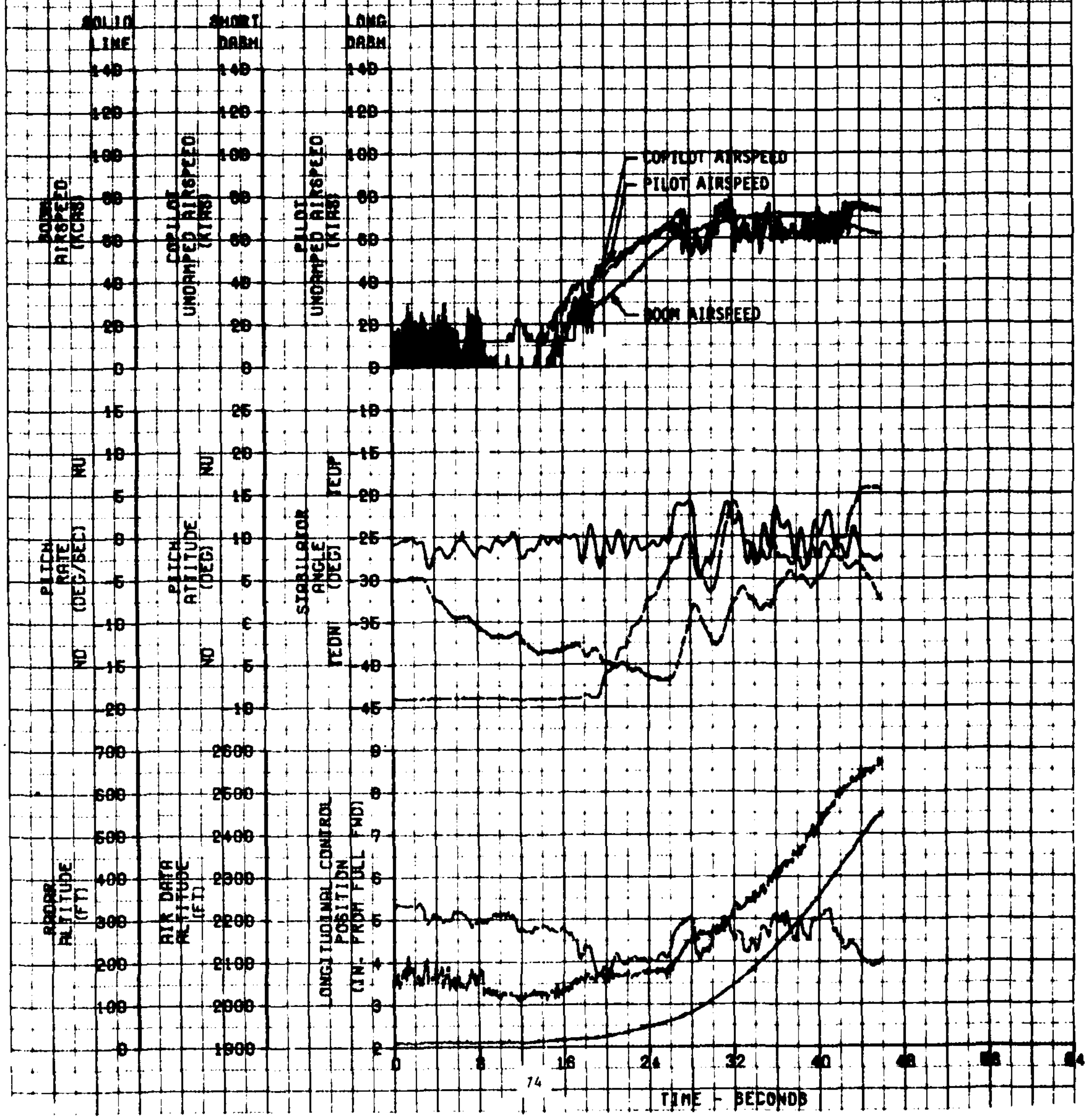


FIGURE 3
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PRODUCTION SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
21200.	360.0(AFT)	0.0(MID)	5000.	10.0	258.	65.	ON

NOTES: 1. IRP CLIMB
2. PRODUCTION STABILATOR SCHEDULE
3. PRODUCTION DAMPED STABILATOR
4. PITOT-STATIC PROBES IN STANDARD CONFIGURATION

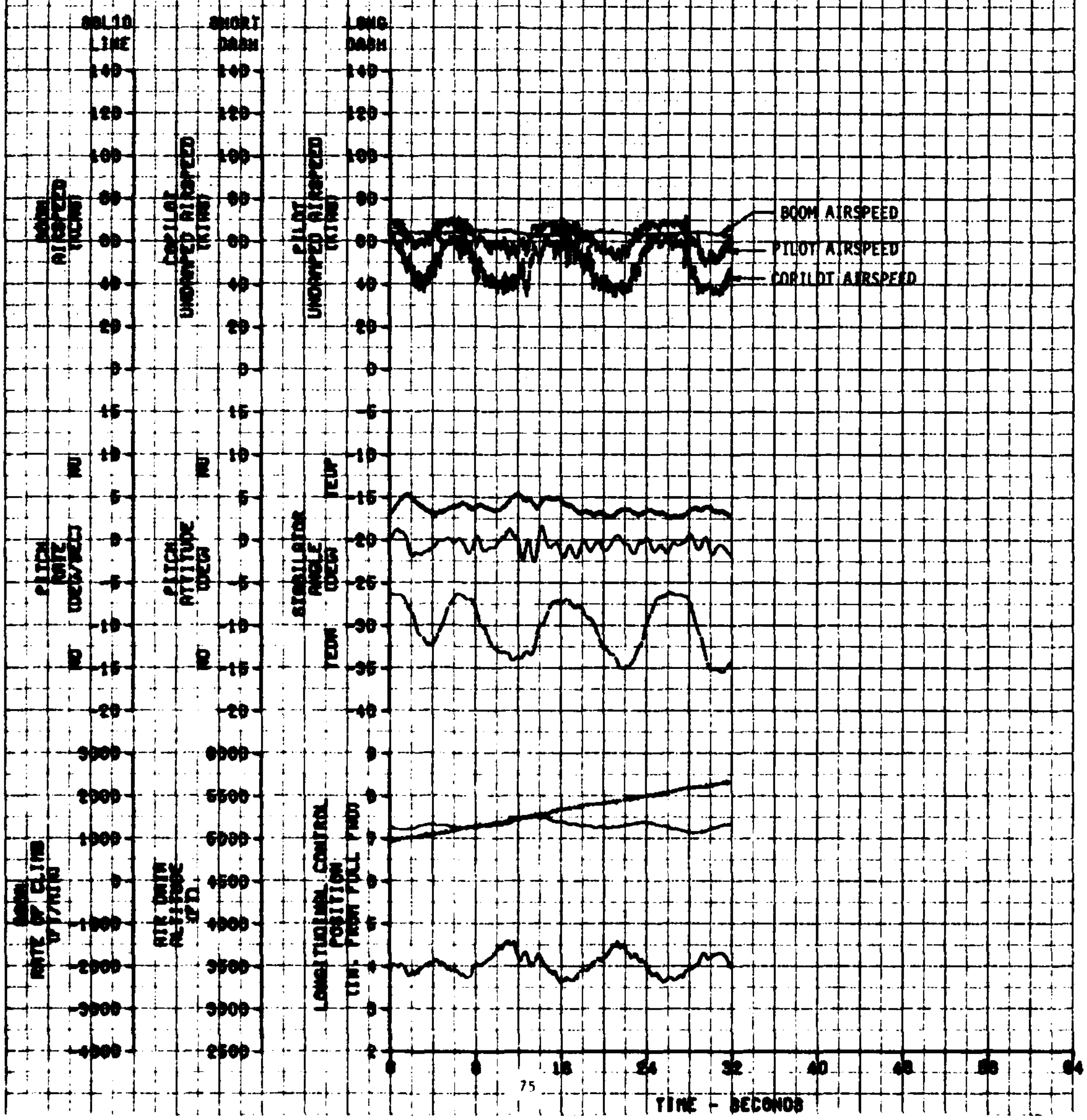
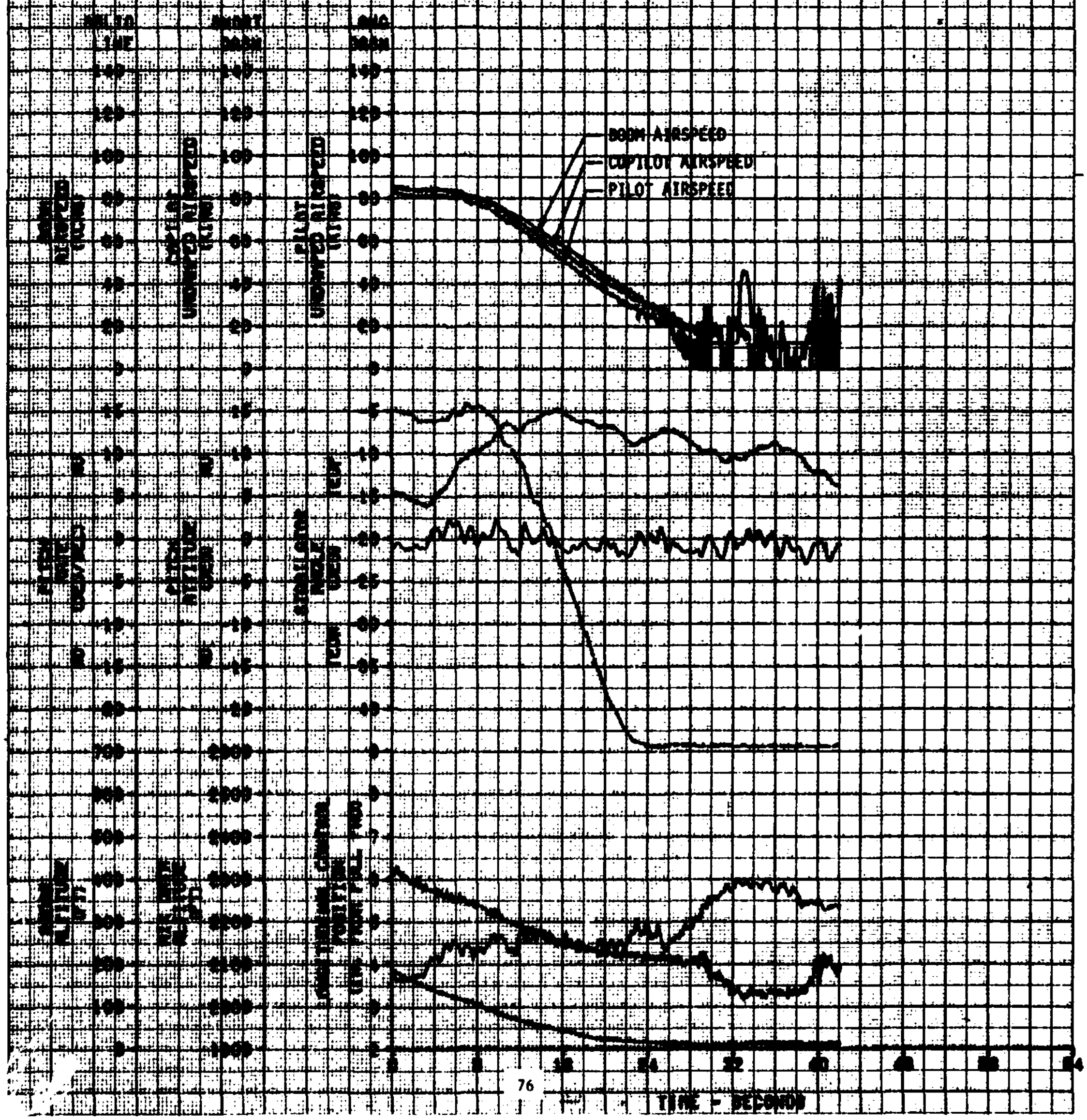


FIGURE 4
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PRODUCTION SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
21000.	360.0(AFT)	0.0(MID)	1800.	7.0	257.	96.	ON

NOTES:
1. FAST APPROACH
2. PRODUCTION STABILATOR SCHEDULE
3. PRODUCTION DAMPED STABILATOR
4. PITOT-STATIC PROBES IN STANDARD CONFIGURATION



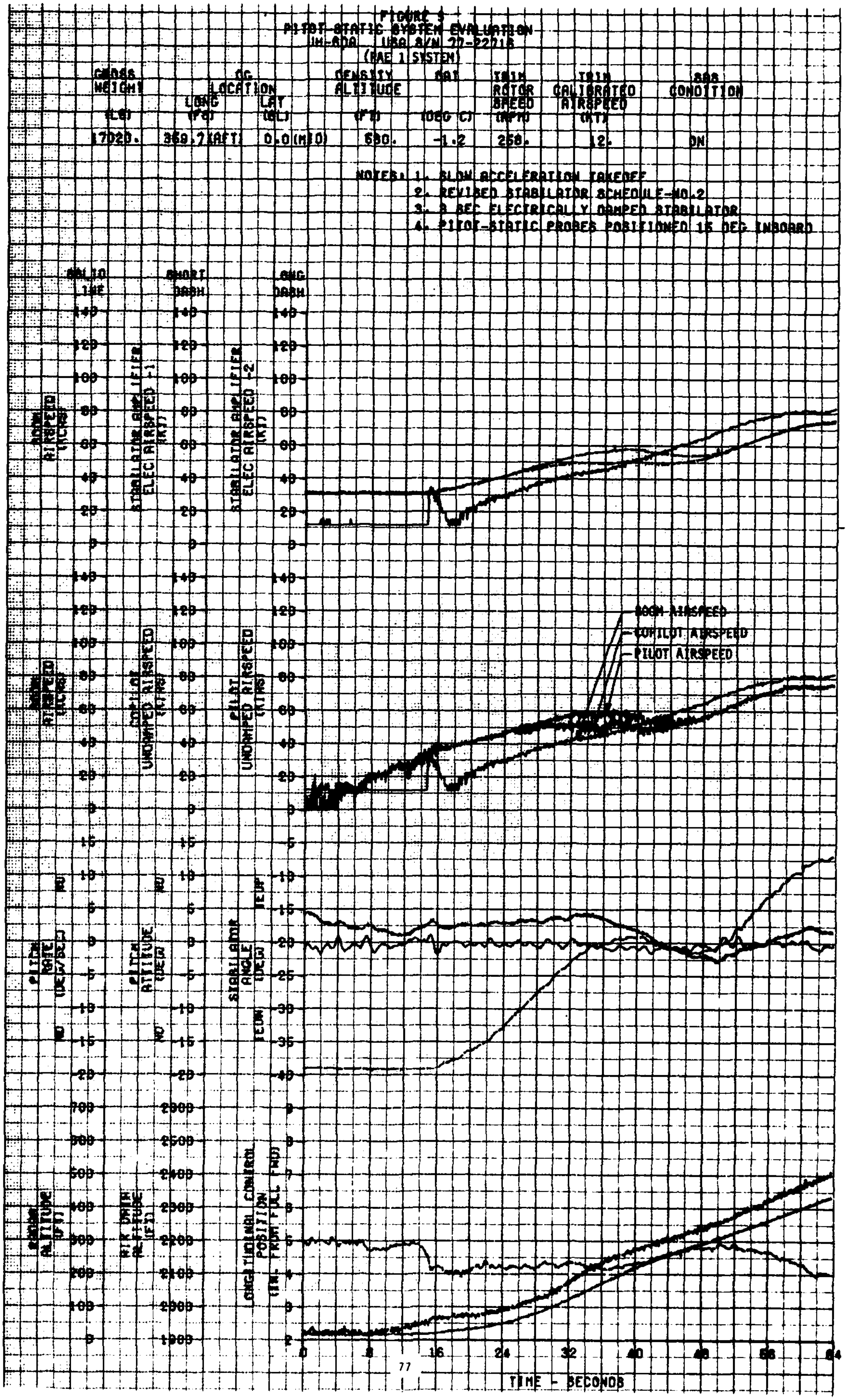
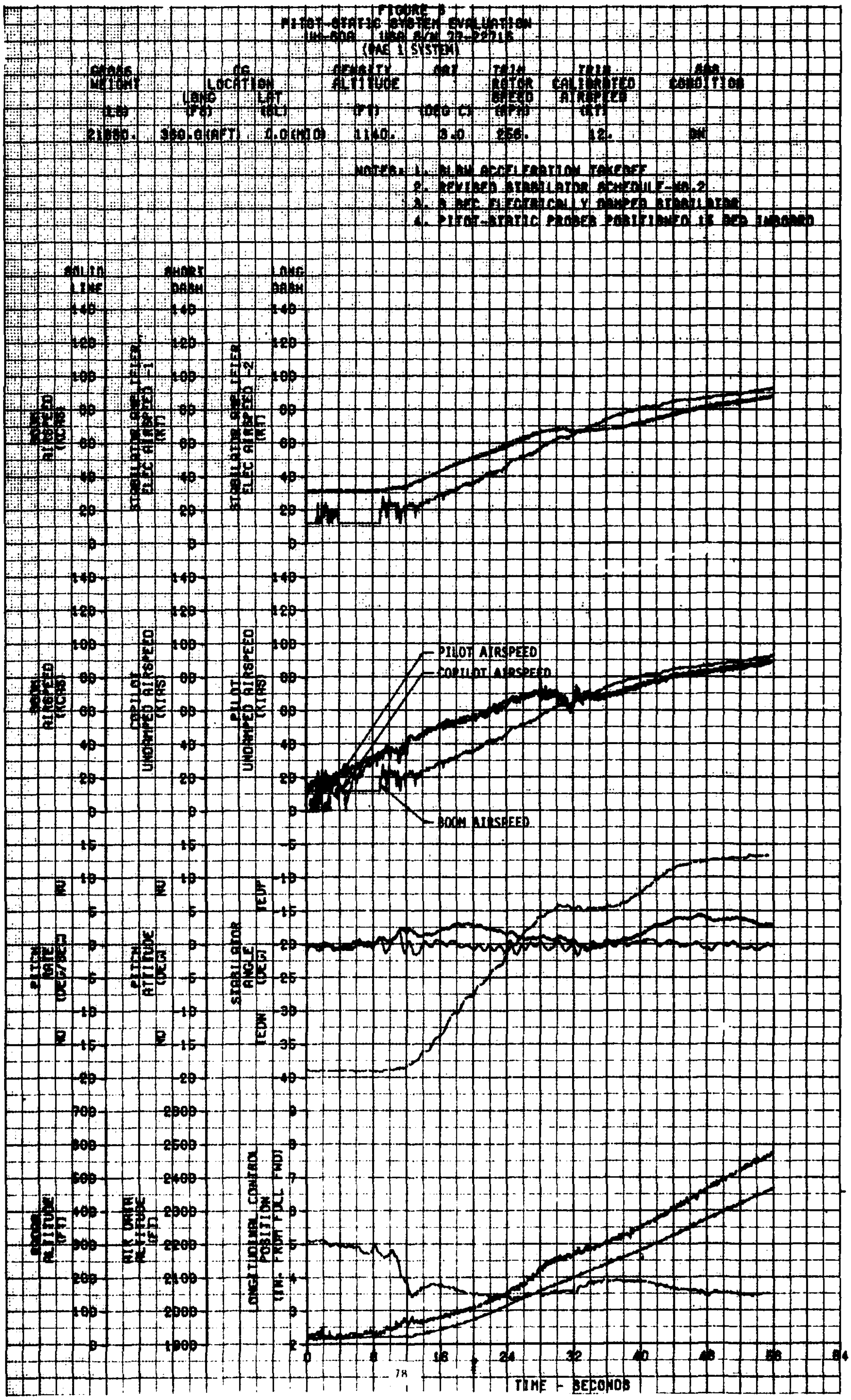


FIGURE 5
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(RAE 1 SYSTEM)
GROSS WEIGHT (LB) 17020.
CG LOCATION LONG (FS) 359.7(AFT)
LAT (BL) 0.0(MID)
DENSITY ALTITUDE (FT) 580.
OAT (DEG C) -1.2
TRIM ROTOR SPEED (RPM) 258.
TRIM CALIBRATED AIRSPEED (KT) 12.
SAS CONDITION ON
NOTES: 1. SLOW ACCELERATION TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
SOLID LINE
SHORT DASH
LONG DASH
BOOM AIRSPEED (KCAS)
STABILATOR AMPLIFIER ELEC AIRSPEED -1 (KT)
STABILATOR AMPLIFIER ELEC AIRSPEED -2 (KT)
COPILOT UNDAMPED AIRSPEED (KIAS)
PILOT UNDAMPED AIRSPEED (KIAS)
BOOM AIRSPEED
COPILOT AIRSPEED
PILOT AIRSPEED
PITCH RATE (DEG/SEC)
PITCH ATTITUDE (DEG)
STABILATOR ANGLE (DEG)
RADAR ALTITUDE (FT)
AIR DATA ALTITUDE (FT)
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TIME - SECONDS



PITOT-STATIC SYSTEM EVALUATION
(PAE 1 SYSTEM)
GROSS WEIGHT
CG LOCATION
LONG
LAT
DENSITY ALTITUDE
ROTOR SPEED
CALIBRATED AIRSPEED
CONDITION
21880.
1140.
256.
12.
NOTES: 1. SLOW ACCELERATION TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
4. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
SOLID LINE
SHORT DASH
LONG DASH
BOOM AIRSPEED (KCAS)
STABILATOR AMPLIFIER ELEC AIRSPEED -1 (KT)
STABILATOR AMPLIFIER ELEC AIRSPEED -2 (KT)
COPILOT UNDAMPED AIRSPEED (KIAS)
PILOT UNDAMPED AIRSPEED (KIAS)
PILOT AIRSPEED
COPILOT AIRSPEED
BOOM AIRSPEED
PITCH RATE (DEG/SEC)
PITCH ATTITUDE (DEG)
STABILATOR ANGLE (DEG)
TEDN
TEUP
NU
ND
BOOM ALTITUDE (FT)
AIR DATA ALTITUDE (FT)
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TIME - SECONDS
0
8
16
24
32
40
48
56
64

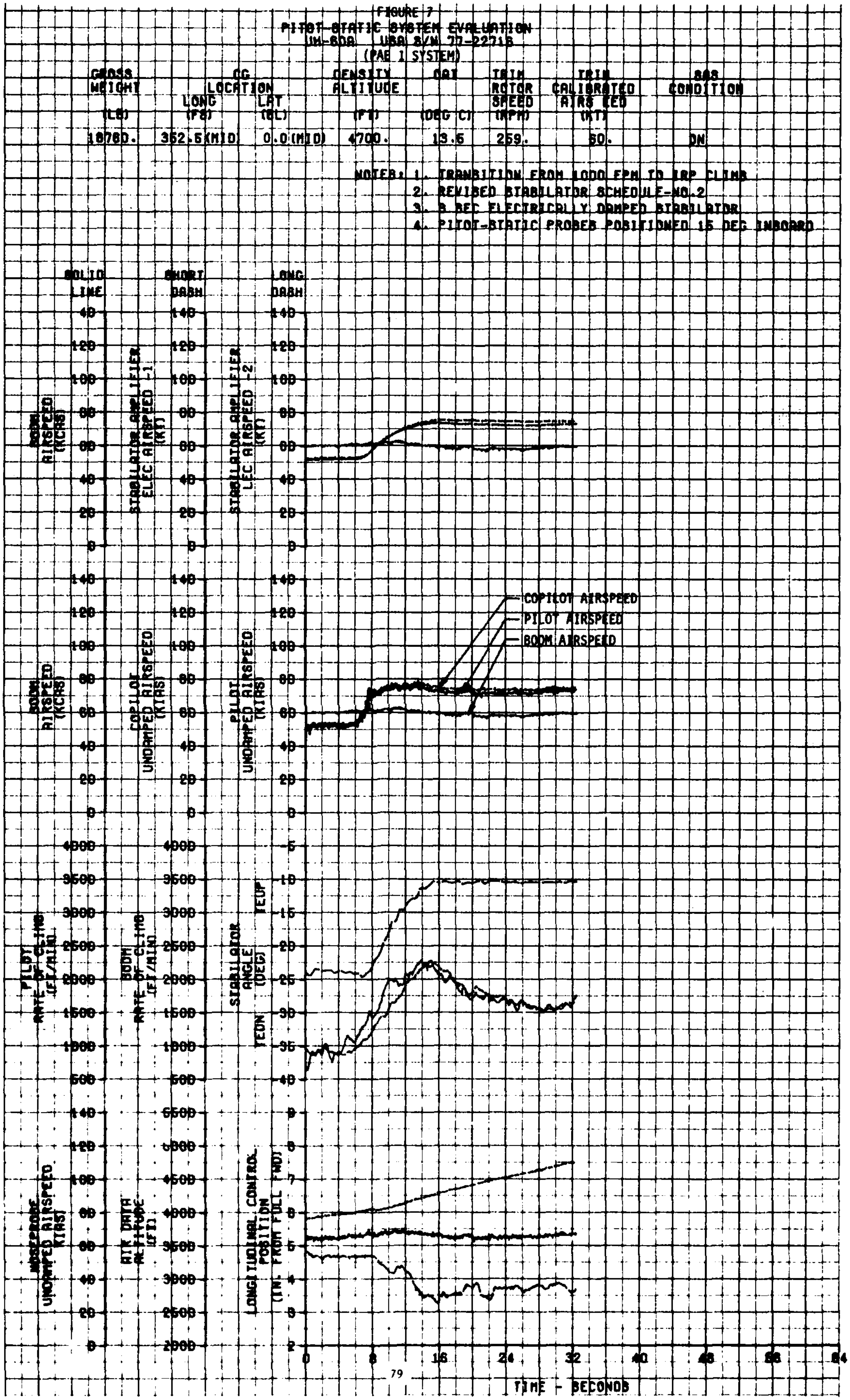


FIGURE 7
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAS 1 SYSTEM)

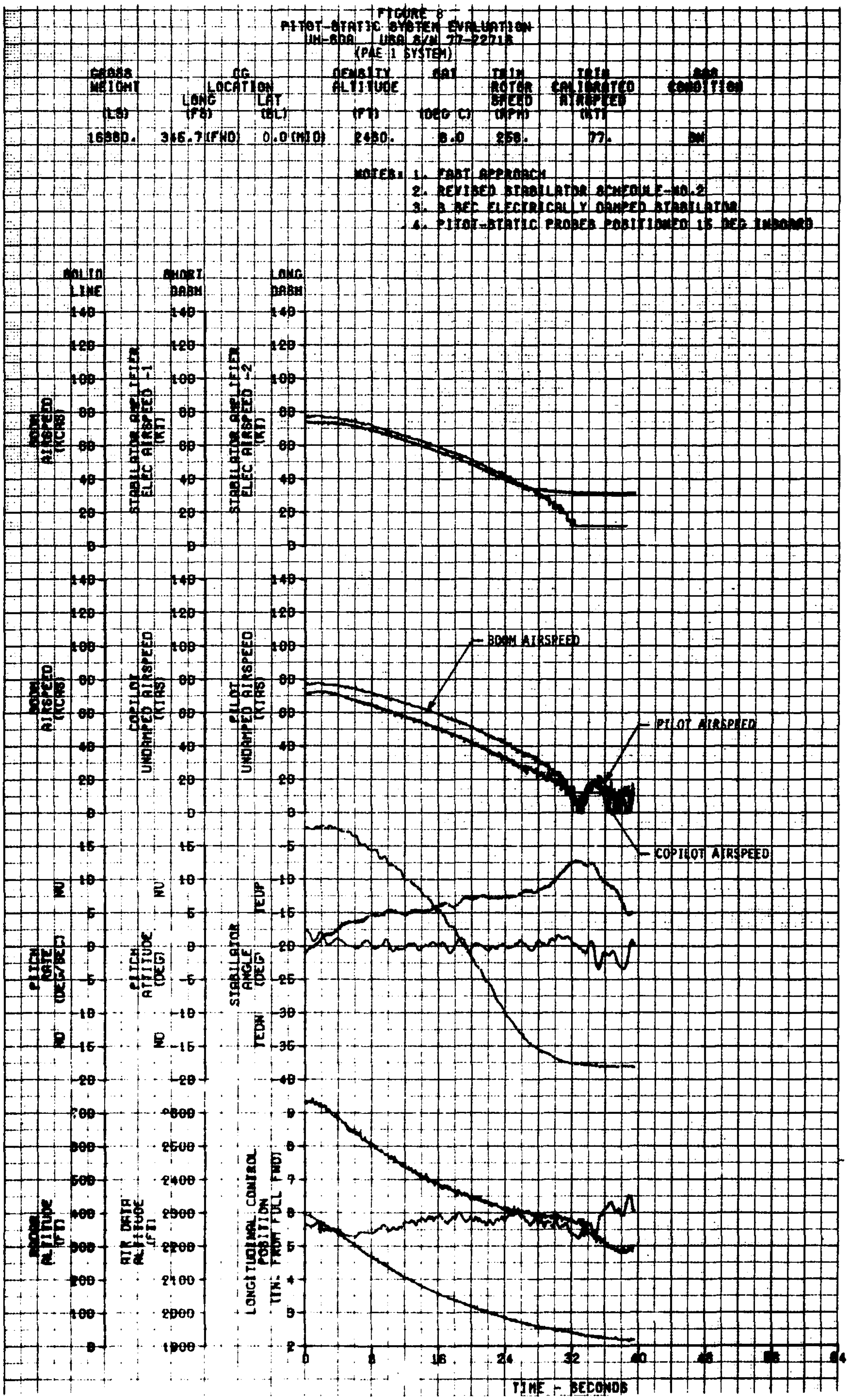


FIGURE 8
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)
GROSS WEIGHT (LB) 16880.
CG LOCATION LONG (FS) 346.7(FWD) LAT (BL) 0.0(MID)
DENSITY ALTITUDE (FT) 2480.
OAT (DEG C) 8.0
TRIM ROTOR SPEED (RPM) 258.
TRIM CALIBRATED AIRSPEED (KT) 77.
SAS CONDITION ON
NOTES: 1. FAST APPROACH
2. REVISED STABILATOR SCHEDULE NO.2
3. 8 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
SOLID LINE
SHORT DASH
LONG DASH
BOOM AIRSPEED (KCAS)
STABILATOR AMPLIFIER ELEC AIRSPEED -1 (KT)
STABILATOR AMPLIFIER ELEC AIRSPEED -2 (KT)
COPILOT UNDAMPED AIRSPEED (KIAS)
PILOT UNDAMPED AIRSPEED (KIAS)
BOOM AIRSPEED
PILOT AIRSPEED
COPILOT AIRSPEED
PITCH RATE (DEG/SEC)
PITCH ATTITUDE (DEG)
STABILATOR ANGLE (DEG)
NU
ND
TEUP
TEDN
RADAR ALTITUDE (FT)
AIR DATA ALTITUDE (FT)
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TIME - SECONDS

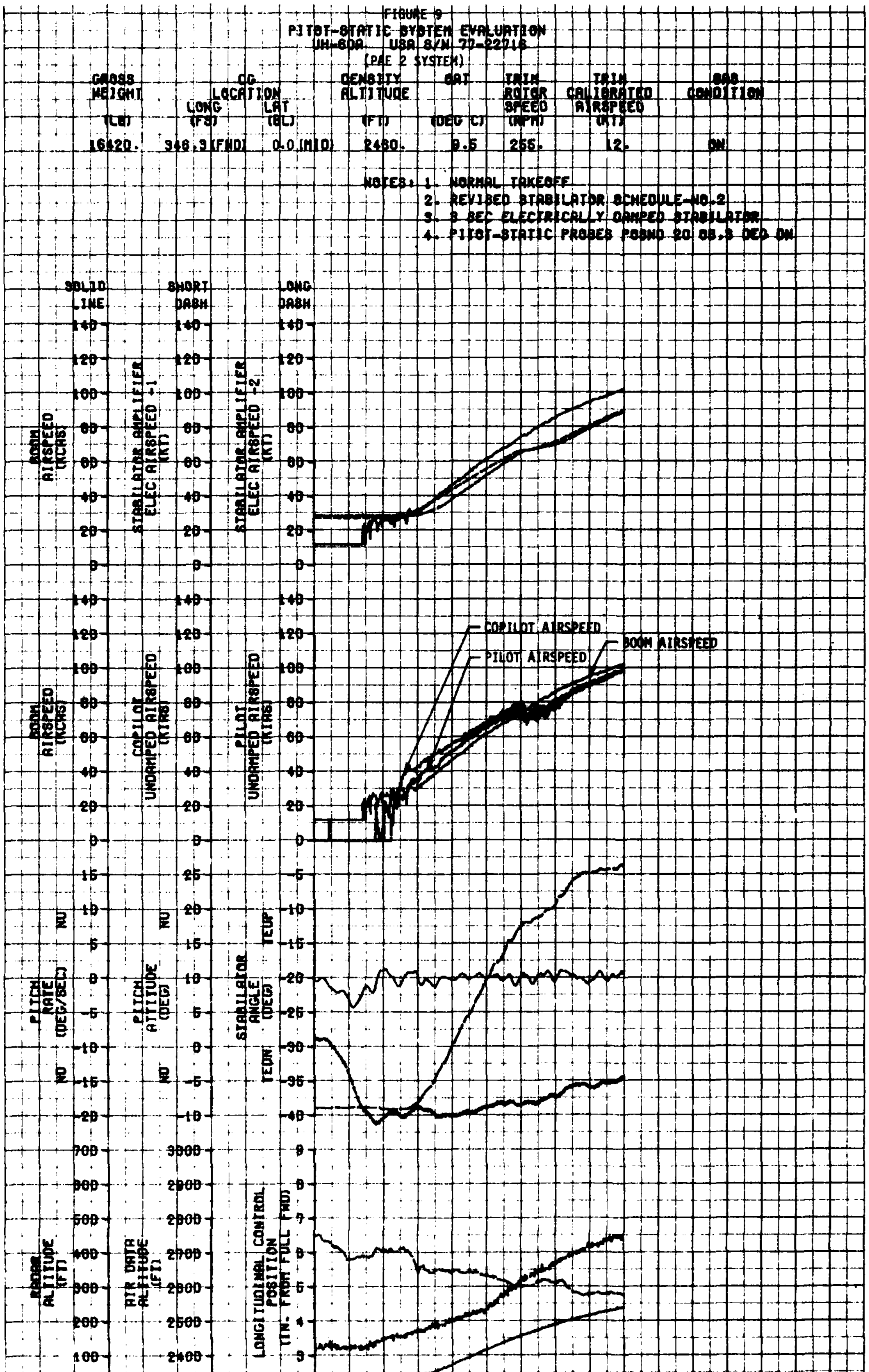


FIGURE 9
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)
GROSS WEIGHT (LB) 16420.
CG LOCATION LONG (FS) 346.9 (FWD)
LAT (BL) 0.0 (MID)
DENSITY ALTITUDE (FT) 2460.
OAT (DEG C) 9.5
TRIM ROTOR SPEED (RPM) 255.
TRIM CALIBRATED AIRSPEED (KT) 12.
SAS CONDITION ON
NOTES: 1. NORMAL TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSND 20 88.3 DEG ON
SOLID LINE
SHORT DASH
LONG DASH
BOOM AIRSPEED (KCAS)
STABILATOR AMPLIFIER ELEC AIRSPEED -1 (KT)
STABILATOR AMPLIFIER ELEC AIRSPEED -2 (KT)
COPILOT AIRSPEED
PILOT AIRSPEED
BOOM AIRSPEED
COPILOT UNDAMPED AIRSPEED (KIAS)
PILOT UNDAMPED AIRSPEED (KIAS)
PITCH RATE (DEG/SEC)
PITCH ATTITUDE (DEG)
STABILATOR ANGLE (DEG)
NU
ND
TEUP
TEDN
RADAR ALTITUDE (FT)
AIR DATA ALTITUDE (FT)
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TIME - SECONDS

FIGURE 10
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
16480.	346.2(FWD)	0.0(MID)	2540.	10.0	258.	12.	ON

NOTES: 1. SLOW ACCELERATION TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSND 20 88.3 DEG DN

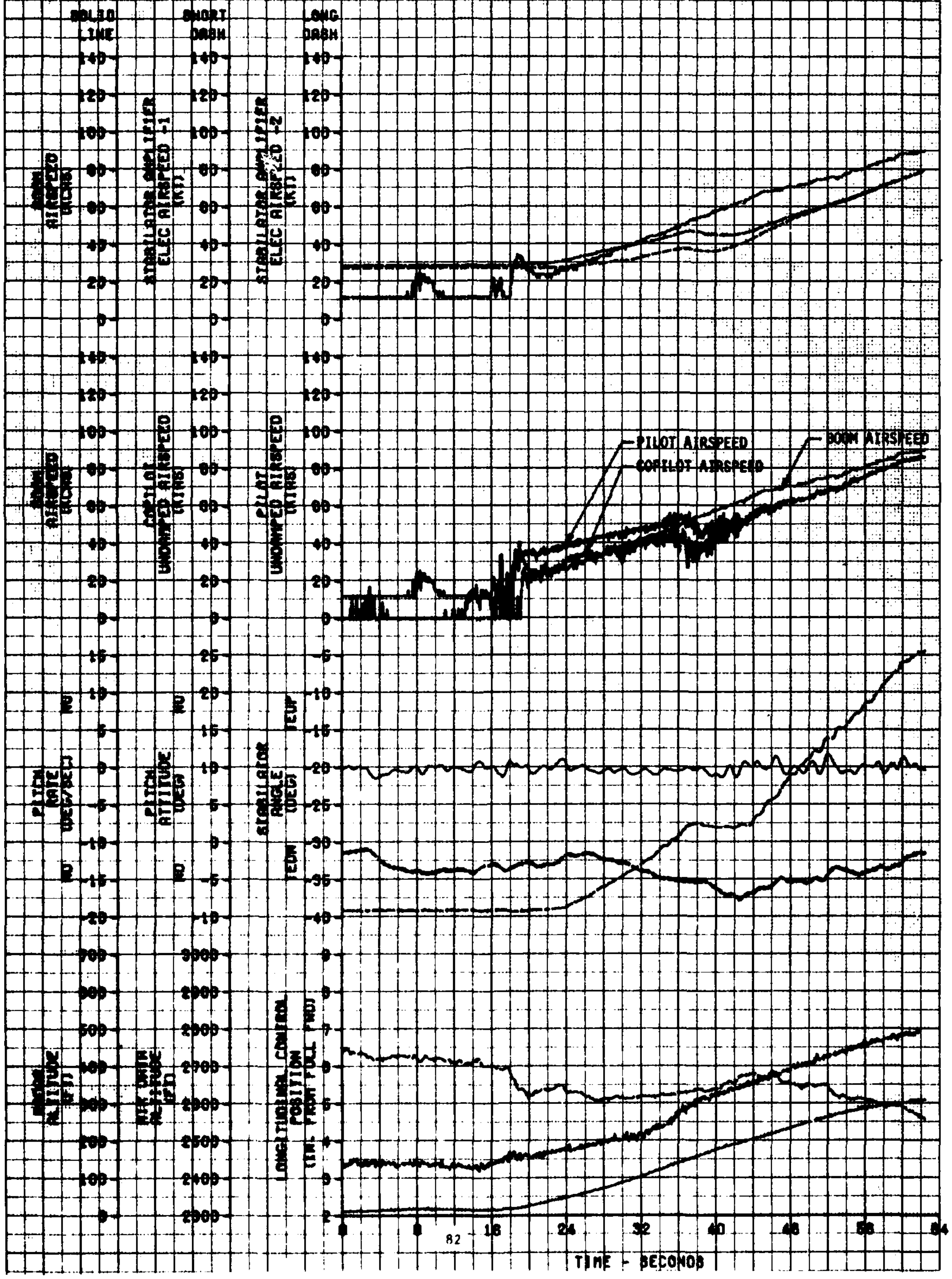


FIGURE 11
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
16320.	348.6 (FWD)	0.0 (MID)	2480.	8.5	258.	12.	ON

NOTES: 1. SLOW ACCELERATION TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSNO 20 88.3 DEG ON

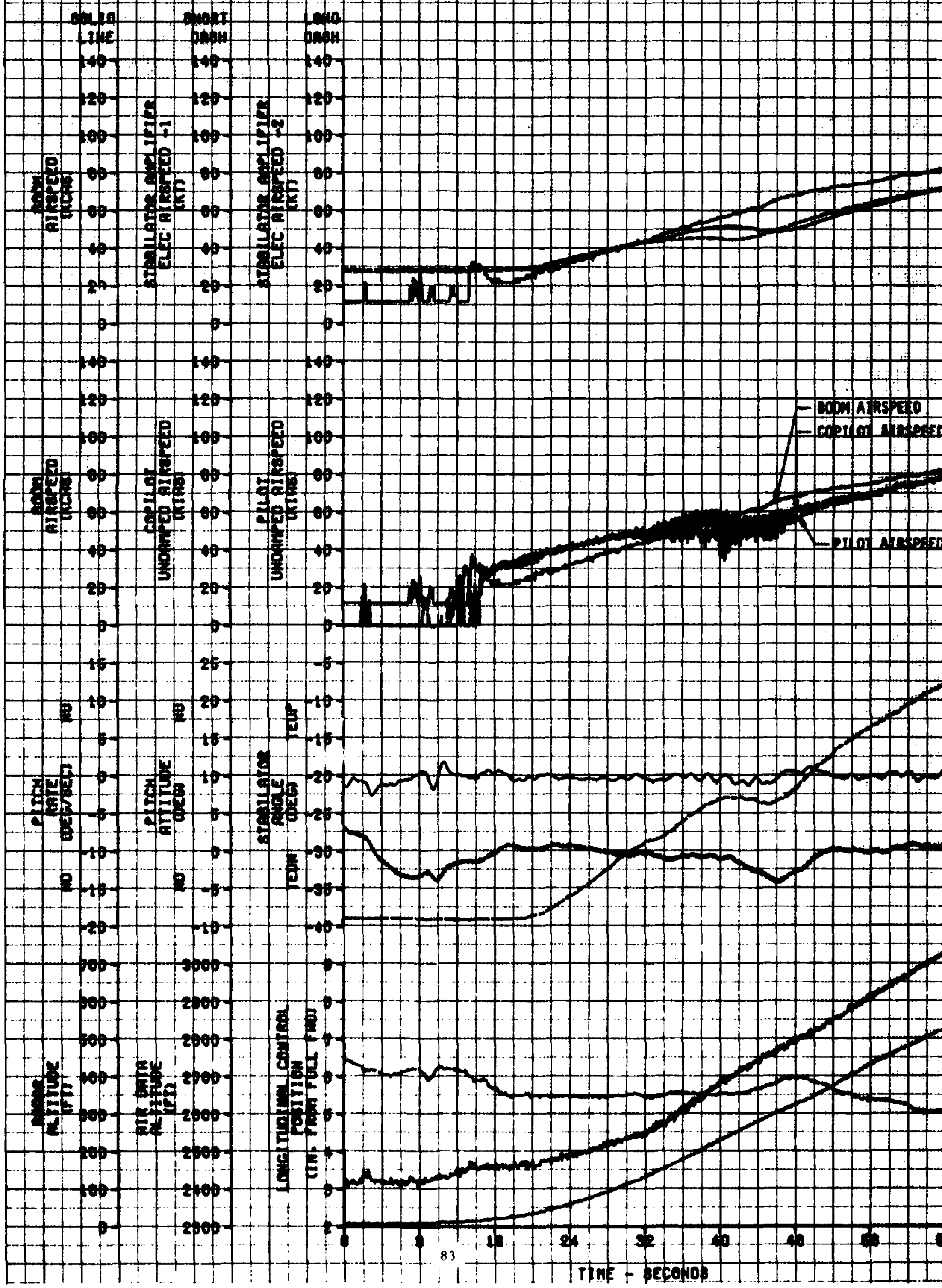
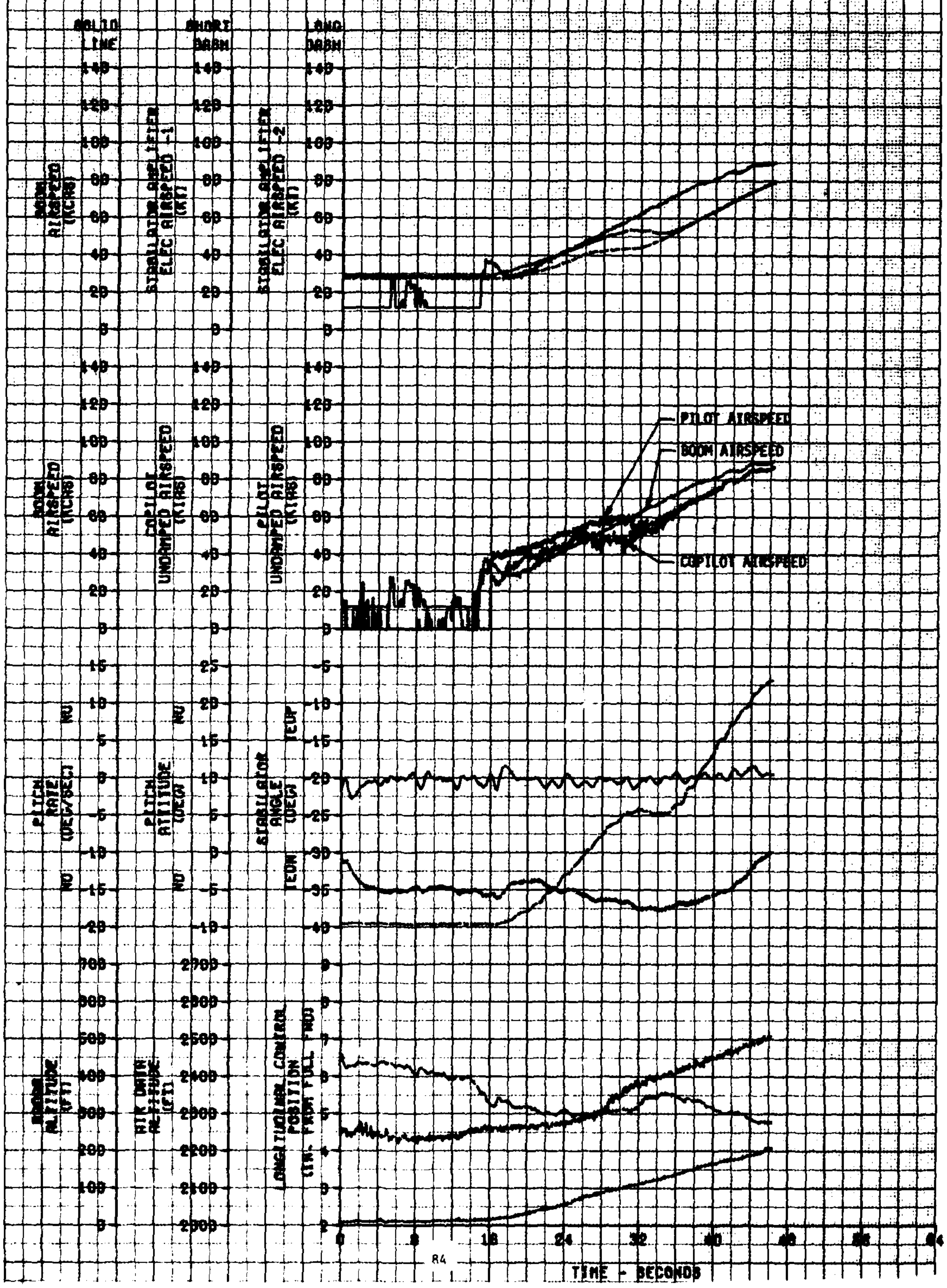


FIGURE 12
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
21900.	357.1(FWD)	0.0(MID)	2150.	8.5	258.	12.	ON

NOTES: 1. NORMAL TAKEOFF
2. REVISED STABILATOR SCHEDULE NO.2
3. 5 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSITIONED 20 DEG DN.5 DEG DN



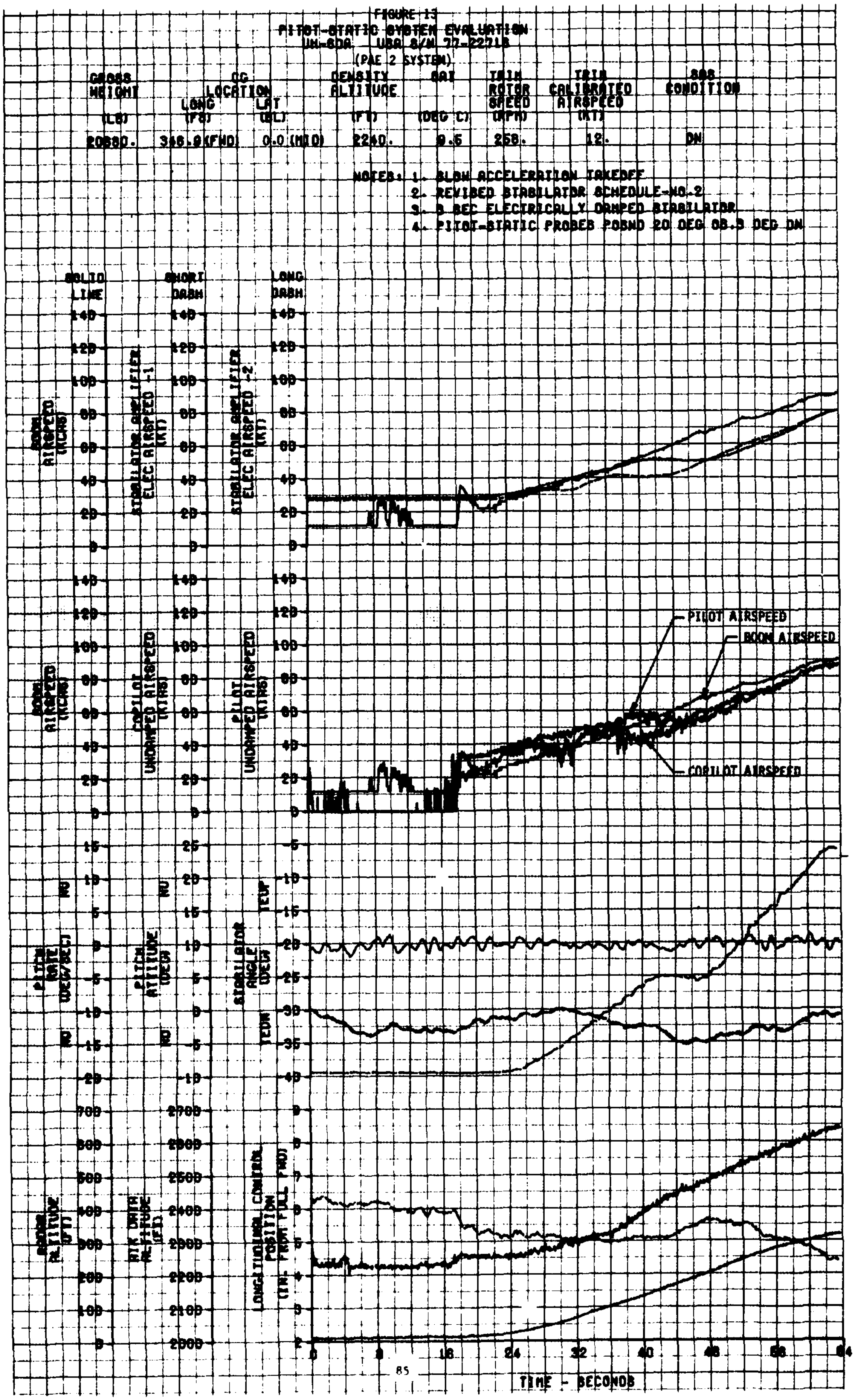


FIGURE 13
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22718
(PAE 2 SYSTEM)
GROSS WEIGHT (LB) 20880.
CG LOCATION LONG (FS) 346.9(FWD)
LAT (BL) 0.0 (MID)
DENSITY ALTITUDE (FT) 2240.
OAT (DEG C) 9.5
TRIM ROTOR SPEED (RPM) 258.
TRIM CALIBRATED AIRSPEED (KT) 12.
SAS CONDITION ON
NOTES: 1. SLOW ACCELERATION TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
3. 8 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSND 20 DEG OB.5 DEG DN
SOLID LINE
SHORT DASH
LONG DASH
BOOM AIRSPEED (KCAS)
STABILATOR AMPLIFIER ELEC AIRSPEED -1 (KT)
STABILATOR AMPLIFIER ELEC AIRSPEED -2 (KT)
COPILOT UNDAMPED AIRSPEED (KIAS)
PILOT UNDAMPED AIRSPEED (KIAS)
PILOT AIRSPEED
BOOM AIRSPEED
COPILOT AIRSPEED
PITCH RATE (DEG/SEC)
PITCH ATTITUDE (DEG)
STABILATOR ANGLE (DEG)
RADAR ALTITUDE (FT)
AIR DATA ALTITUDE (FT)
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TIME - SECONDS

FIGURE 14

PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
15840.	360.5(AFT)	0.0(MID)	1480.	4.0	258.	12.	ON

NOTES: 1. NORMAL TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
3. 8 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSND 20 DEG OB.8 DEG DN

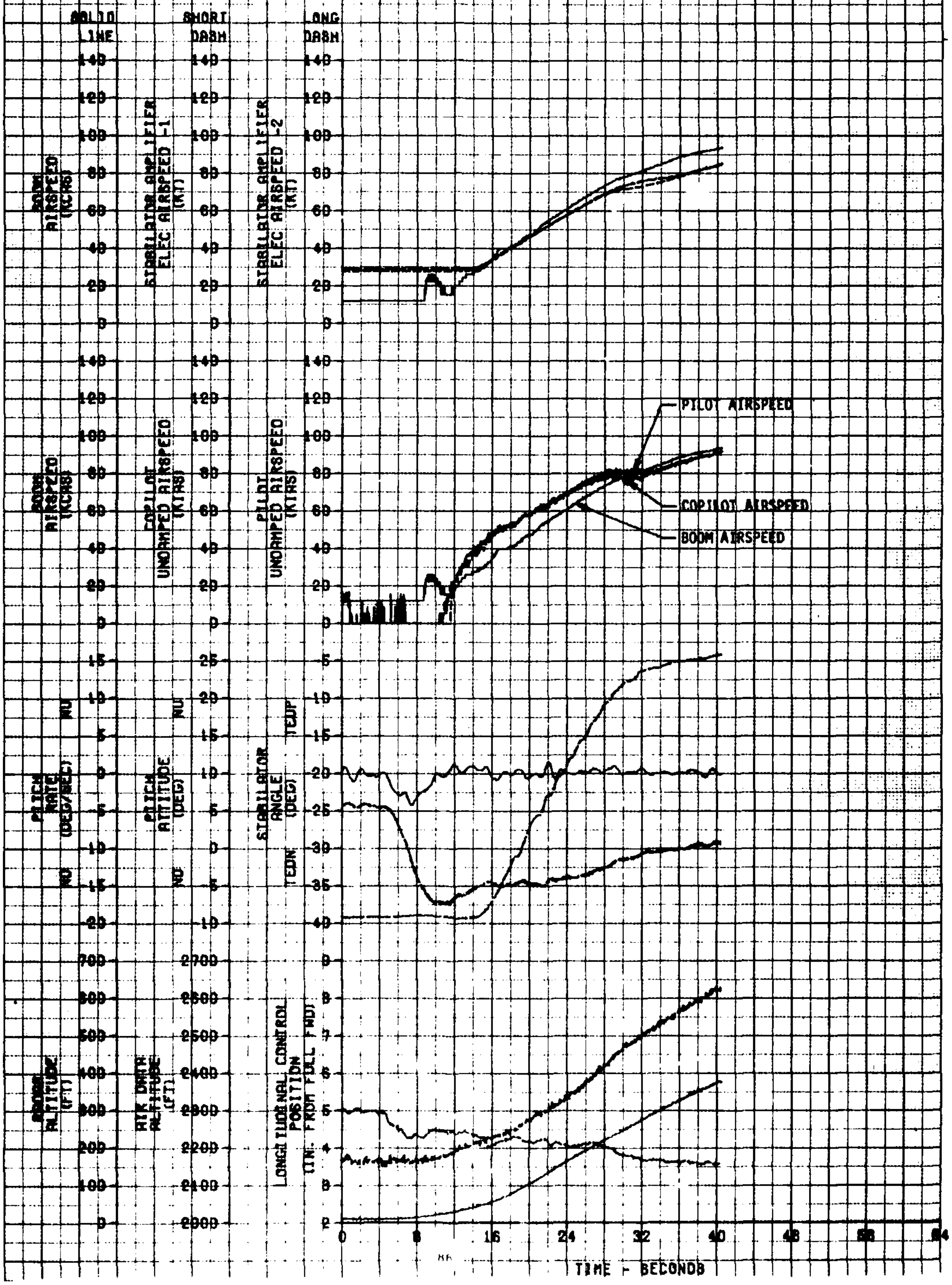


FIGURE 16
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
16920.	360.4 (AFT)	0.0 (MID)	1480.	4.0	257.	12.	ON

NOTES: 1. LEVEL ACCELERATION TAKEOFF (FPS OFF)
2. REVISED STABILATOR SCHEDULE-NO.2
3. 8 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSND 20 DEG DN 8.8 DEG DN

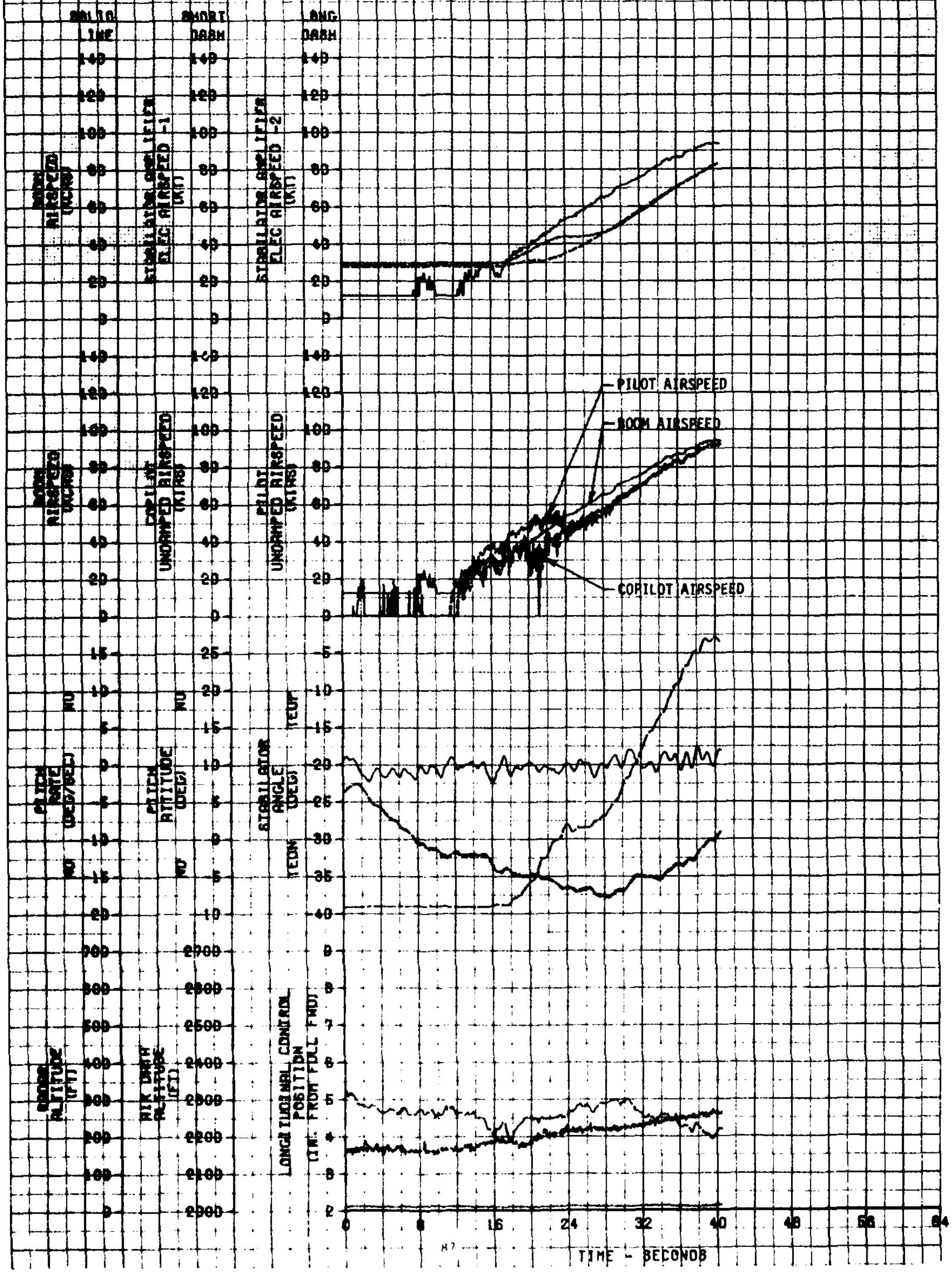


FIGURE 16
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
16740.	360.1 (AFT)	0.0 (MID)	1490.	4.0	257.	12.	ON

NOTES: 1. SLOW ACCELERATION TAKEOFF (FPS DEF)
2. REVISED STABILATOR SCHEDULE-NO.2
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POUND 20 DEG 88.8 DEG DN

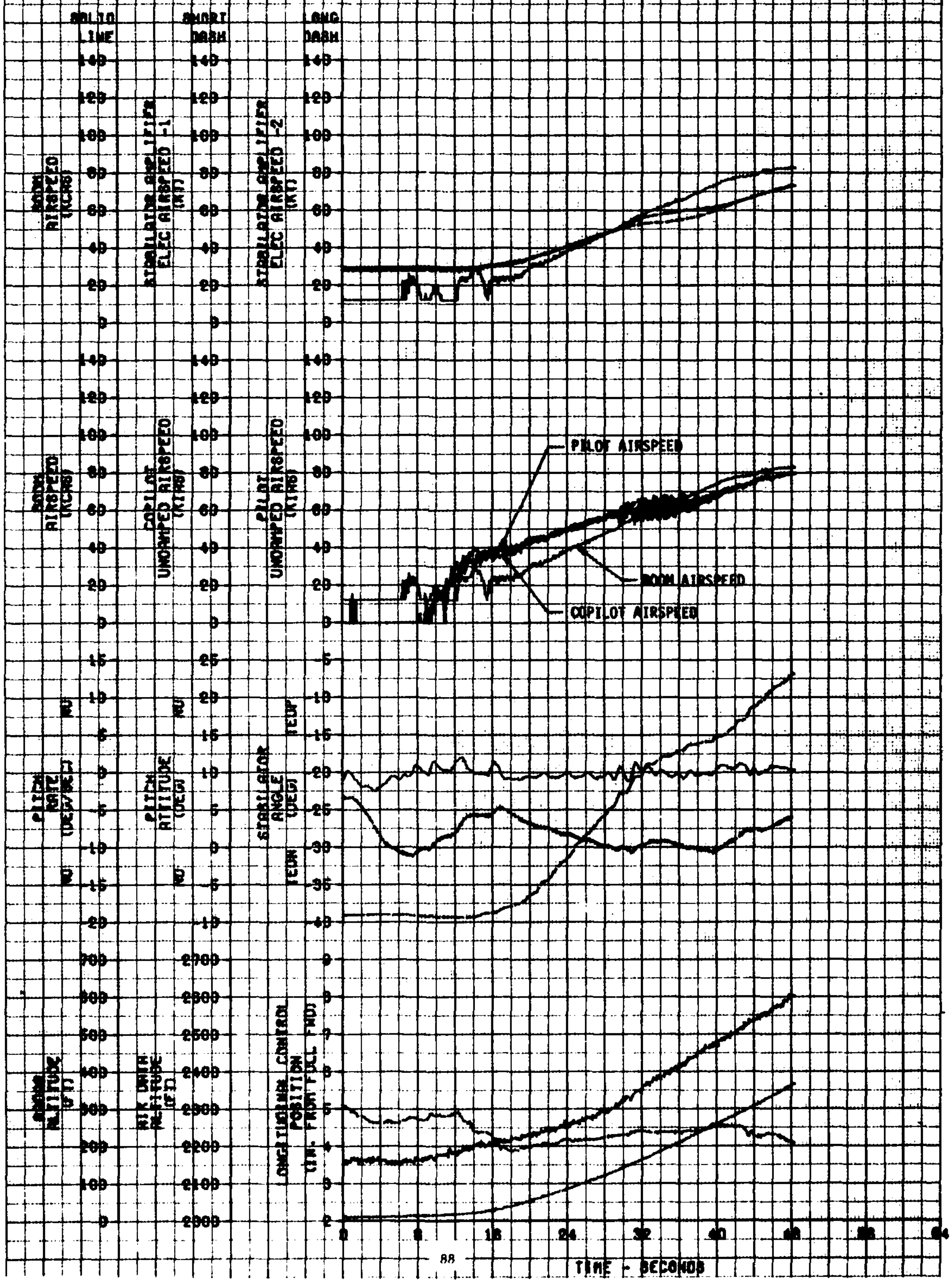
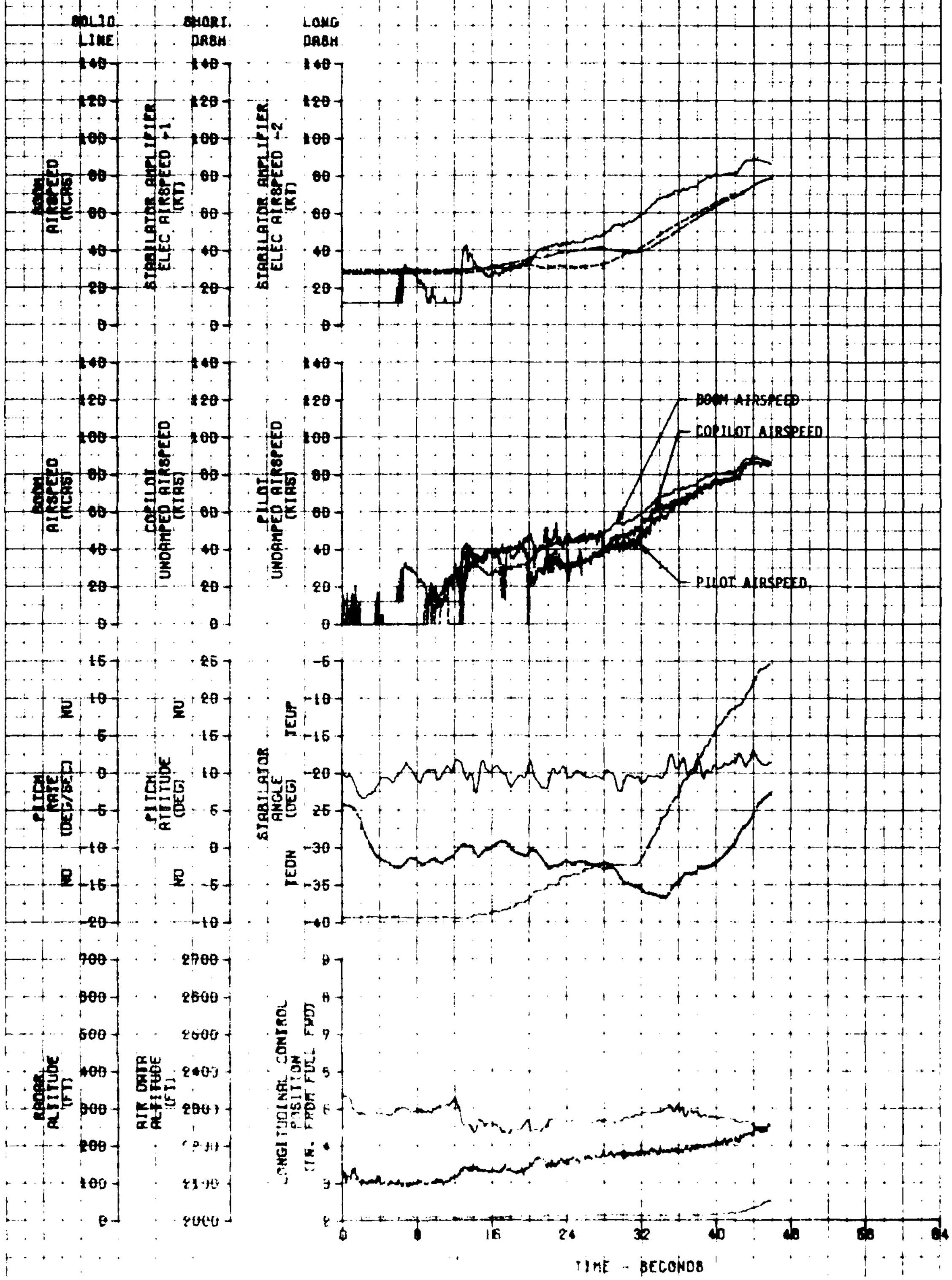


FIGURE 17
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
21500.	359.0(AFT)	0.0 (MID)	2280.	11.0	256.	12.	ON

NOTES: 1. LEVEL ACCELERATION TAKEOFF (FPS OFF)
2. REVISED STABILATOR SCHEDULE-NO.2
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSNO 20 DEG OB.5 DEG DN



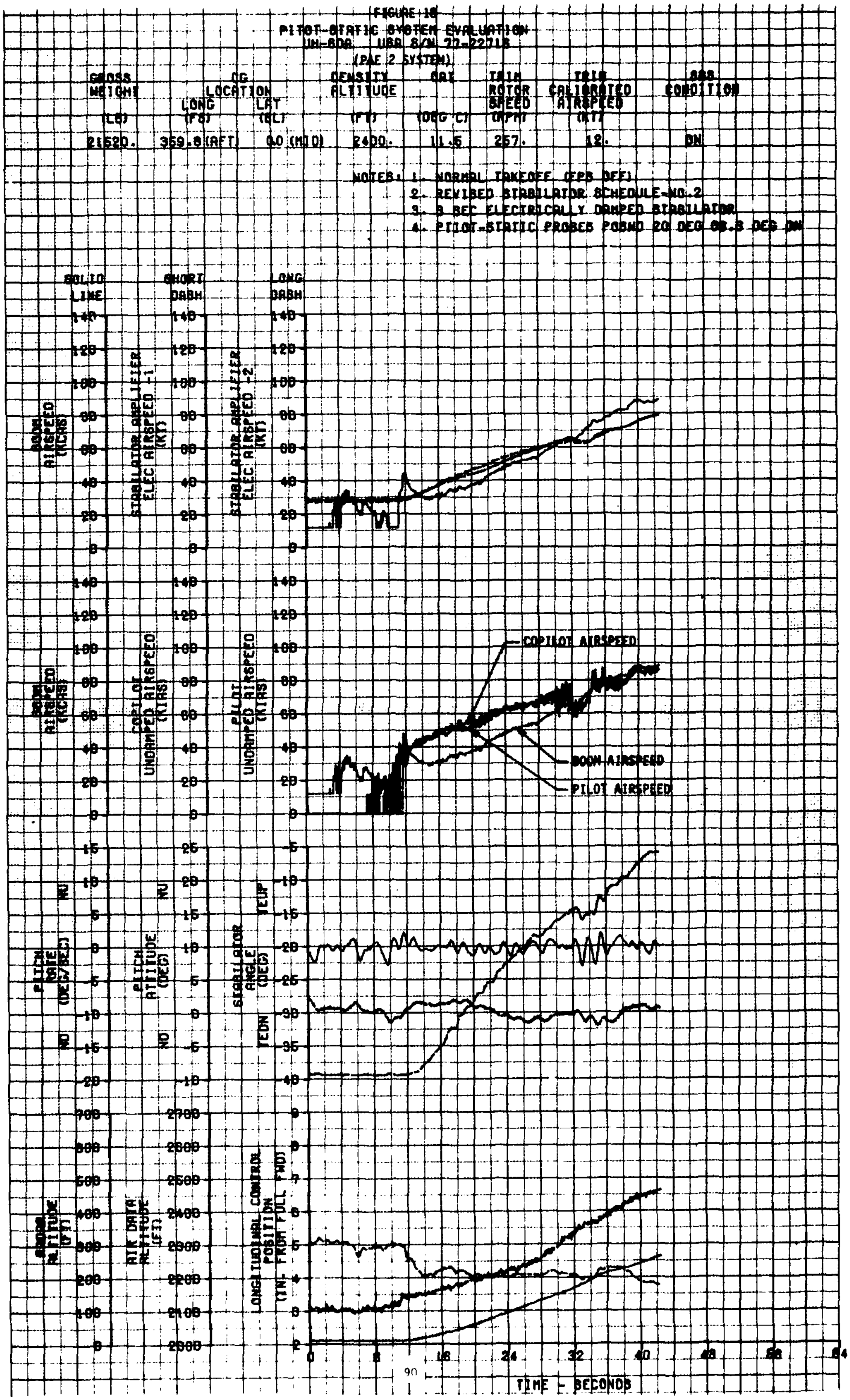


FIGURE 18
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)
GROSS WEIGHT (LB) 21520.
CG LOCATION LONG (FS) 359.8 (AFT)
CG LOCATION LAT (BL) 0.0 (MID)
DENSITY ALTITUDE (FT) 2400.
OAT (DEG C) 11.5
TRIM ROTOR SPEED (RPM) 257.
TRIM CALIBRATED AIRSPEED (KT) 12.
SAS CONDITION ON
NOTES: 1. NORMAL TAKEOFF (FPS OFF)
2. REVISED STABILATOR SCHEDULE-NO.2
3. 8 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSND 20 DEG UP.3 DEG DN
SOLID LINE
SHORT DASH
LONG DASH
BOOM AIRSPEED (KCAS)
STABILATOR AMPLIFIER ELEC AIRSPEED -1 (KT)
STABILATOR AMPLIFIER ELEC AIRSPEED -2 (KT)
COPILOT UNDAMPED AIRSPEED (KIAS)
PILOT UNDAMPED AIRSPEED (KIAS)
COPILOT AIRSPEED
BOOM AIRSPEED
PILOT AIRSPEED
PITCH RATE (DEG/SEC)
PITCH ATTITUDE (DEG)
STABILATOR ANGLE (DEG)
NU
ND
TEUP
TEDN
RADAR ALTITUDE (FT)
AIR DATA ALTITUDE (FT)
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TIME - SECONDS

FIGURE 19
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
21520.	359.7(AFT)	0.0(MID)	2280.	10.5	257.	12.	ON

NOTES: 1. IRP TAKEOFF (FPS OFF)
2. REVISED STABILATOR SCHEDULE-NO.2
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSND 20 DEG DN.3 DEG DN

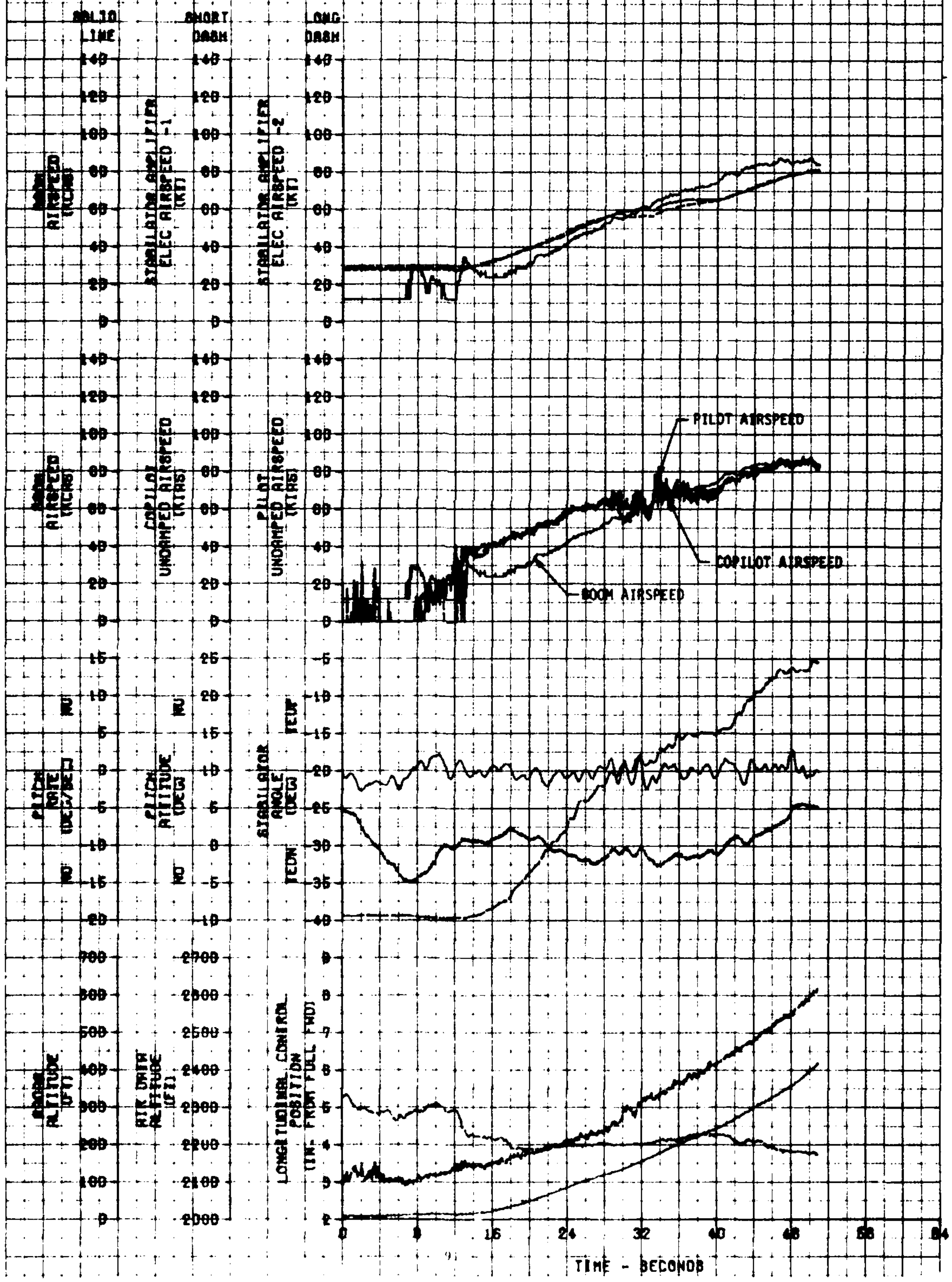


FIGURE 20

PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
21940.	359.8 (AFT)	0.0 (MID)	2940.	11.5	258.	12.	ON

NOTES: 1. SLOW ACCELERATION TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. PITOT-STATIC PROBES POSND 20 DEG 9_ DEG DN

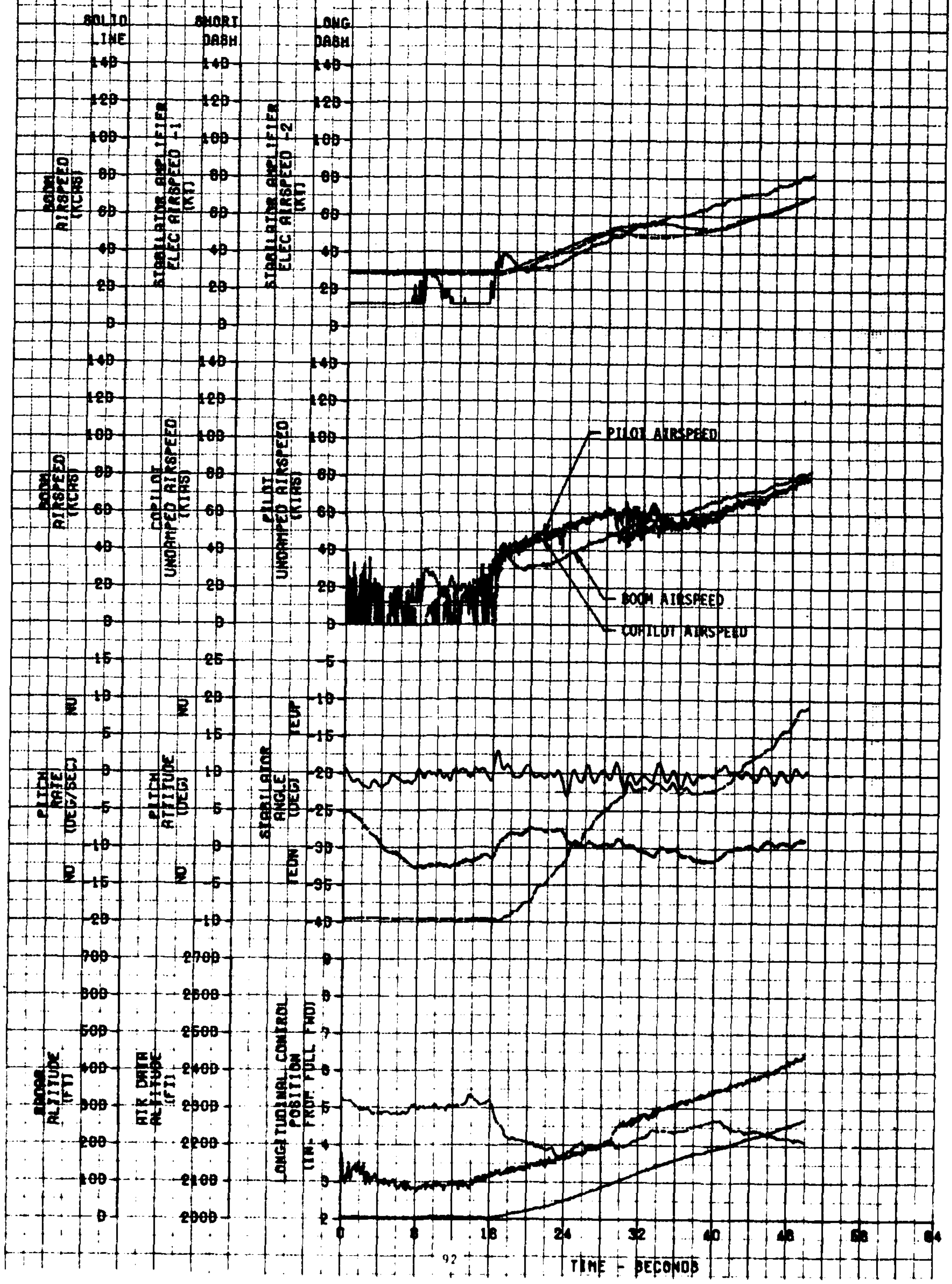
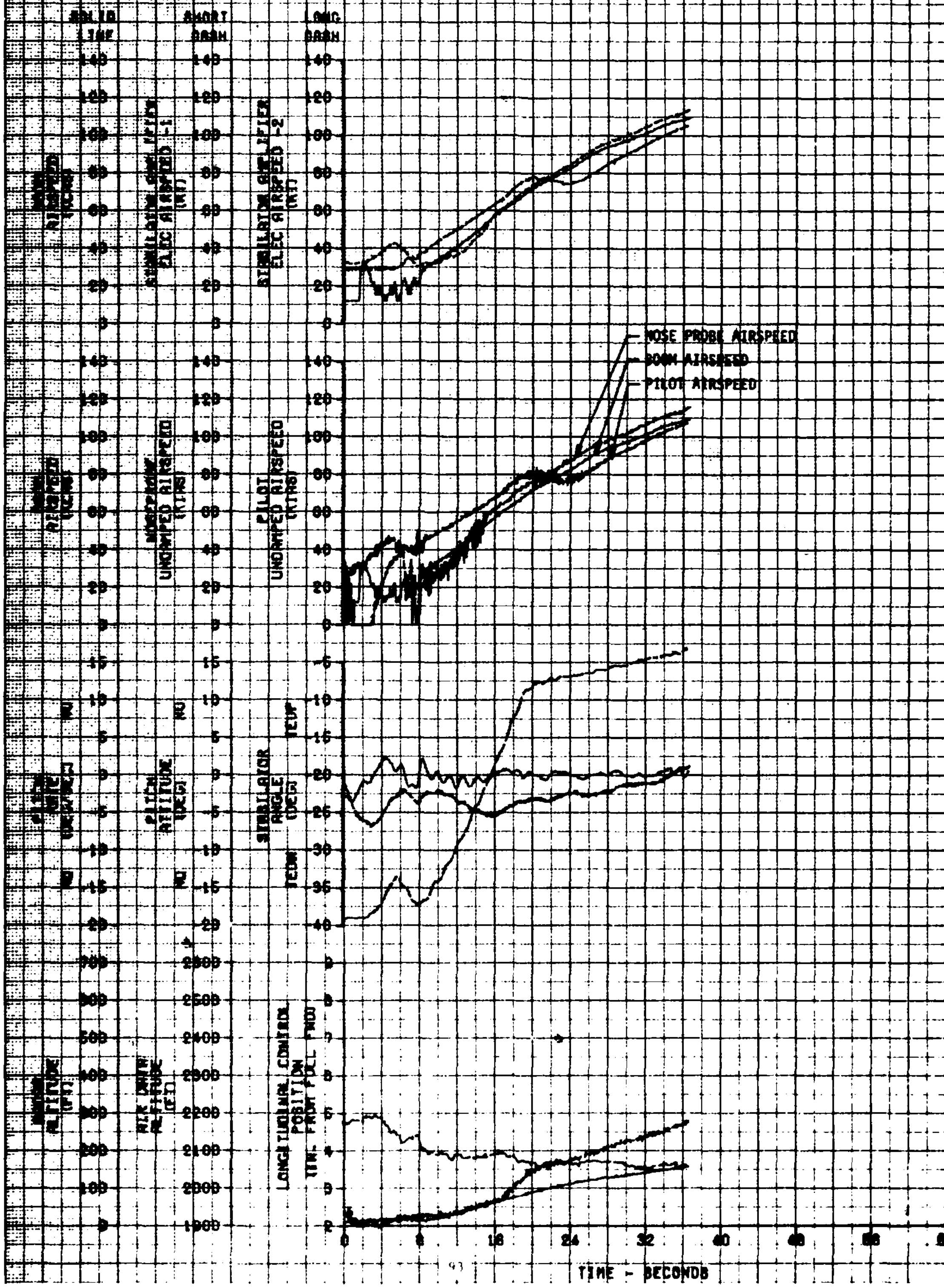


FIGURE 21
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(NOSE PROBE 1 SYSTEM)

GROSS WEIGHT (LB)	CG LOCATION LONG (FS)	CG LOCATION LAT (BL)	DENSITY ALTITUDE (FT)	OAT (DEG C)	TRIM ROTOR SPEED (RPM)	TRIM CALIBRATED AIRSPEED (KT)	SAS CONDITION
21920.	360.1 (AFT)	0.0 (MID)	860.	1.5	257.	12.	ON

NOTES: 1. NORMAL TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
3. PRODUCTION DAMPED STABILATOR
4. PITOT-STATIC PROBES IN STANDARD CONFIGURATION



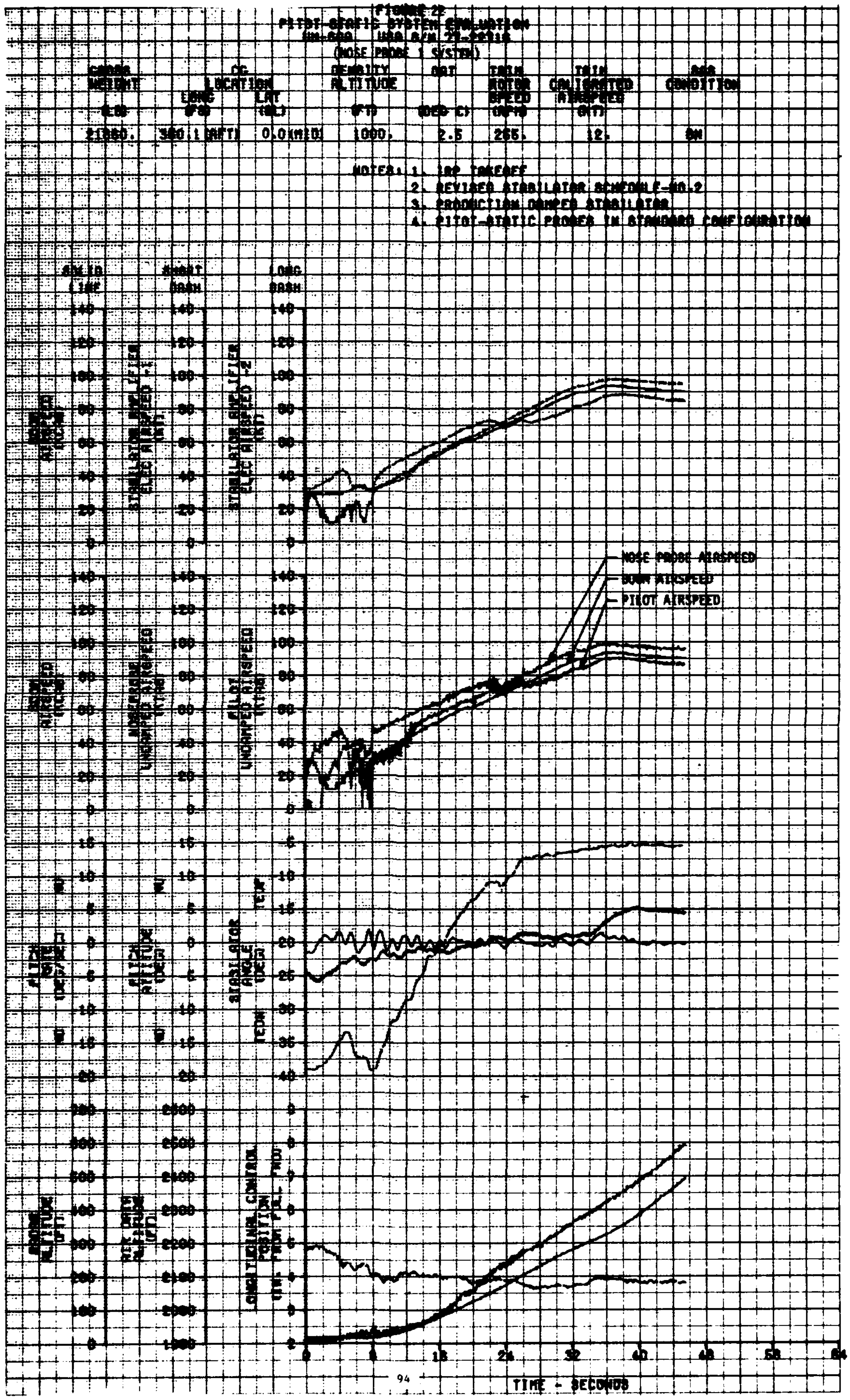


FIGURE 22
PITOT-STATIC SYSTEM EVALUATION
(NOSE PROBE 1 SYSTEM)
GROSS WEIGHT (LB) 21860.
CG LOCATION LONG (FS) 360.1(AFT) LAT (BL) 0.0(MID)
DENSITY ALTITUDE (FT) 1000.
OAT (DEG C) 2.5
TRIM ROTOR SPEED (RPM) 255.
TRIM CALIBRATED AIRSPEED (KT) 12.
SAS CONDITION ON
NOTES: 1. IRP TAKEOFF
2. REVISED STABILATOR SCHEDULE-NO.2
3. PRODUCTION DAMPED STABILATOR
4. PITOT-STATIC PROBES IN STANDARD CONFIGURATION
NOSE PROBE AIRSPEED
BOOM AIRSPEED
PILOT AIRSPEED
TIME - SECONDS

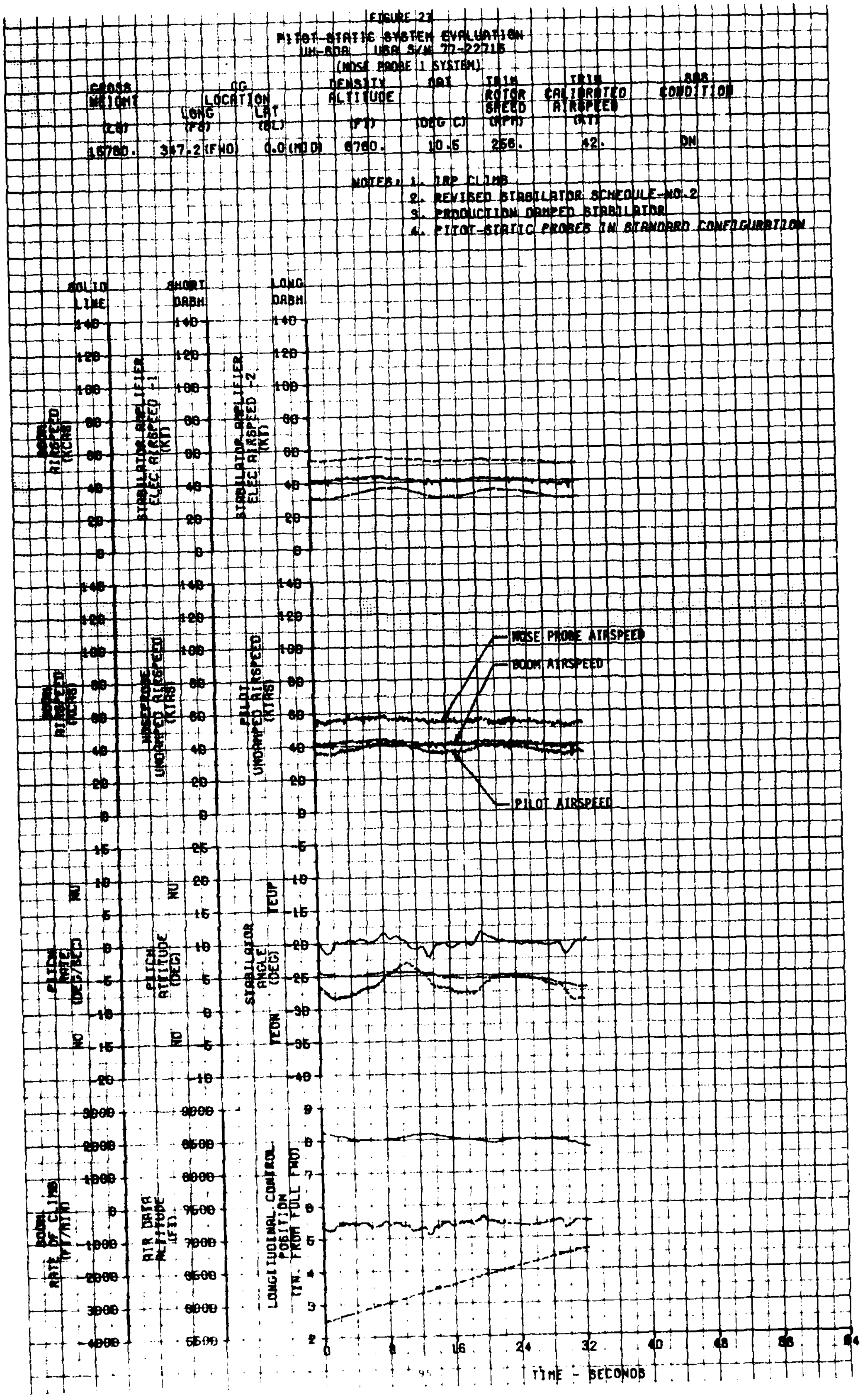


FIGURE 21
PITOT-STATIC SYSTEM EVALUATION
UH-60A USA S/N 77-22716
(NOSE PROBE 1 SYSTEM)
GROSS WEIGHT (LB) 16780.
CG LOCATION LONG (FS) 347.2(FWD)
CG LOCATION LAT (BL) 0.0(MID)
DENSITY ALTITUDE (FT) 6760.
OAT (DEG C) 10.5
TRIM ROTOR SPEED (RPM) 256.
TRIM CALIBRATED AIRSPEED (KT) 42.
SAS CONDITION ON
NOTES: 1. IRP CLIMB
2. REVISED STABILATOR SCHEDULE-NO.2
3. PRODUCTION DAMPED STABILATOR
4. PITOT-STATIC PROBES IN STANDARD CONFIGURATION
SOLID LINE
SHORT DASH
LONG DASH
BOOM AIRSPEED (KCAS)
STABILATOR AMPLIFIER ELEC AIRSPEED -1 (KT)
STABILATOR AMPLIFIER ELEC AIRSPEED -2 (KT)
BOOM AIRSPEED (KCAS)
NOSEPROBE UNDAMPED AIRSPEED (KIAS)
PILOT UNDAMPED AIRSPEED (KIAS)
NOSE PROBE AIRSPEED
BOOM AIRSPEED
PILOT AIRSPEED
PITCH RATE (DEG/SEC)
PITCH ATTITUDE (DEG)
STABILATOR ANGLE (DEG)
NU
ND
TEUP
TEDN
BOOM RATE OF CLIMB (FT/MIN)
AIR DATA ALTITUDE (FT)
LONGITUDINAL CONTROL POSITION (IN. FROM FULL FWD)
TIME - SECONDS

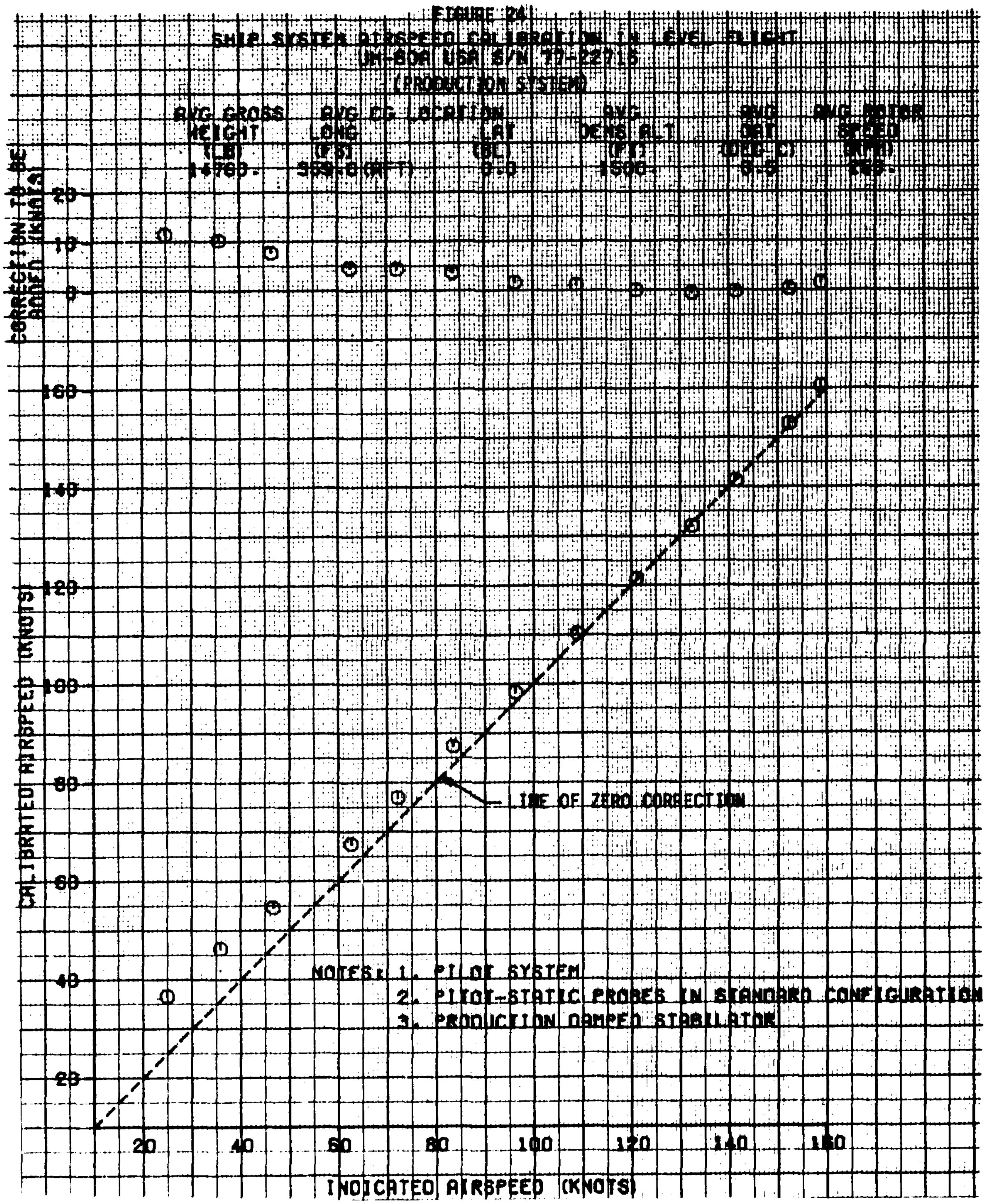
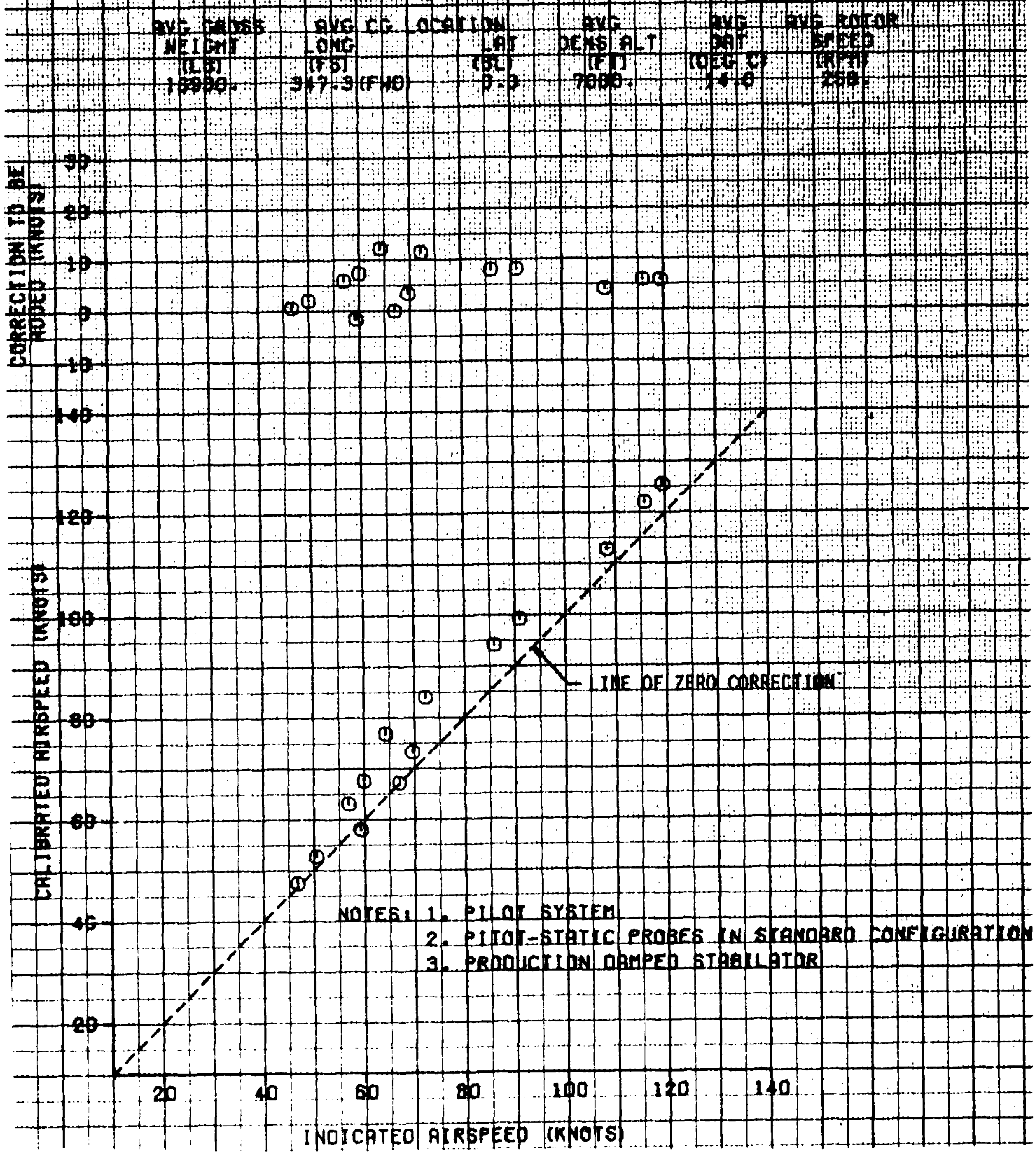


FIGURE 24
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22716
(PRODUCTION SYSTEM)
AVG GROSS WEIGHT (LB) 14760.
AVG CG LOCATION LONG (FS) 359.0(AFT)
LAT (BL) 0.0
AVG DENS ALT (FT) 1500.
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES IN STANDARD CONFIGURATION
3. PRODUCTION DAMPED STABILATOR
INDICATED AIRSPEED (KNOTS)
20
10
0
160
140
120
100
80
60
40
20
40
60
80
100
120
140
160

FIGURE 25
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(PRODUCTION SYSTEM)



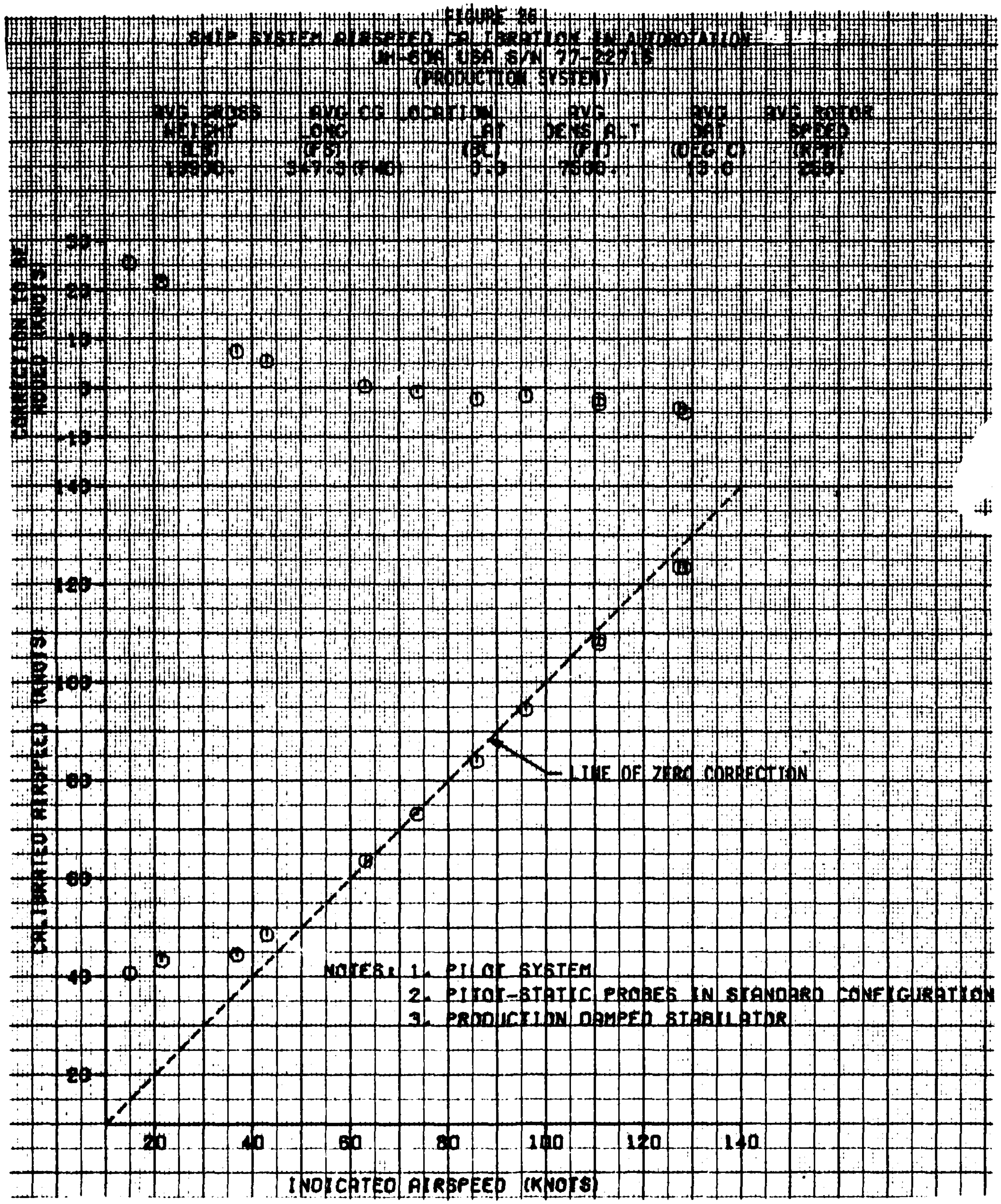


FIGURE 26
SHIP SYSTEM AIRSPEED CALIBRATION IN AUTOROTATION
UH-60A USA S/N 77-22716
(PRODUCTION SYSTEM)
CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES IN STANDARD CONFIGURATION
3. PRODUCTION DAMPED STABILATOR
INDICATED AIRSPEED (KNOTS)

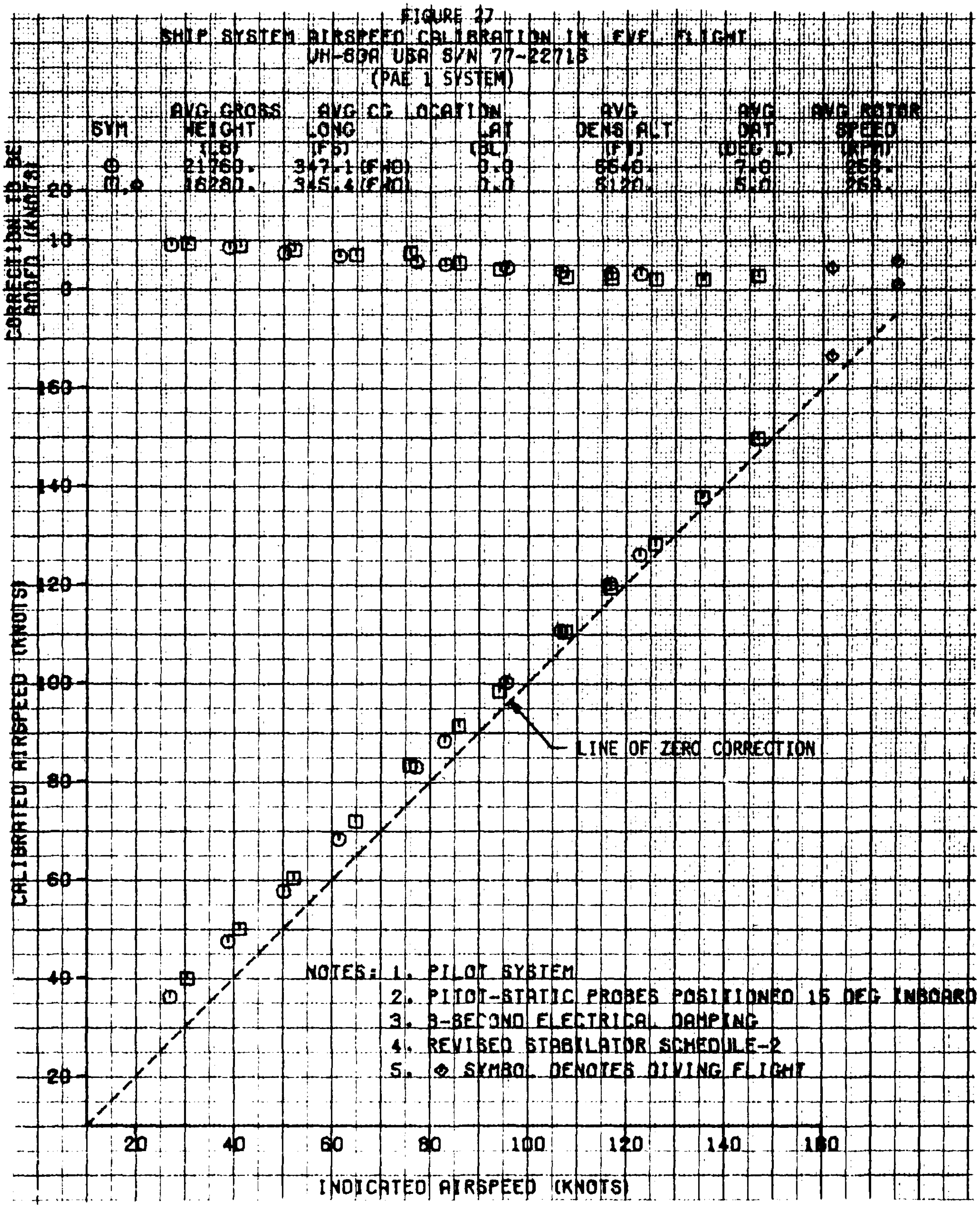
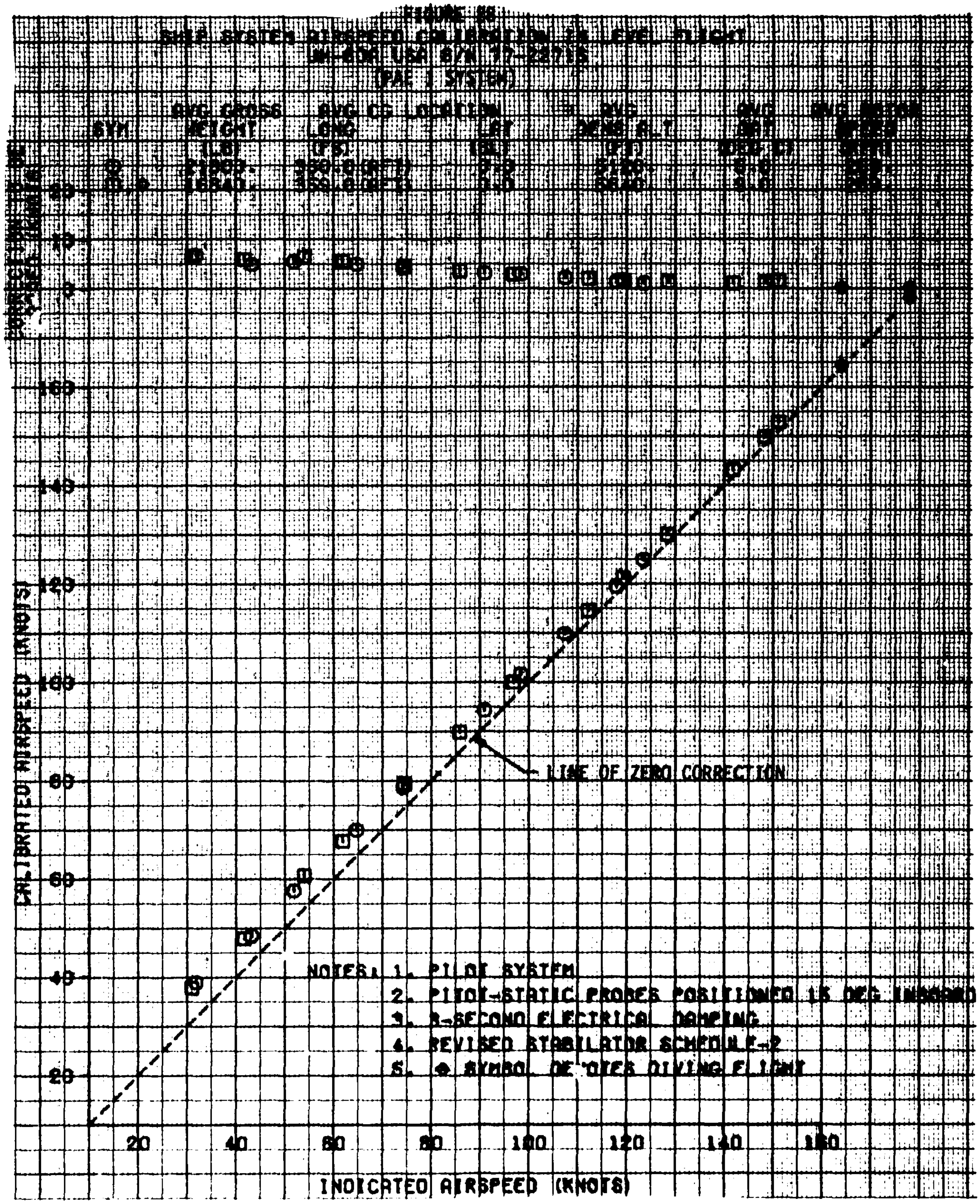


FIGURE 27
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
⊕ 21760. 347.1 (FWD) 0.0 5540. 7.0 258.
□,◈ 16280. 345.4 (FWD) 0.0 8120. 5.0 258.
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. ◈ SYMBOL DENOTES DIVING FLIGHT


CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
20
40
60
80
100
120
140
160
INDICATED AIRSPEED (KNOTS)

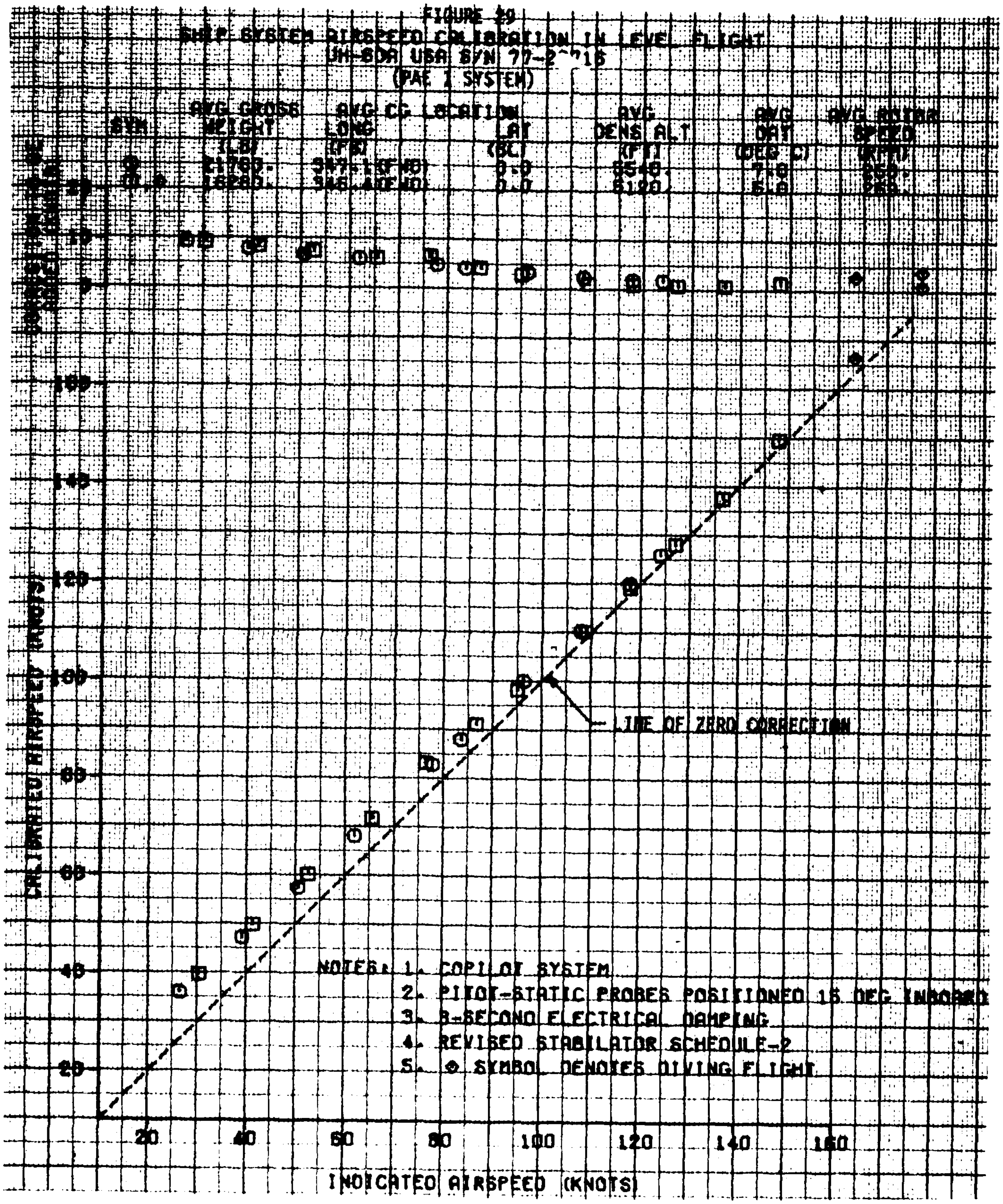


FIGURE 29
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-2~716
(PAE 1 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
LINE OF ZERO CORRECTION
NOTES: 1. COPILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
3. 8-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. ⊕ SYMBOL DENOTES DIVING FLIGHT
CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
20
40
60
80
100
120
140
160

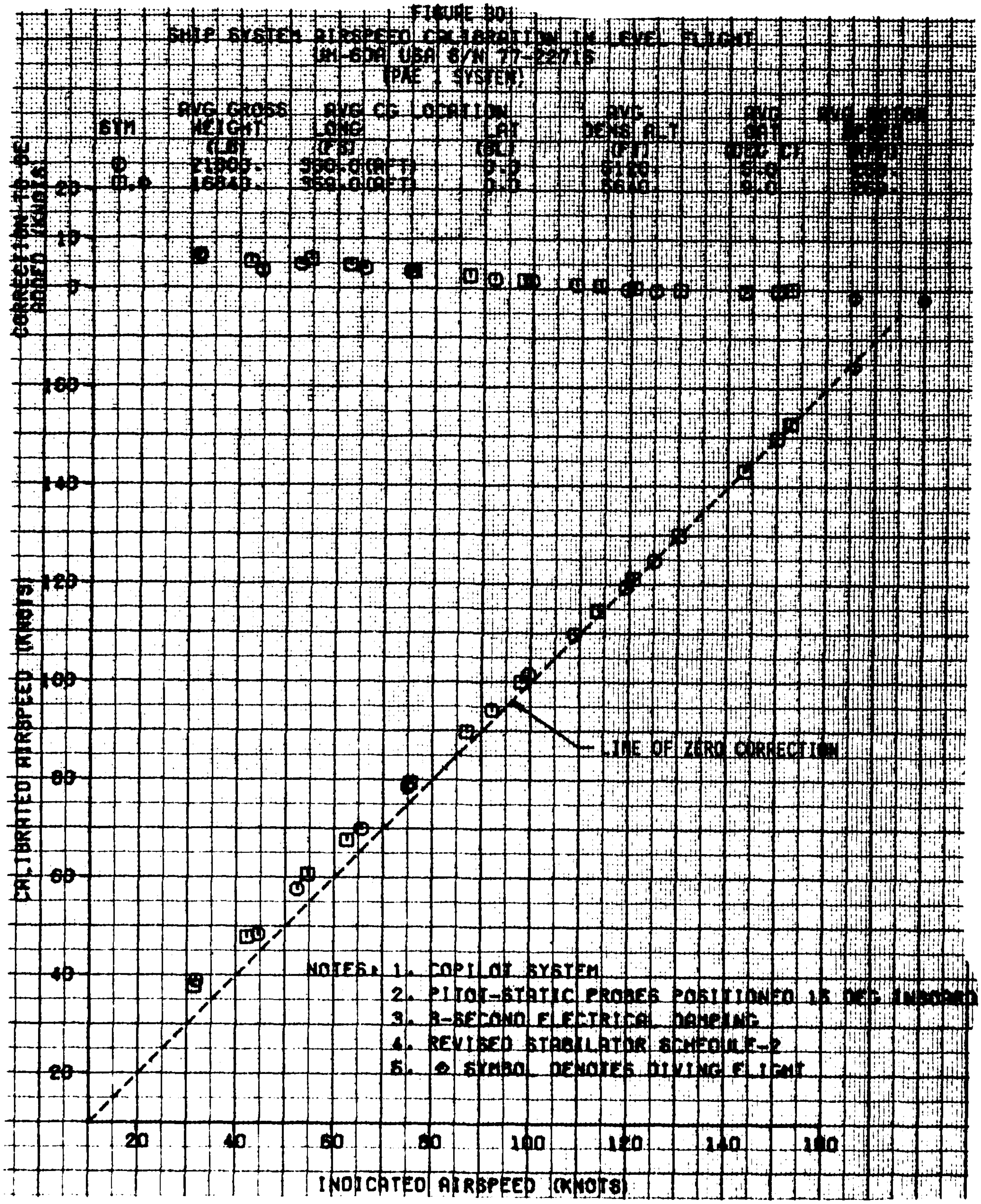


FIGURE 80
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22716
(PAE SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
21900.
360.0(AFT)
0.0
16840.
360.0(AFT)
0.0
CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. COPILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
3. 8-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. SYMBOL DENOTES DIVING FLIGHT

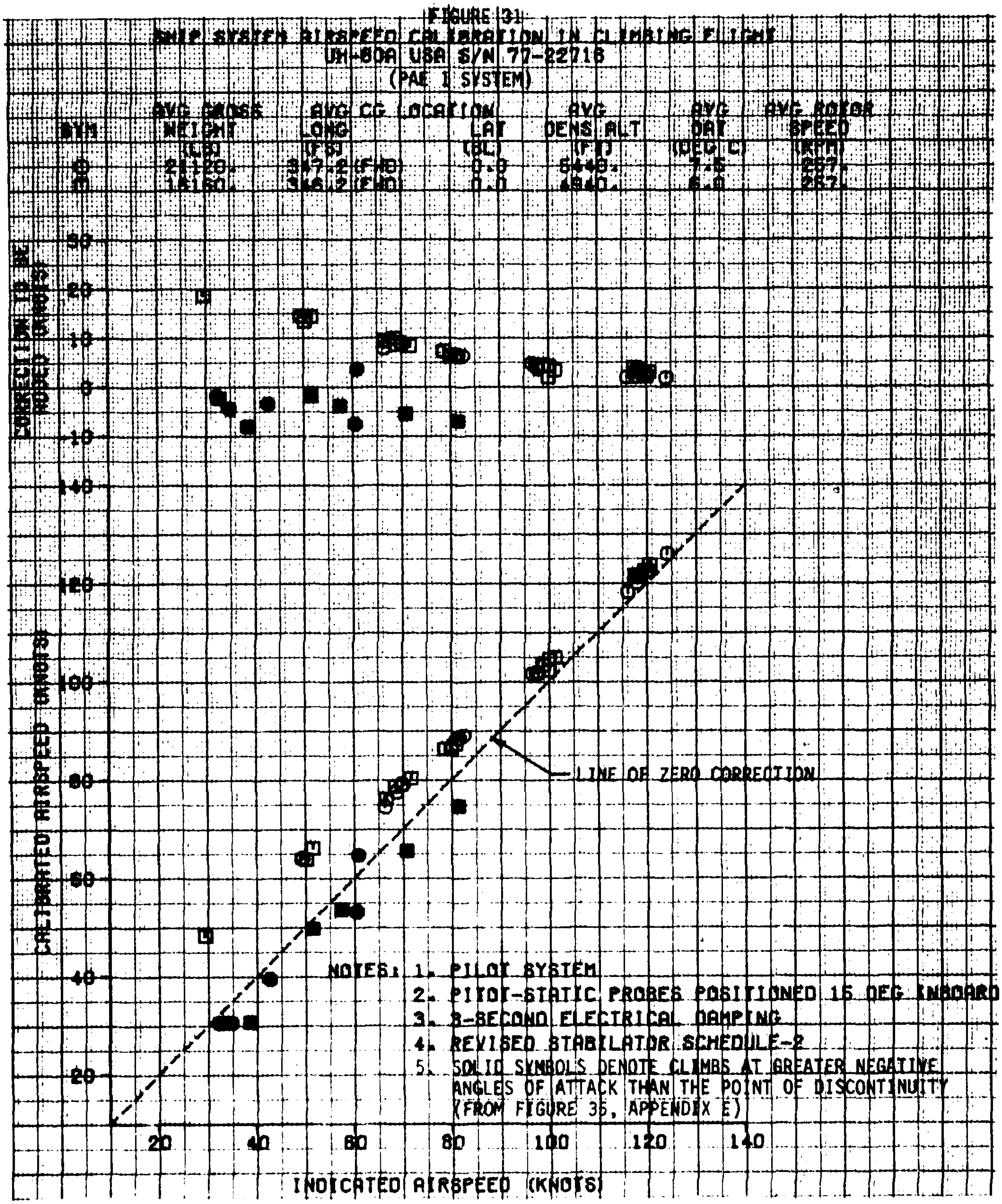
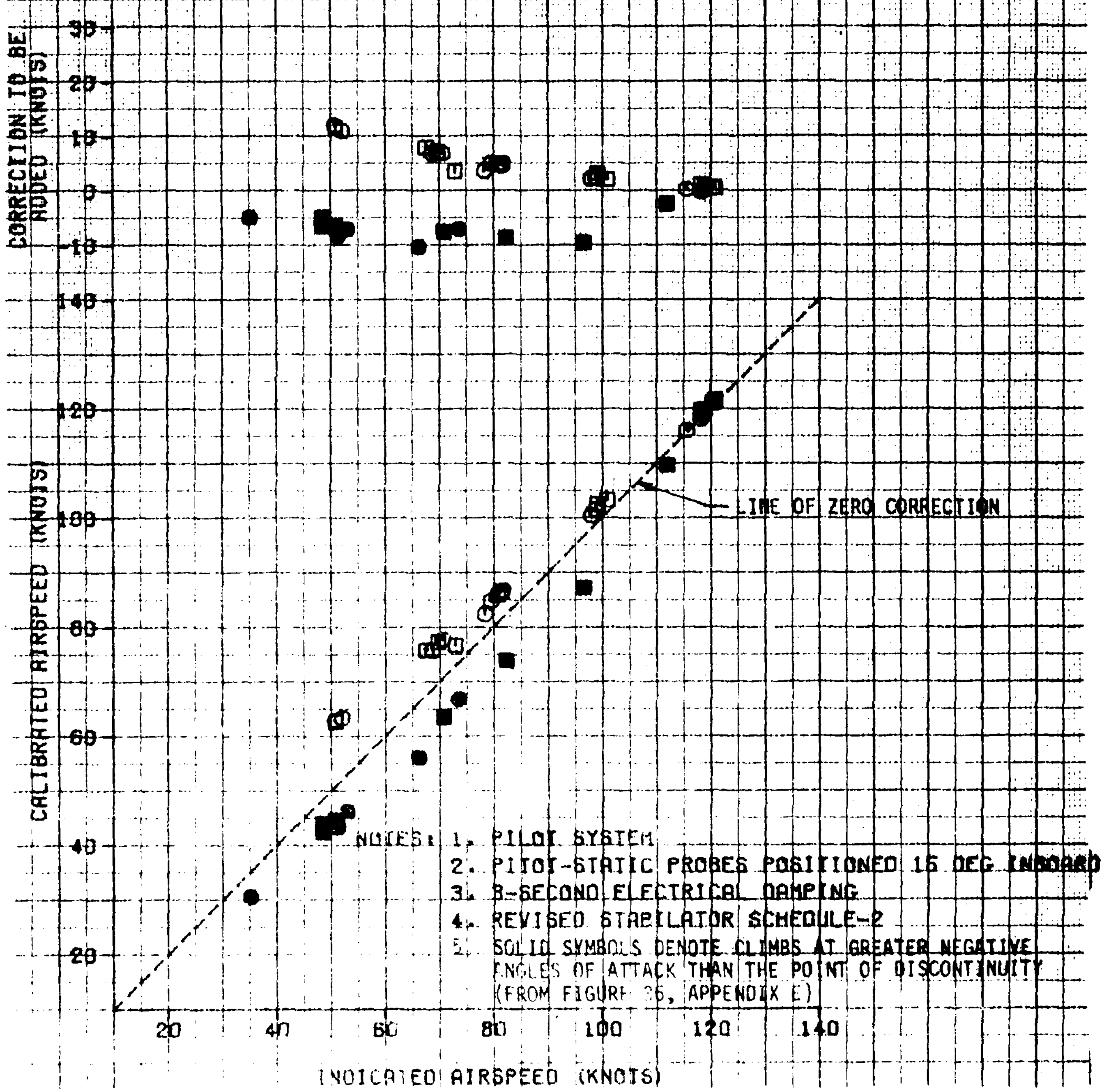


FIGURE 31
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
21120.
347.2 (FWD)
0.0
7.5
257.
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 16 DEG INBOARD
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. SOLID SYMBOLS DENOTE CLIMBS AT GREATER NEGATIVE ANGLES OF ATTACK THAN THE POINT OF DISCONTINUITY (FROM FIGURE 35, APPENDIX E)
INDICATED AIRSPEED (KNOTS)

FIGURE 32
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)
○	21220.	360.0(AFT)	0.0	4780.	5.5	256.
□	16500.	360.9(AFT)	0.0	6440.	9.5	258.



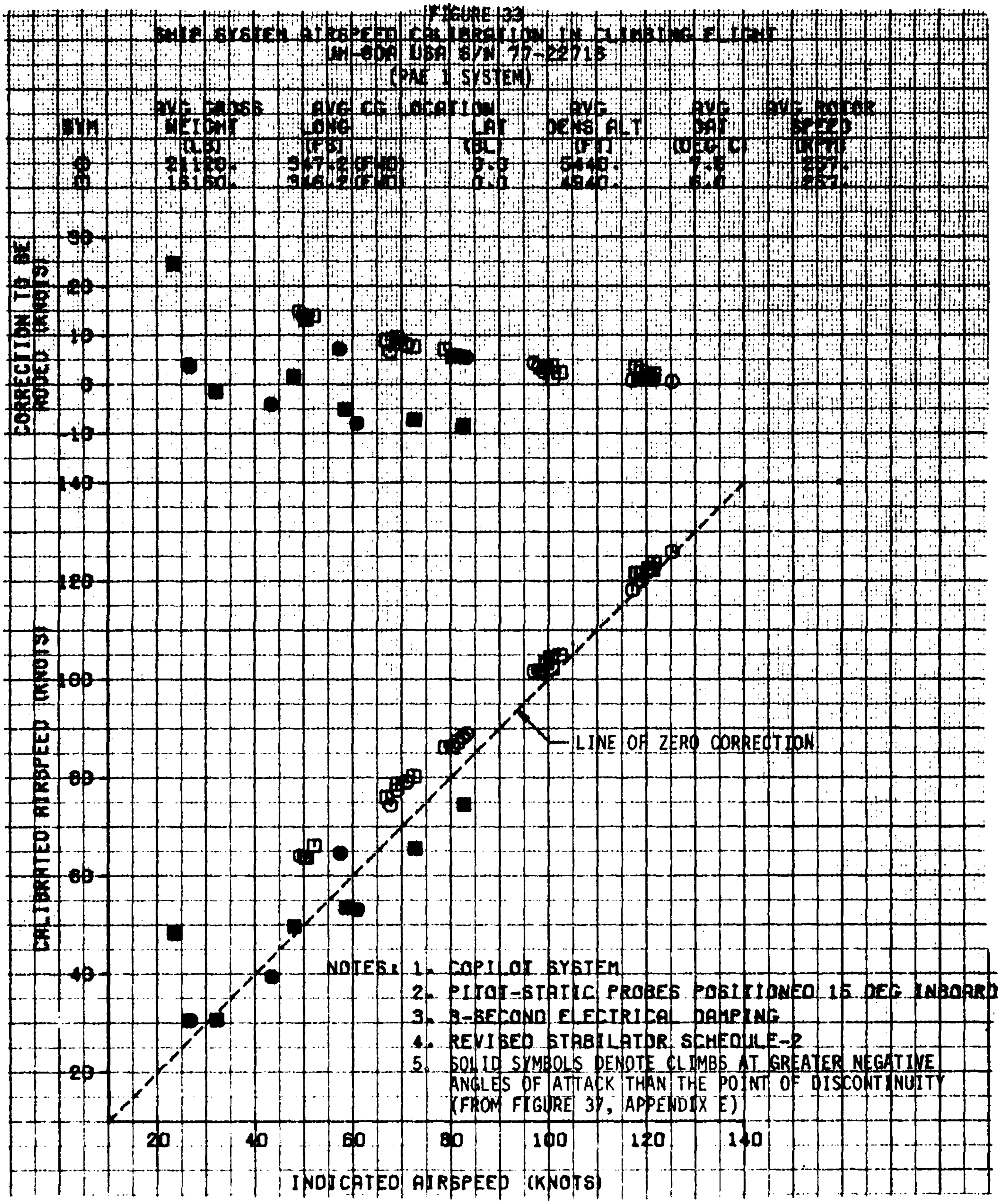


FIGURE 33
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)

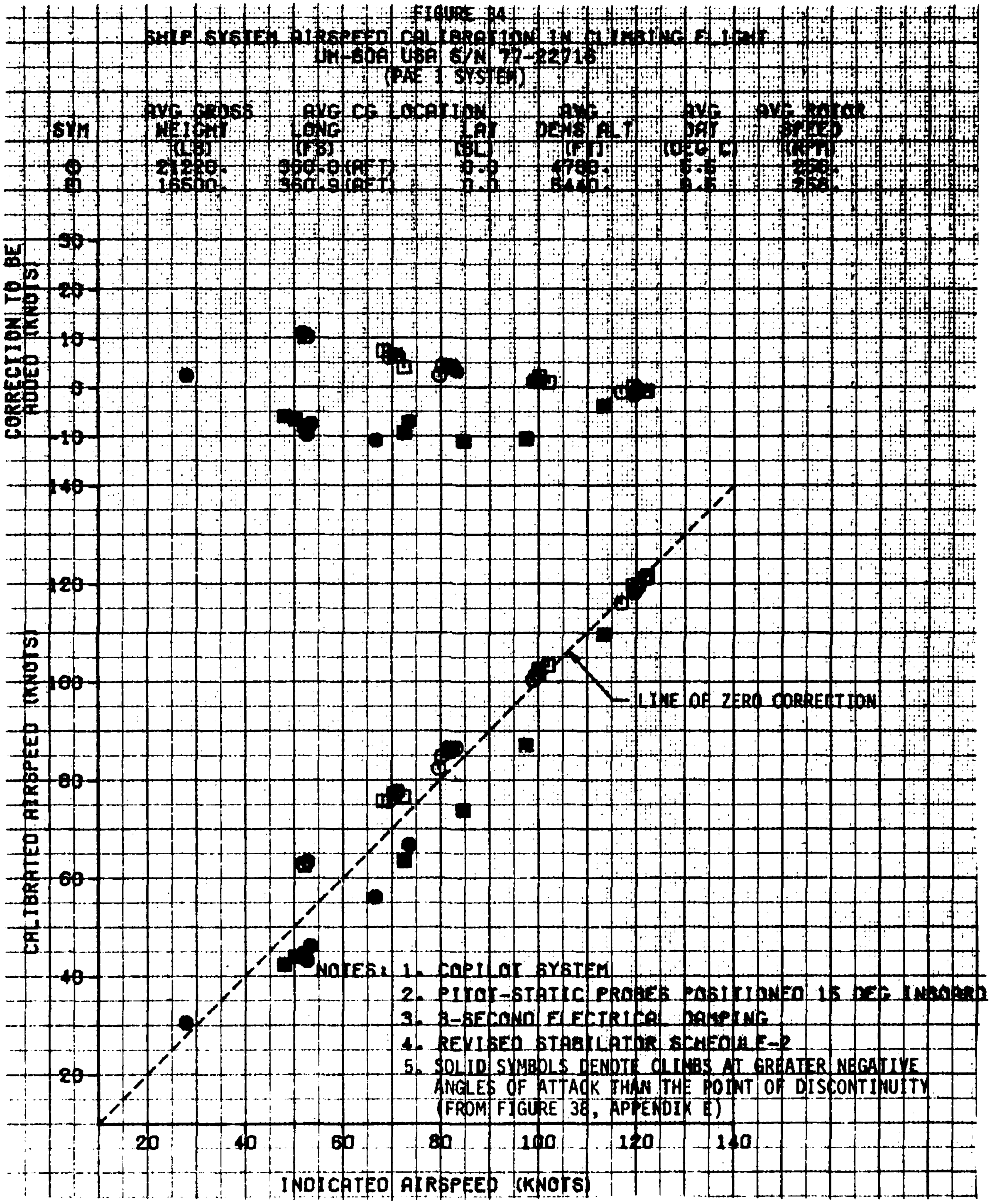
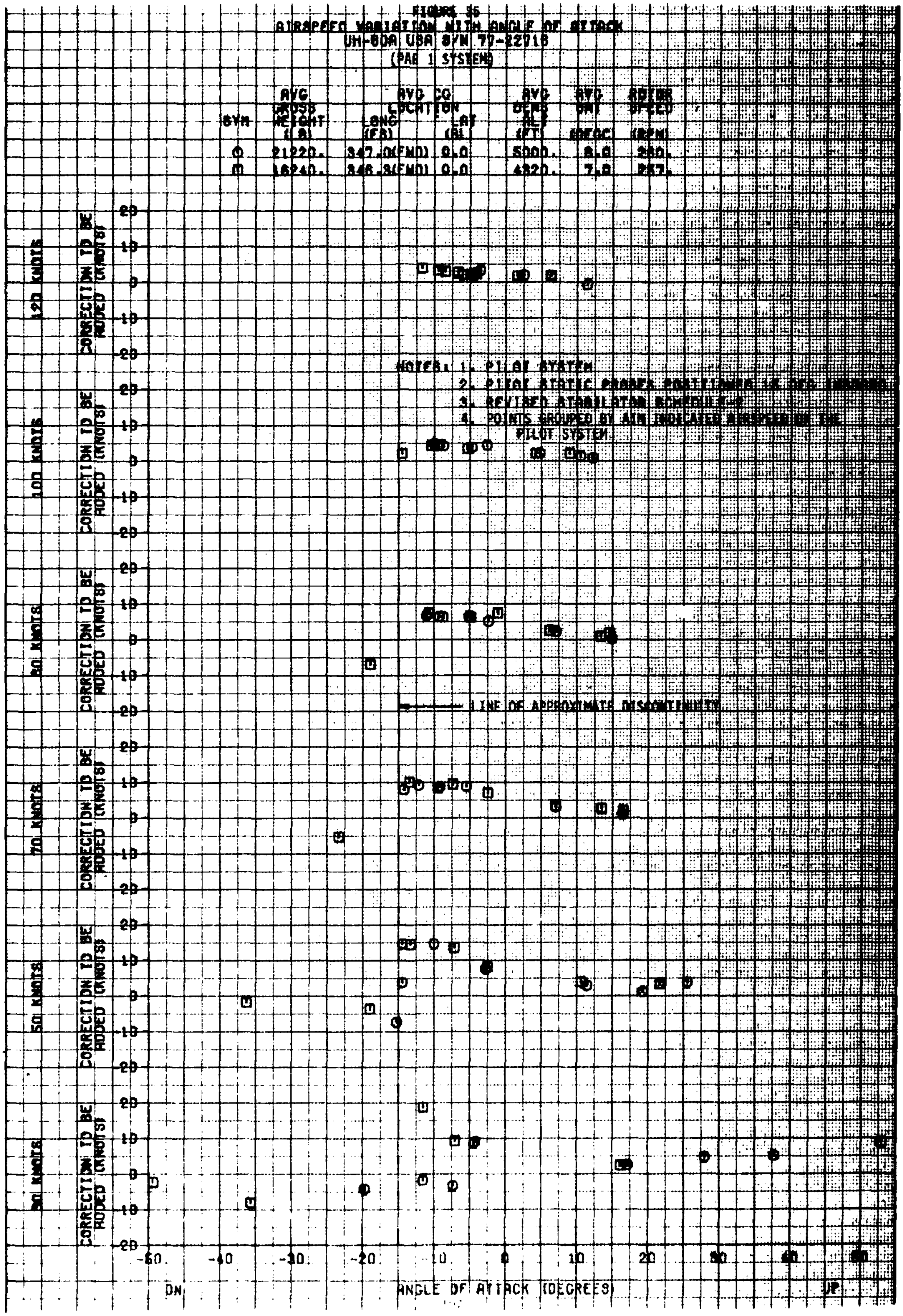


FIGURE 34
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
16500.
360.9(AFT)
0.0
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. COPILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. SOLID SYMBOLS DENOTE CLIMBS AT GREATER NEGATIVE ANGLES OF ATTACK THAN THE POINT OF DISCONTINUITY (FROM FIGURE 38, APPENDIX E)
INDICATED AIRSPEED (KNOTS)


AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
ROTOR SPEED (RPM)
21220.
347.0(FWD)
0.0
5000.
16240.
346.3(FWD)
0.0
4820.
7.0
NOTES: 1. PILOT SYSTEM
2. PITOT STATIC
3. REVISED STABILATOR SCHEDULE
4. POINTS GROUPED BY AIR INDICATED AIRSPEED ON THE PILOT SYSTEM
LINE OF APPROXIMATE DISCONTINUITY
120 KNOTS
100 KNOTS
90 KNOTS
70 KNOTS
50 KNOTS
30 KNOTS
CORRECTION TO BE ADDED (KNOTS)
20
10
0
-10
-20
-50
-40
-30
-20
-10
0
10
20
DN
ANGLE OF ATTACK (DEGREES)
UP

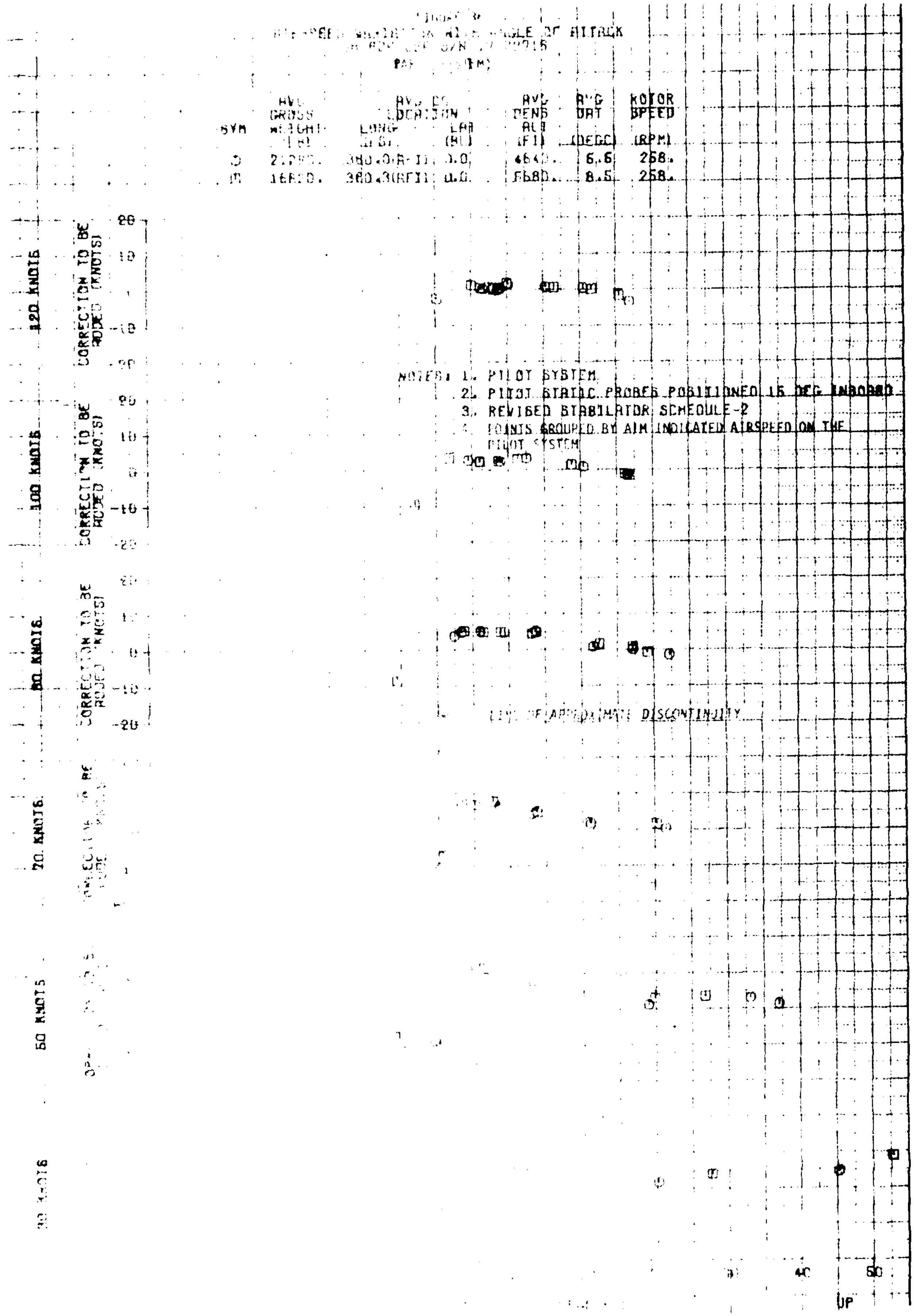

AIRSPEED VARIATION WITH ANGLE OF ATTACK
SYM
AVG GROSS WEIGHT
AVG CG LOCATION
LONG
LAT
AVG DENS ALT (FT)
AVG OAT (DEG C)
ROTOR SPEED (RPM)
21290.
380.0(AFT)
0.0
4640.
6.6
258.
16880.
380.3(AFT)
0.0
5680.
8.5
258.
NOTES: 1. PILOT SYSTEM
2. PITOT STATIC PROBES POSITIONED 15 DEG INBOARD
3. REVISED STABILATOR SCHEDULE-2
4. POINTS GROUPED BY AIM INDICATED AIRSPEED ON THE PILOT SYSTEM
LINE OF APPROXIMATE DISCONTINUITY
120 KNOTS
100 KNOTS
80 KNOTS
70 KNOTS
50 KNOTS
CORRECTION TO BE ADDED (KNOTS)
20
10
0
-10
-20
40
50
UP

FIGURE 37
AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	ROTOR SPEED (RPM)
○	21220.	347.0(FWD)	0.0	5000.	8.0	260.
□	16240.	346.3(FWD)	0.0	4820.	7.0	257.

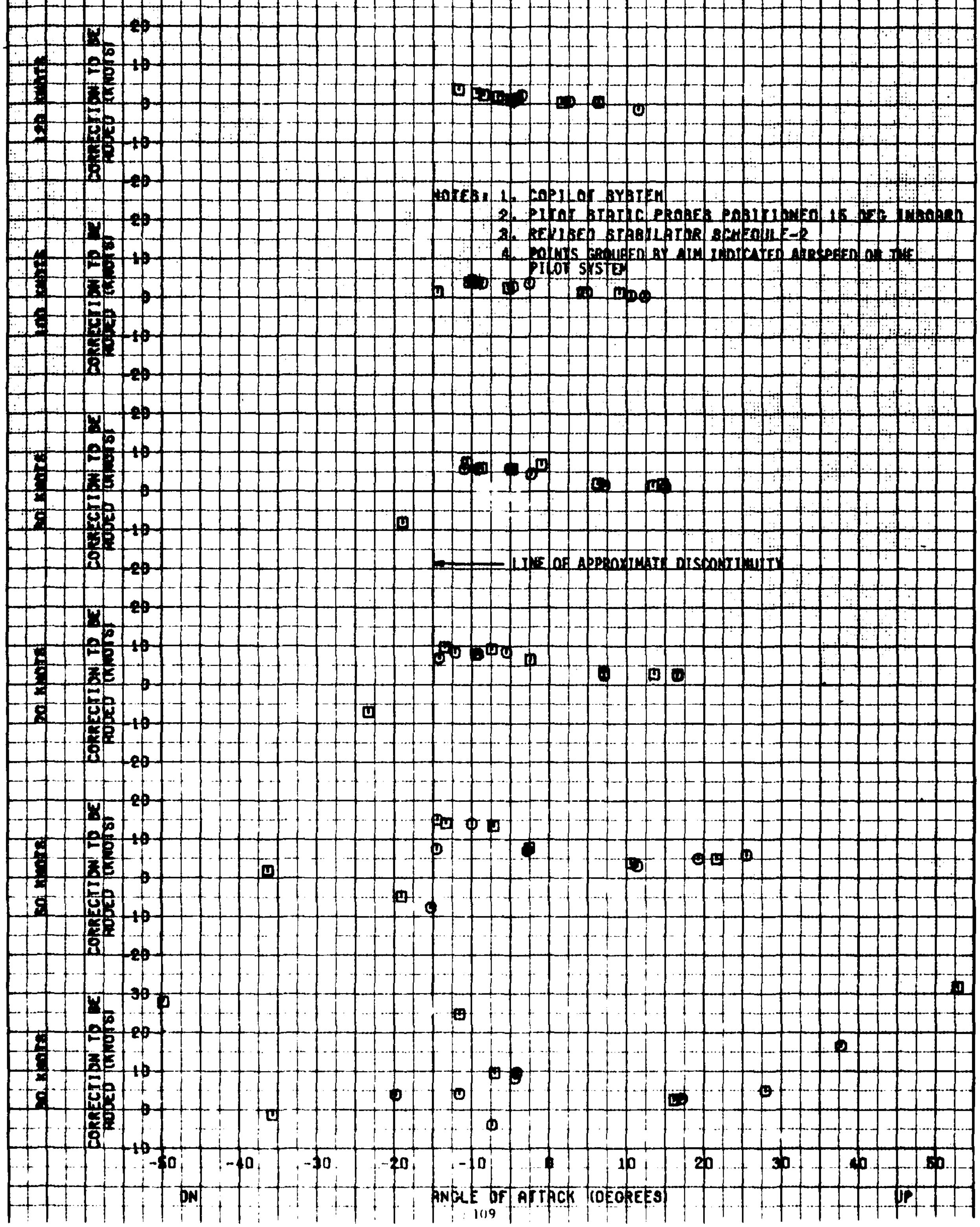
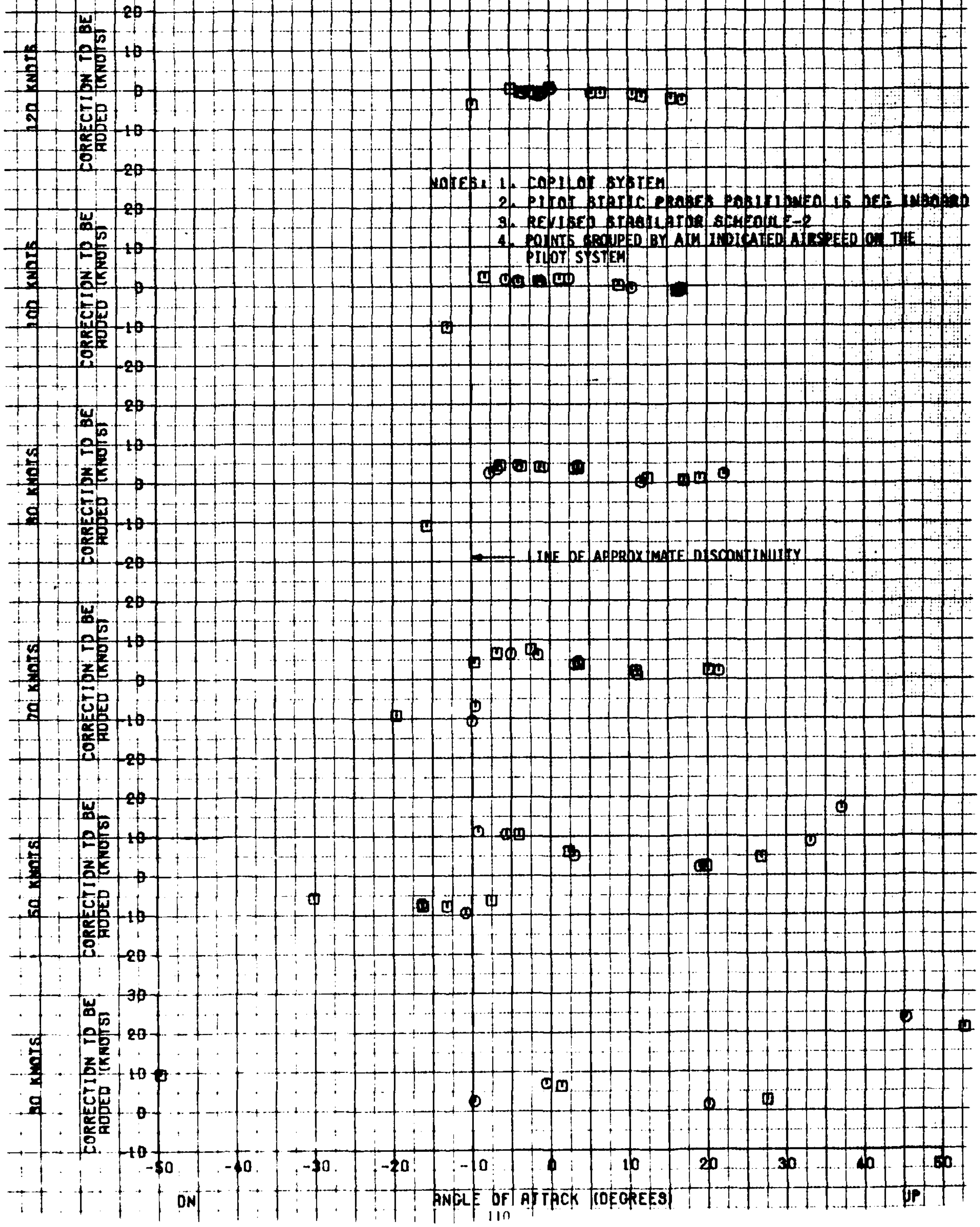
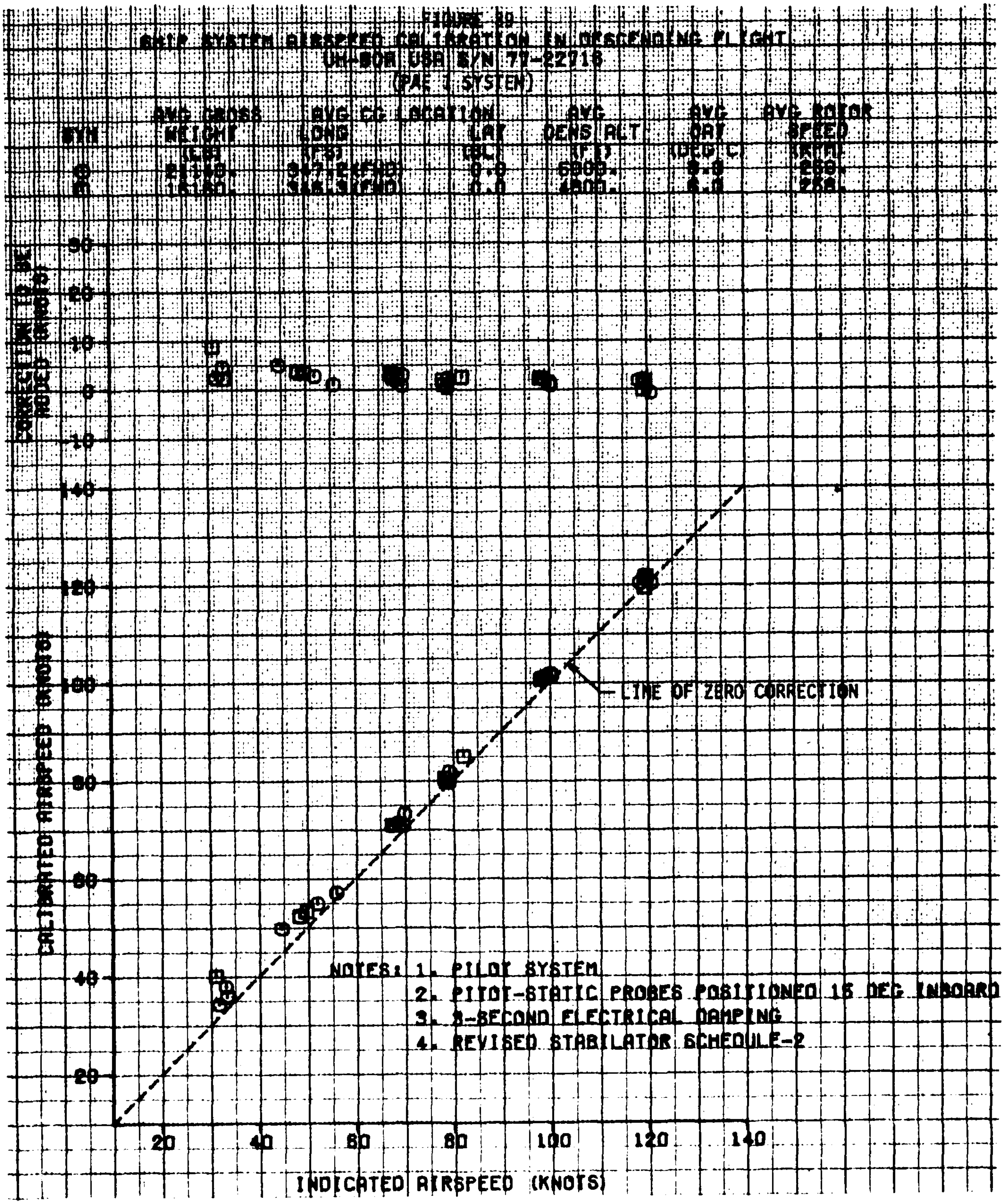
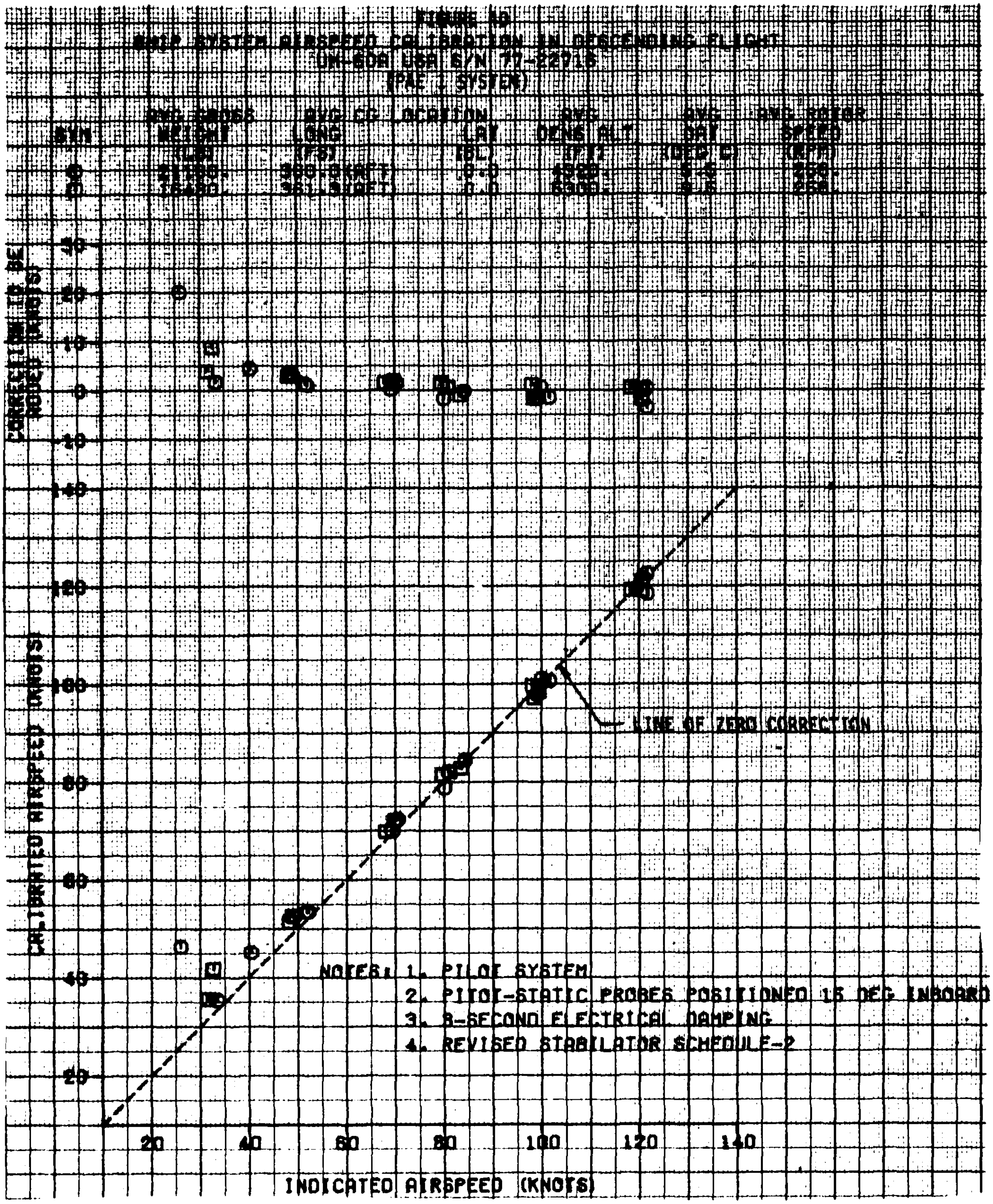


FIGURE 38
AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22718
(PAE 1 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	ROTOR SPEED (RPM)
○	21280.	360.0(AFT)	0.0	4840.	6.6	258.
□	16560.	360.3(AFT)	0.0	5560.	9.0	258.




LAT
DENS ALT
SPEED
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
3. 8-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
20
40
60
80
100
120
140



CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
20
40
60
80
100
120
140
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2

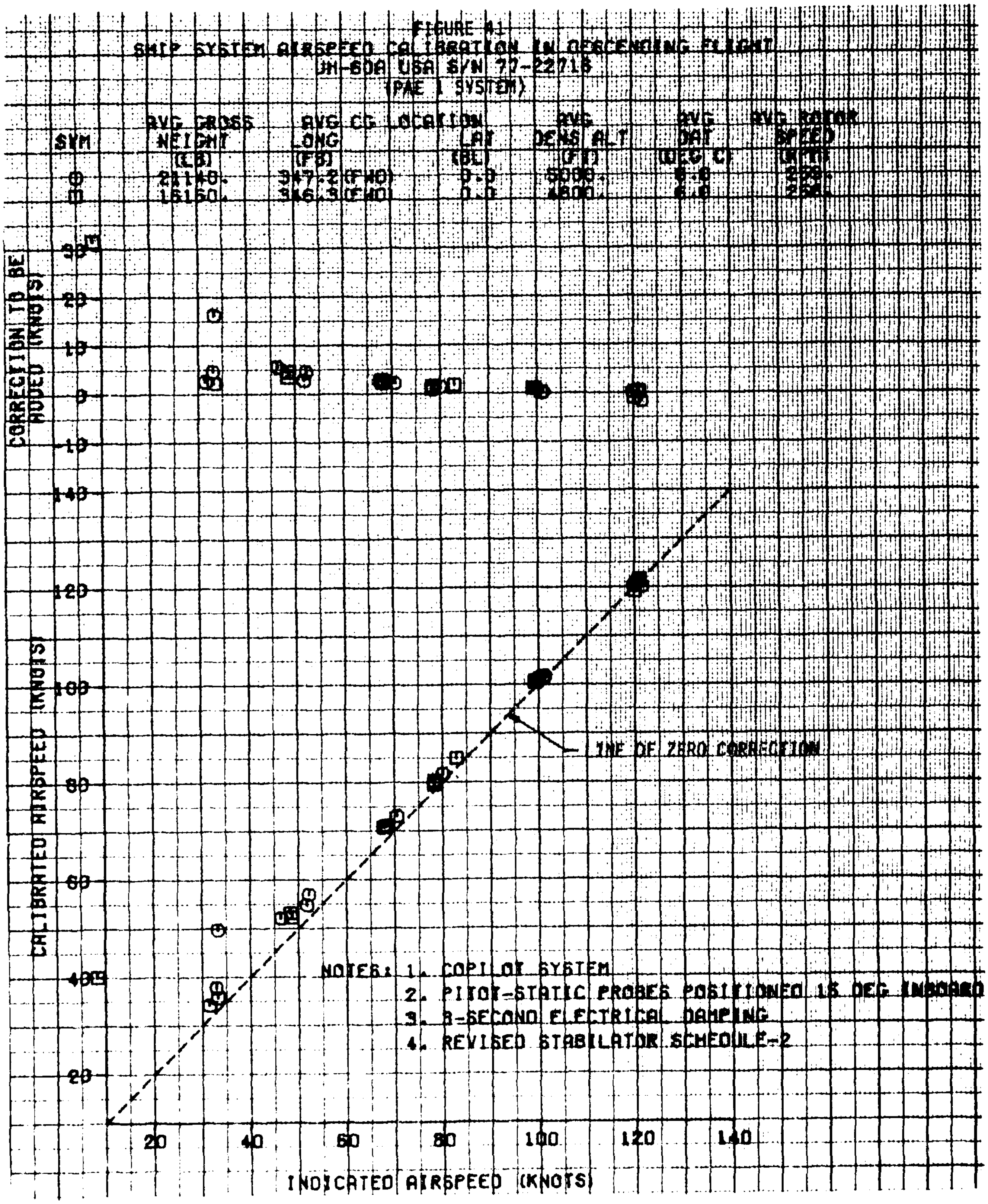
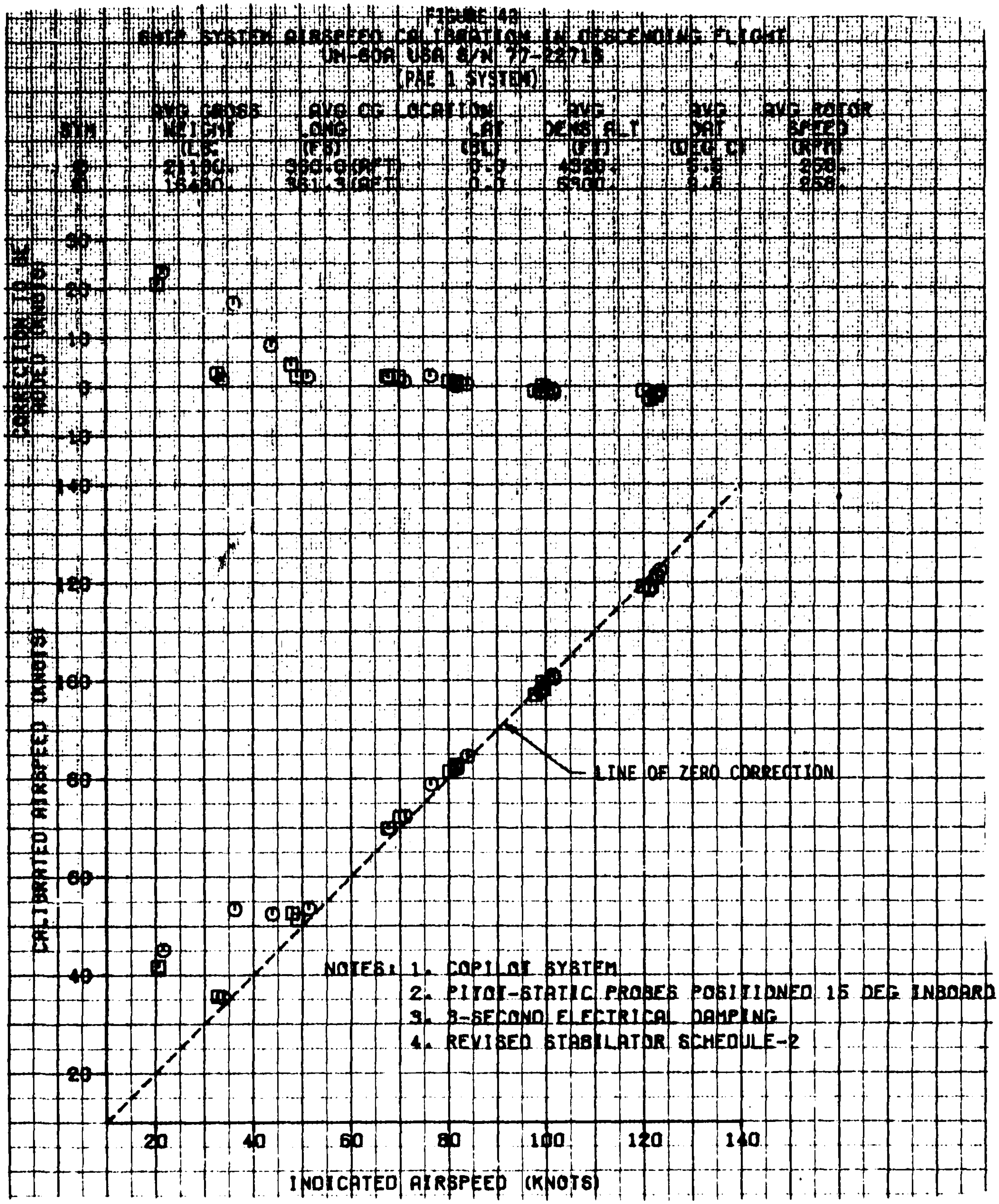


FIGURE 41
SHIP SYSTEM AIRSPEED CALIBRATION IN DESCENDING FLIGHT
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
21140. 347.2 (FWD) 0.0 5000. 6.0 258.
16160. 346.3 (FWD) 0.0 4800. 6.0 258.
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. COPILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
3. 8-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
INDICATED AIRSPEED (KNOTS)


(PAE 1 SYSTEM)
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. COPILOT SYSTEM
2. PITOT-STATIC PROBES POSITIONED 15 DEG INBOARD
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2

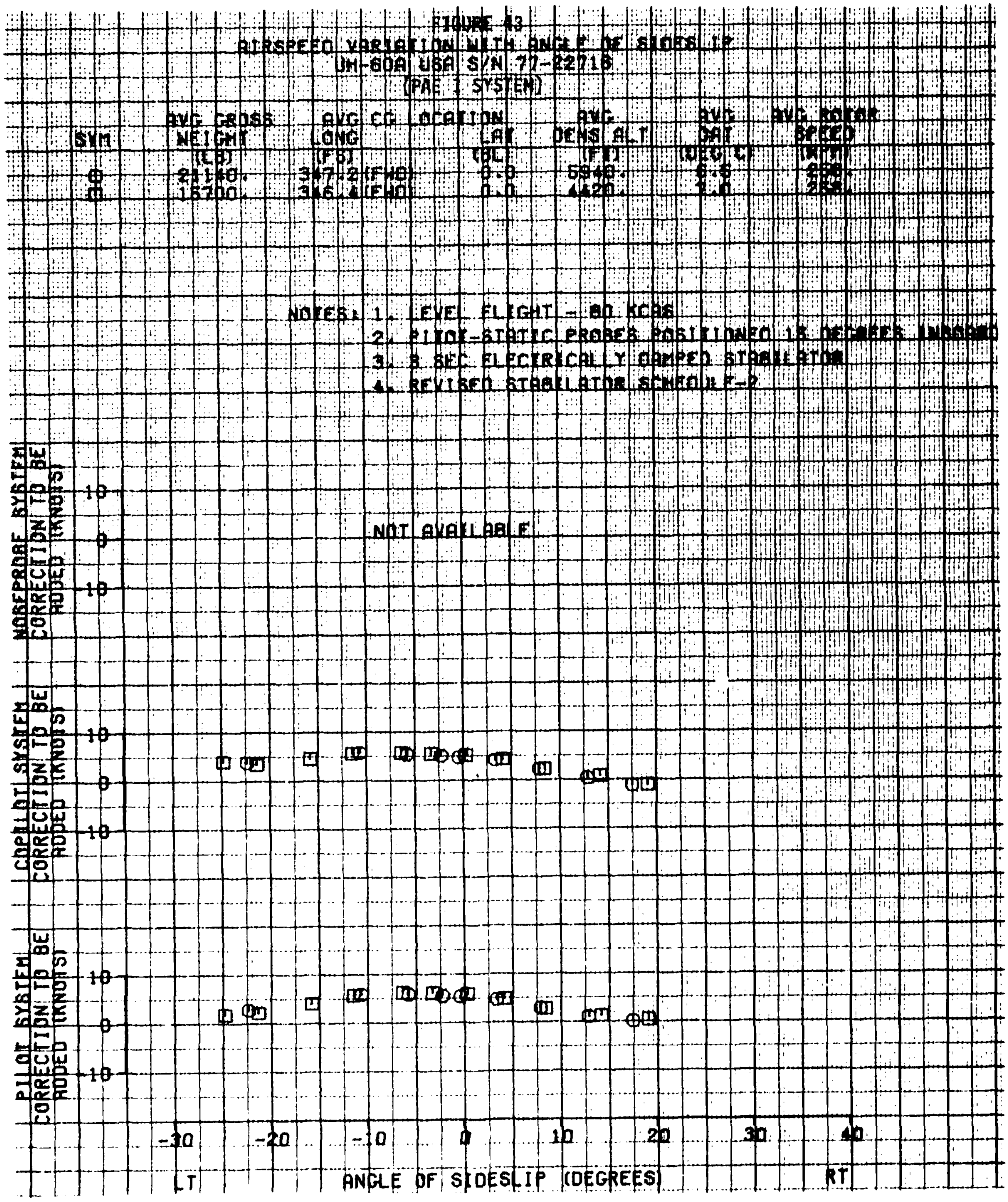


FIGURE 43
AIRSPEED VARIATION WITH ANGLE OF SIDESLIP
UH-60A USA S/N 77-22716
(PAE 1 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
15700.
347.2(FWD)
346.4(FWD)
0.0
5940.
4420.
NOTES: 1. LEVEL FLIGHT - 80 KCAS
3. 8 SEC ELECTRICALLY DAMPED STABILATOR
4. REVISED STABILATOR SCHEDULE-2
NOSEPROBE SYSTEM CORRECTION TO BE ADDED (KNOTS)
NOT AVAILABLE
COPILOT SYSTEM CORRECTION TO BE ADDED (KNOTS)
PILOT SYSTEM CORRECTION TO BE ADDED (KNOTS)
10
0
10
-30
-20
-10
0
10
20
30
40
LT
ANGLE OF SIDESLIP (DEGREES)
RT

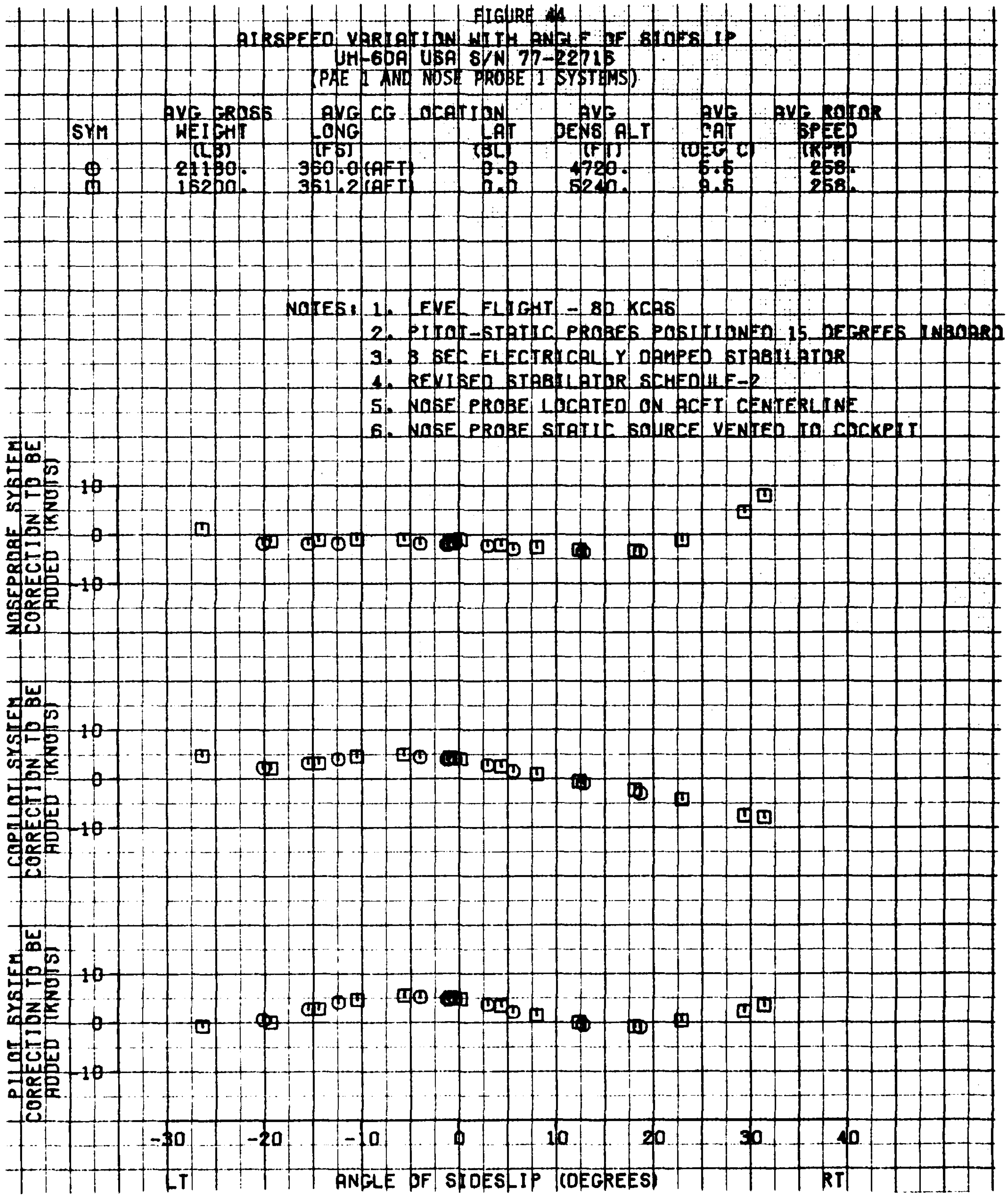


FIGURE 44
AIRSPEED VARIATION WITH ANGLE OF SIDESLIP
UH-60A USA S/N 77-22716
(PAE 1 AND NOSE PROBE 1 SYSTEMS)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
○ 21180. 360.0(AFT) 0.0 4720. 5.5 258.
□ 16200. 361.2(AFT) 0.0 5240. 9.5 258.
NOTES: 1. LEVEL FLIGHT - 80 KCAS
2. PITOT-STATIC PROBES POSITIONED 15 DEGREES INBOARD
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. REVISED STABILATOR SCHEDULE-2
5. NOSE PROBE LOCATED ON ACFT CENTERLINE
6. NOSE PROBE STATIC SOURCE VENTED TO COCKPIT
NOSEPROBE SYSTEM CORRECTION TO BE ADDED (KNOTS)
COPILOT SYSTEM CORRECTION TO BE ADDED (KNOTS)
PILOT SYSTEM CORRECTION TO BE ADDED (KNOTS)
10
0
-10
-30
-20
-10
0
10
20
30
40
LT
ANGLE OF SIDESLIP (DEGREES)
RT

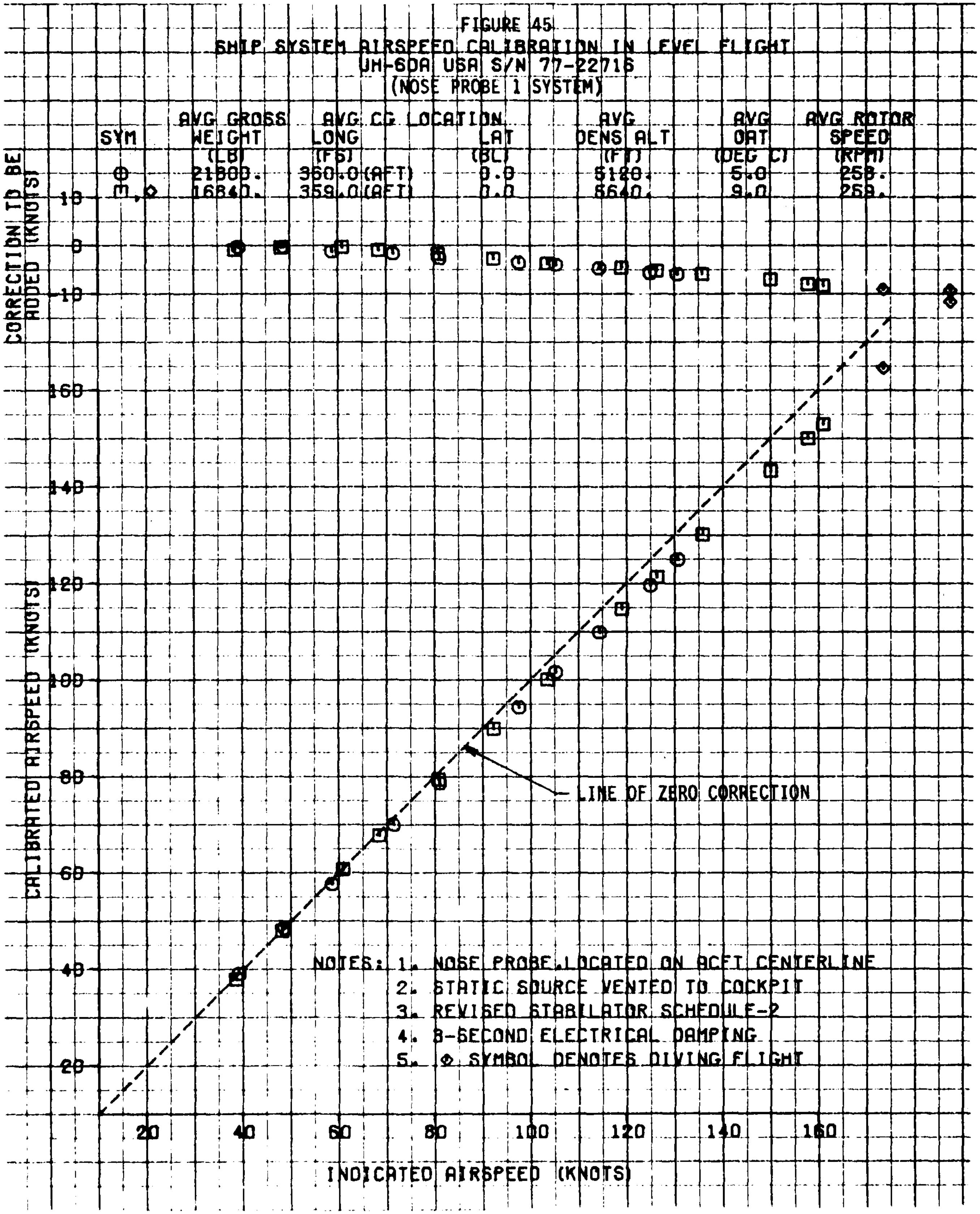
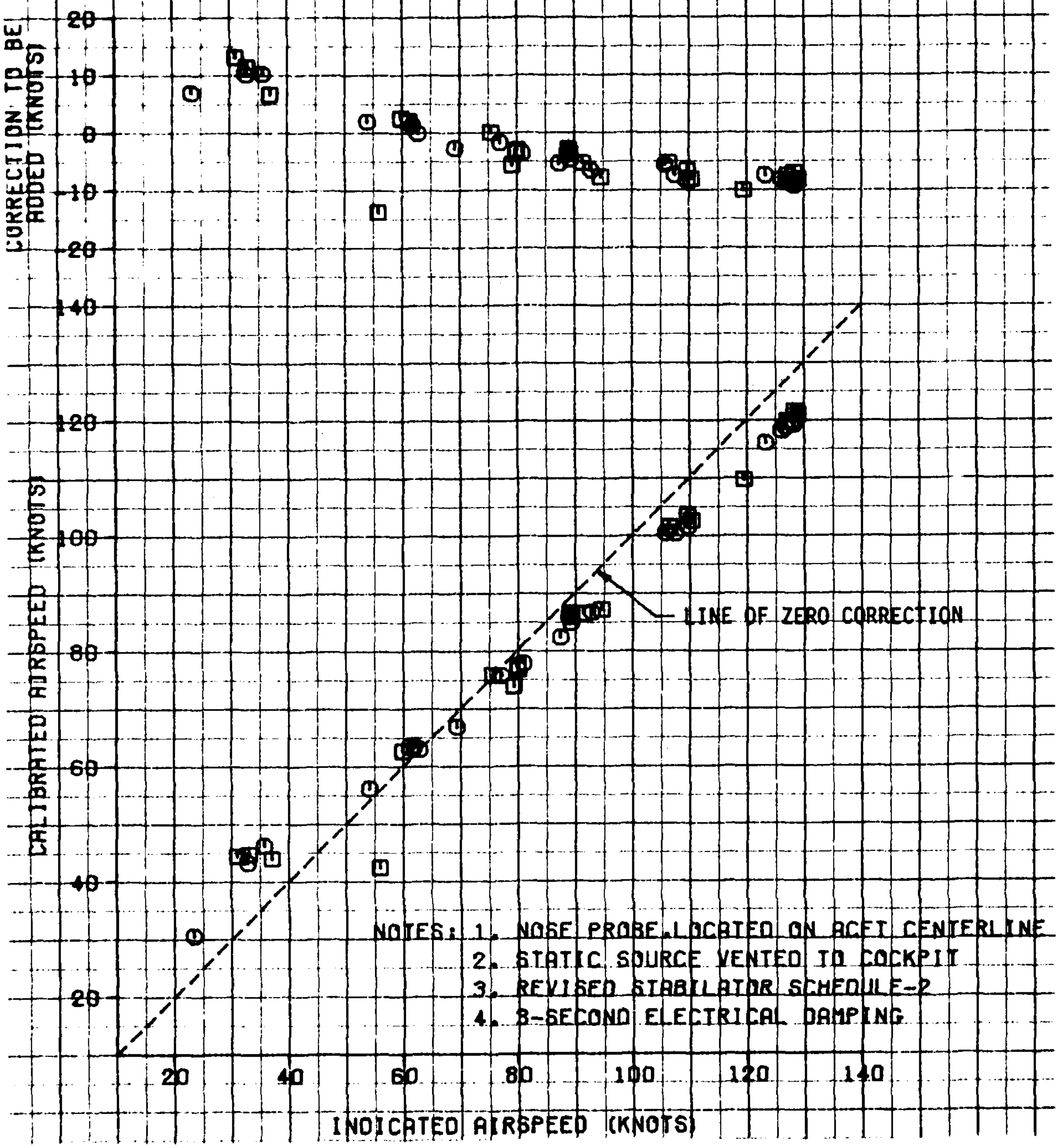


FIGURE 45
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22716
(NOSE PROBE 1 SYSTEM)

FIGURE 46
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(NOSE PROBE 1 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)
○	21220.	360.0(AFT)	0.0	4780.	5.5	256.
□	16500.	360.9(AFT)	0.0	5440.	9.5	258.



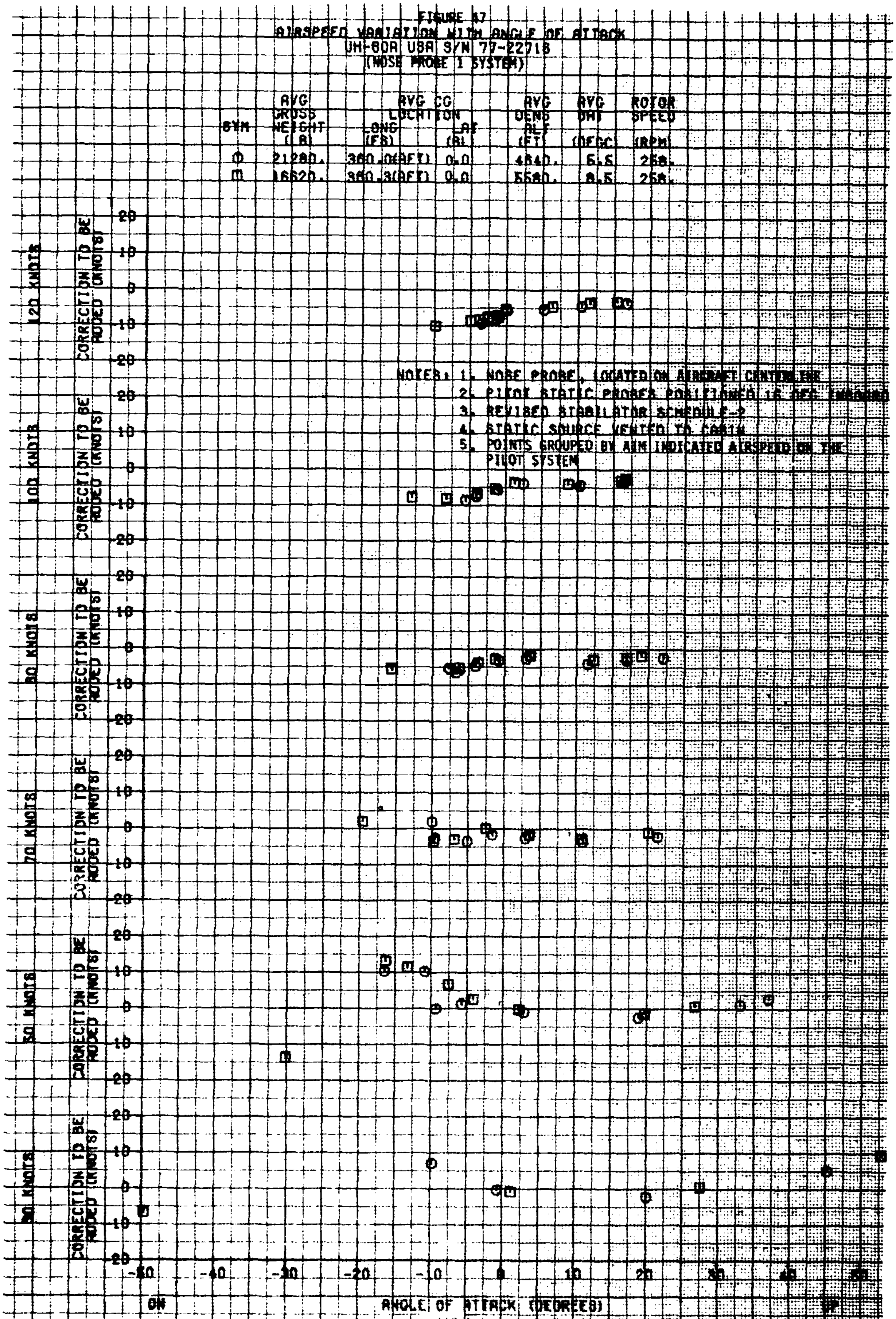


FIGURE 87
AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22718
(NOSE PROBE 1 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
ROTOR SPEED (RPM)
21280.
360.0(AFT)
0.0
4840.
5.5
258.
16620.
360.3(AFT)
0.0
5580.
8.5
258.
NOTES: 1. NOSE PROBE, LOCATED ON AIRCRAFT CENTERLINE
2. PITOT STATIC PROBES POSITIONED 16 DEG INBOARD
3. REVISED STABILATOR SCHEDULE-2
4. STATIC SOURCE VENTED TO CABIN
5. POINTS GROUPED BY ARM INDICATED AIRSPEED ON THE PILOT SYSTEM
120 KNOTS
100 KNOTS
80 KNOTS
70 KNOTS
50 KNOTS
30 KNOTS
CORRECTION TO BE ADDED (KNOTS)
20
10
0
-10
-20
-50
-40
-30
-20
-10
0
10
20
30
40
50
DN
ANGLE OF ATTACK (DEGREES)
UP

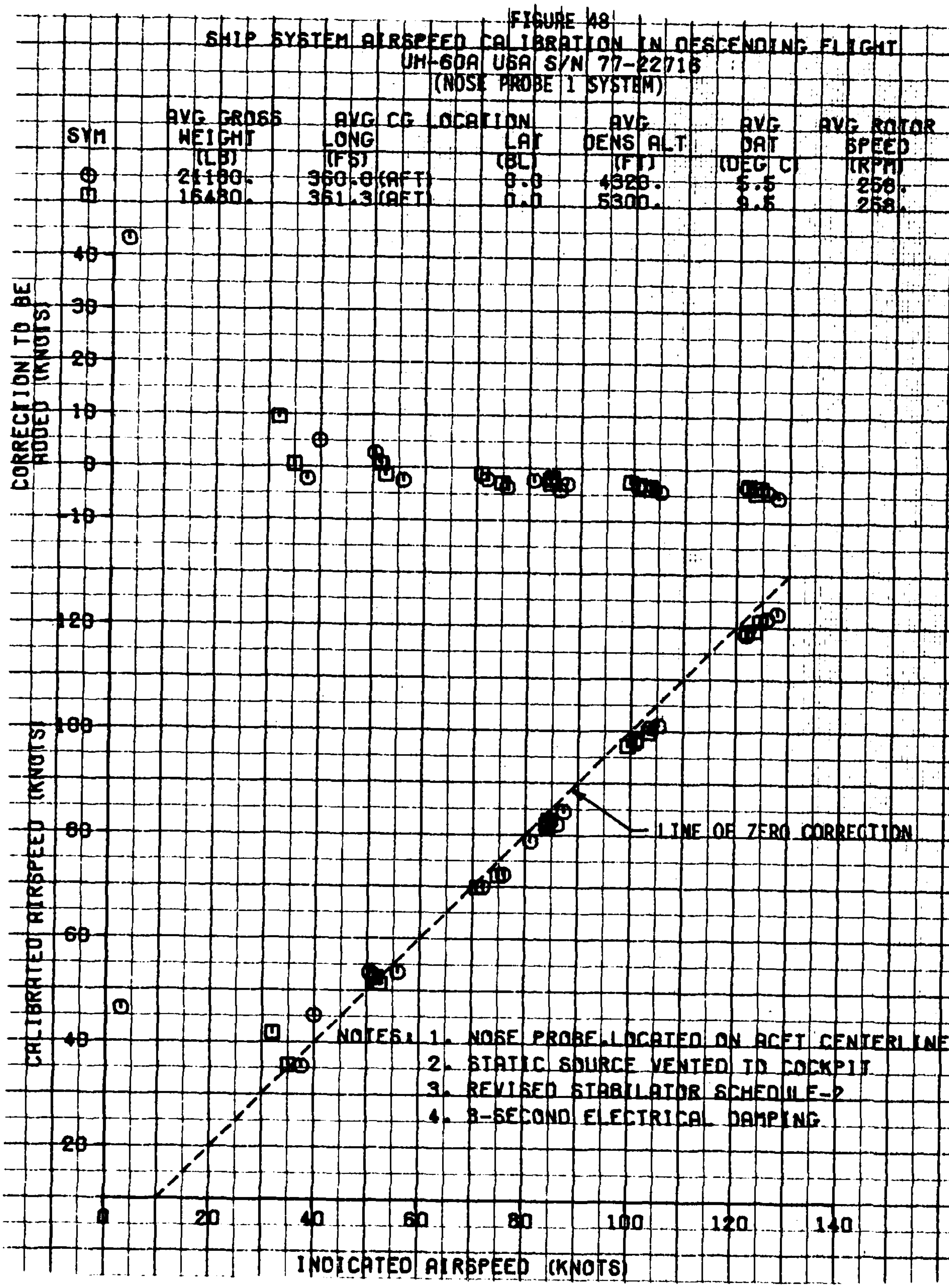


FIGURE 48
SHIP SYSTEM AIRSPEED CALIBRATION IN DESCENDING FLIGHT
UH-60A USA S/N 77-22716
(NOSE PROBE 1 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
21180. 360.8(AFT) 0.0 4320. 5.5 258.
16480. 361.3(AFT) 0.0 5300. 9.5 258.
CORRECTION TO BE ADDED (KNOTS)
40
30
20
10
0
-10
CALIBRATED AIRSPEED (KNOTS)
120
100
80
60
40
20
LINE OF ZERO CORRECTION
NOTES: 1. NOSE PROBE LOCATED ON ACFT CENTERLINE
2. STATIC SOURCE VENTED TO COCKPIT
3. REVISED STABILATOR SCHEDULE-2
4. 3-SECOND ELECTRICAL DAMPING
0
20
40
60
80
100
120
140
INDICATED AIRSPEED (KNOTS)

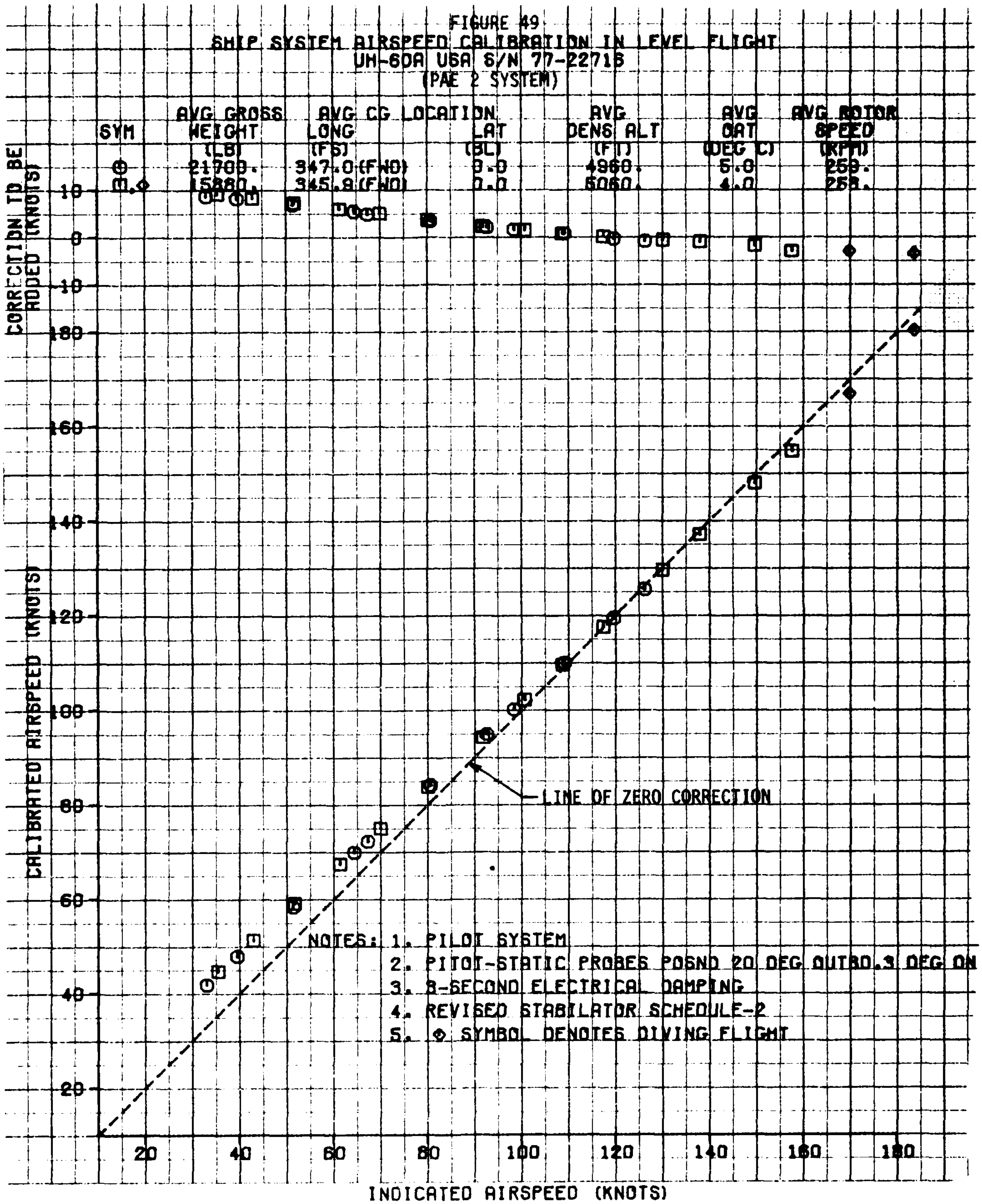


FIGURE 49
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22718
(PAE 2 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
21700. 347.0(FWD) 0.0 4960. 5.0 259.
15880. 345.8(FWD) 0.0 5060. 4.0 258.
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD,3 DEG ON
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. ◇ SYMBOL DENOTES DIVING FLIGHT

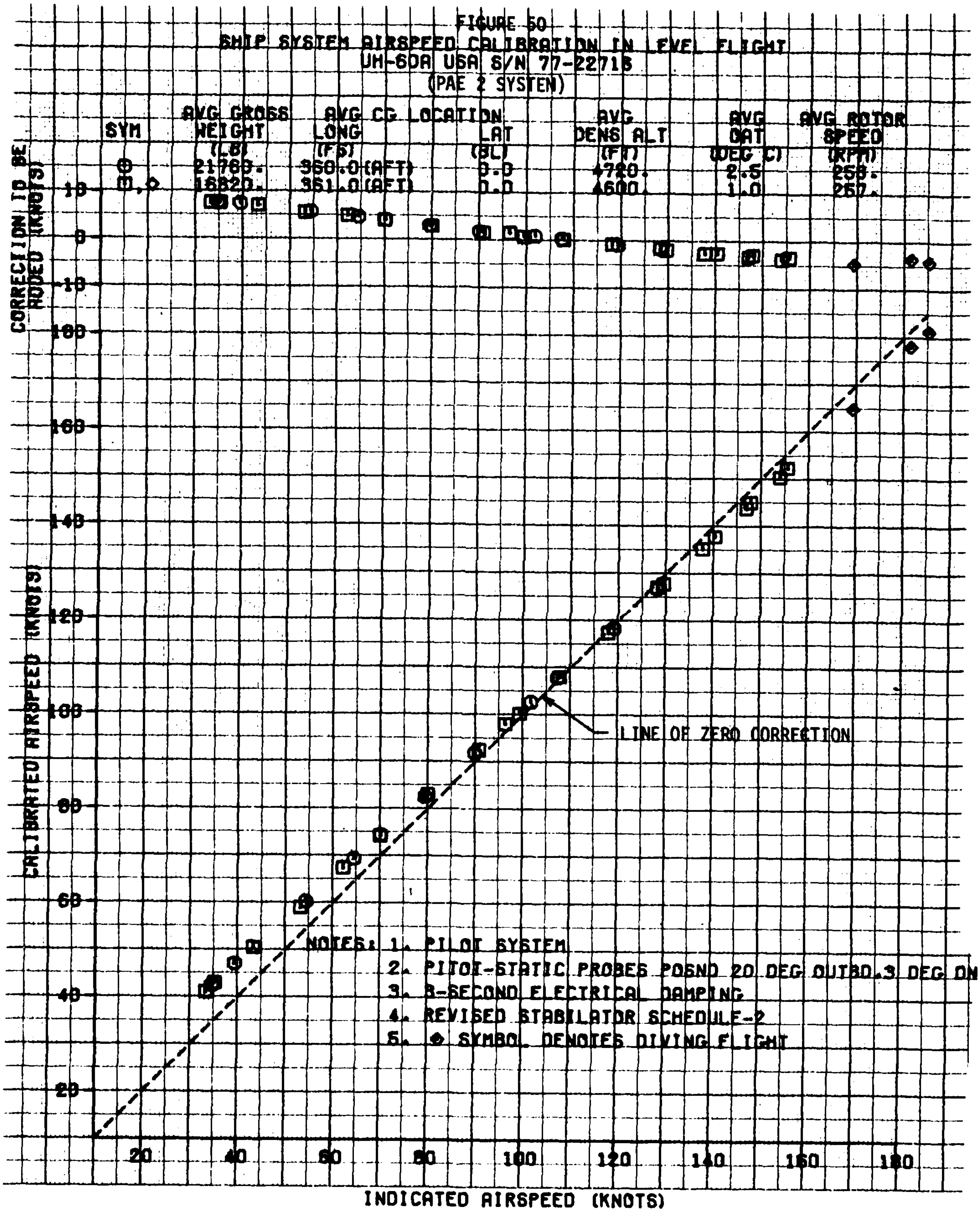


FIGURE 50
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22718
(PAE 2 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
21760. 360.0(AFT) 0.0 4720. 2.5 258.
16820. 361.0(AFT) 0.0 4600. 1.0 257.
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD,3 DEG DN
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. ◆ SYMBOL DENOTES DIVING FLIGHT
INDICATED AIRSPEED (KNOTS)

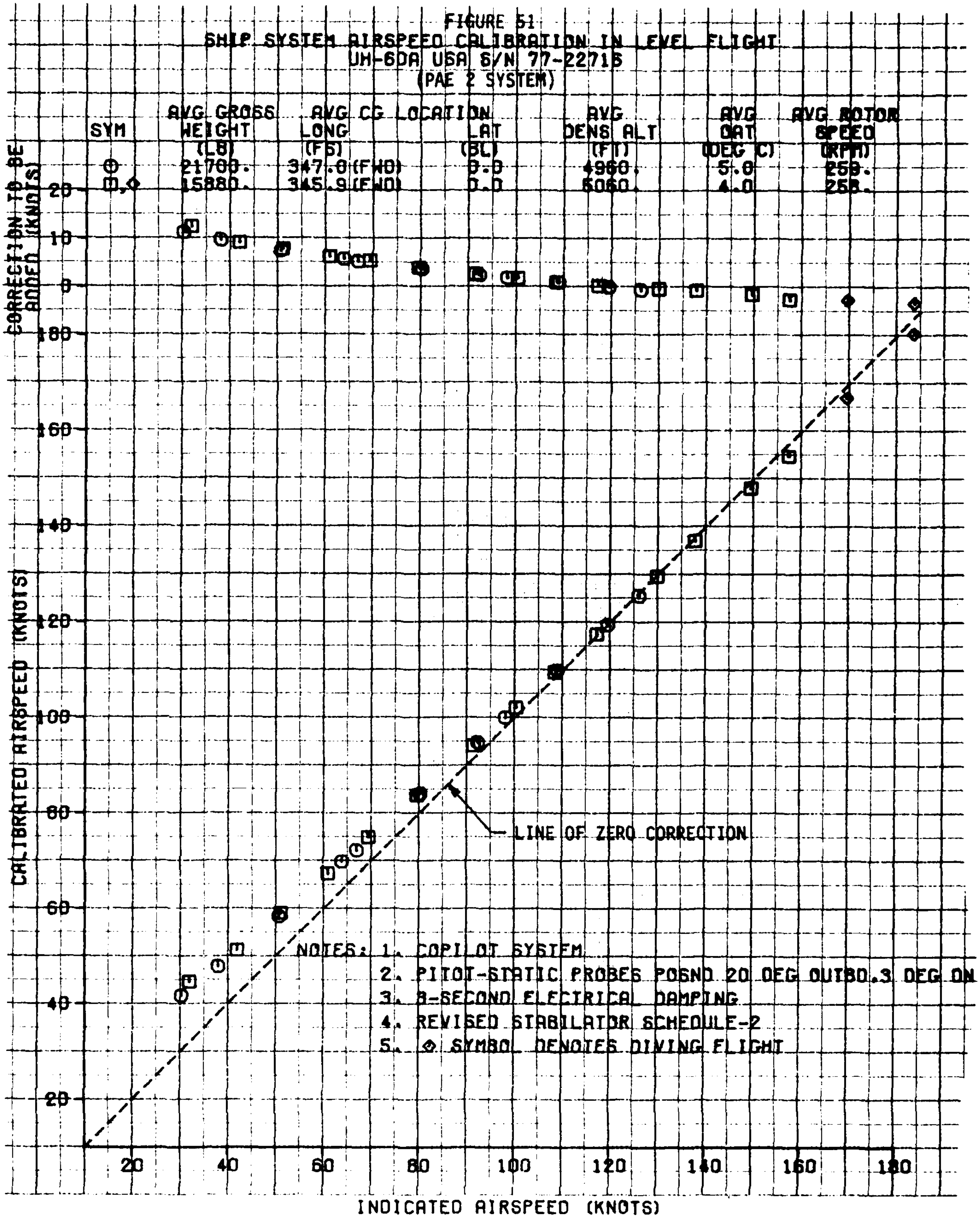


FIGURE 51
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
21700. 347.0(FWD) 0.0 4960. 5.0 259.
15880. 345.9(FWD) 0.0 6060. 4.0 258.
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. COPILOT SYSTEM
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD,3 DEG DN
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. ◇ SYMBOL DENOTES DIVING FLIGHT
INDICATED AIRSPEED (KNOTS)

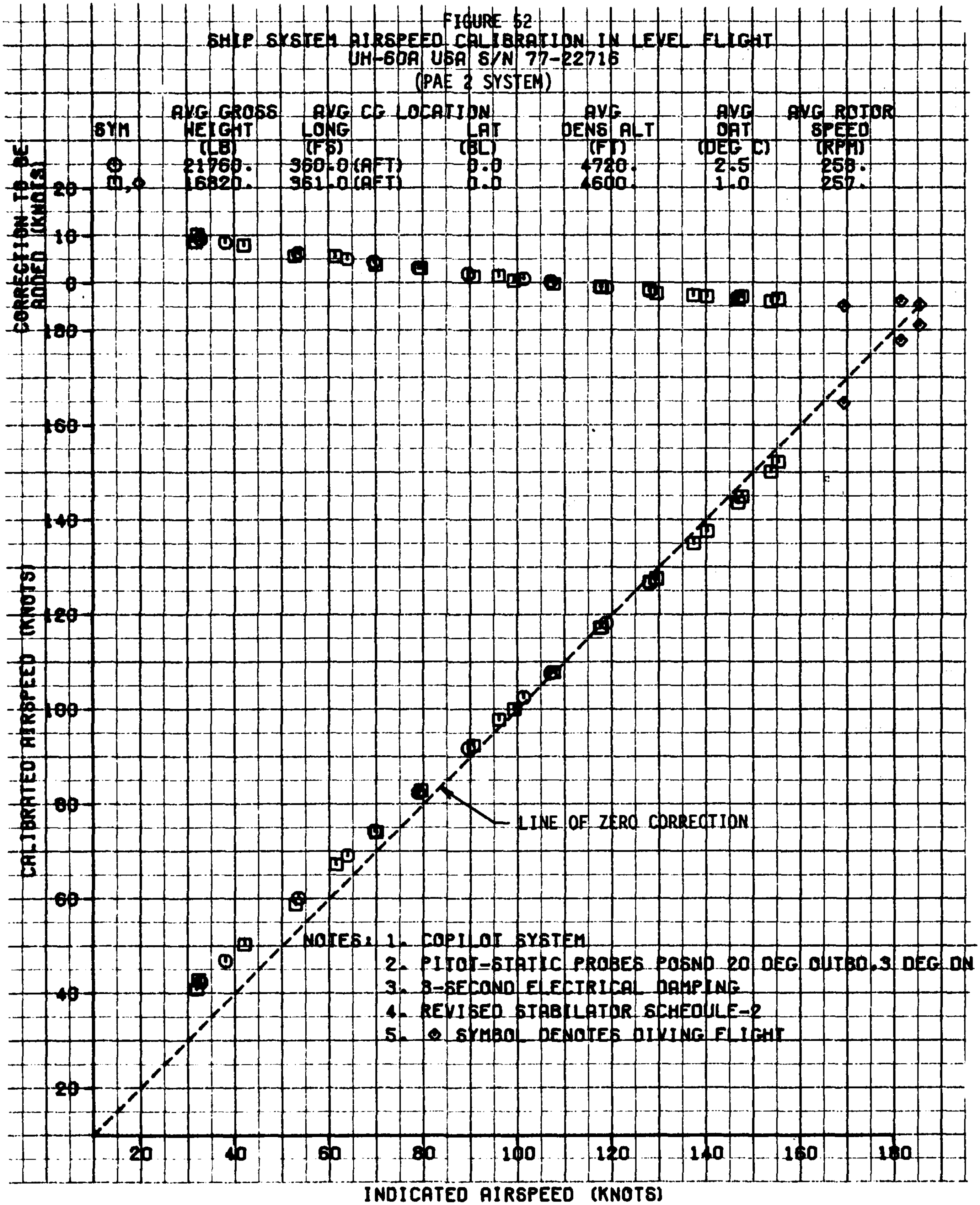


FIGURE 52
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
21760. 360.0(AFT) 0.0 4720. 2.5 258.
16820. 361.0(AFT) 0.0 4600. 1.0 257.
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. COPILOT SYSTEM
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD,3 DEG DN
3. 8-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. ◇ SYMBOL DENOTES DIVING FLIGHT
INDICATED AIRSPEED (KNOTS)

FIGURE 53
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

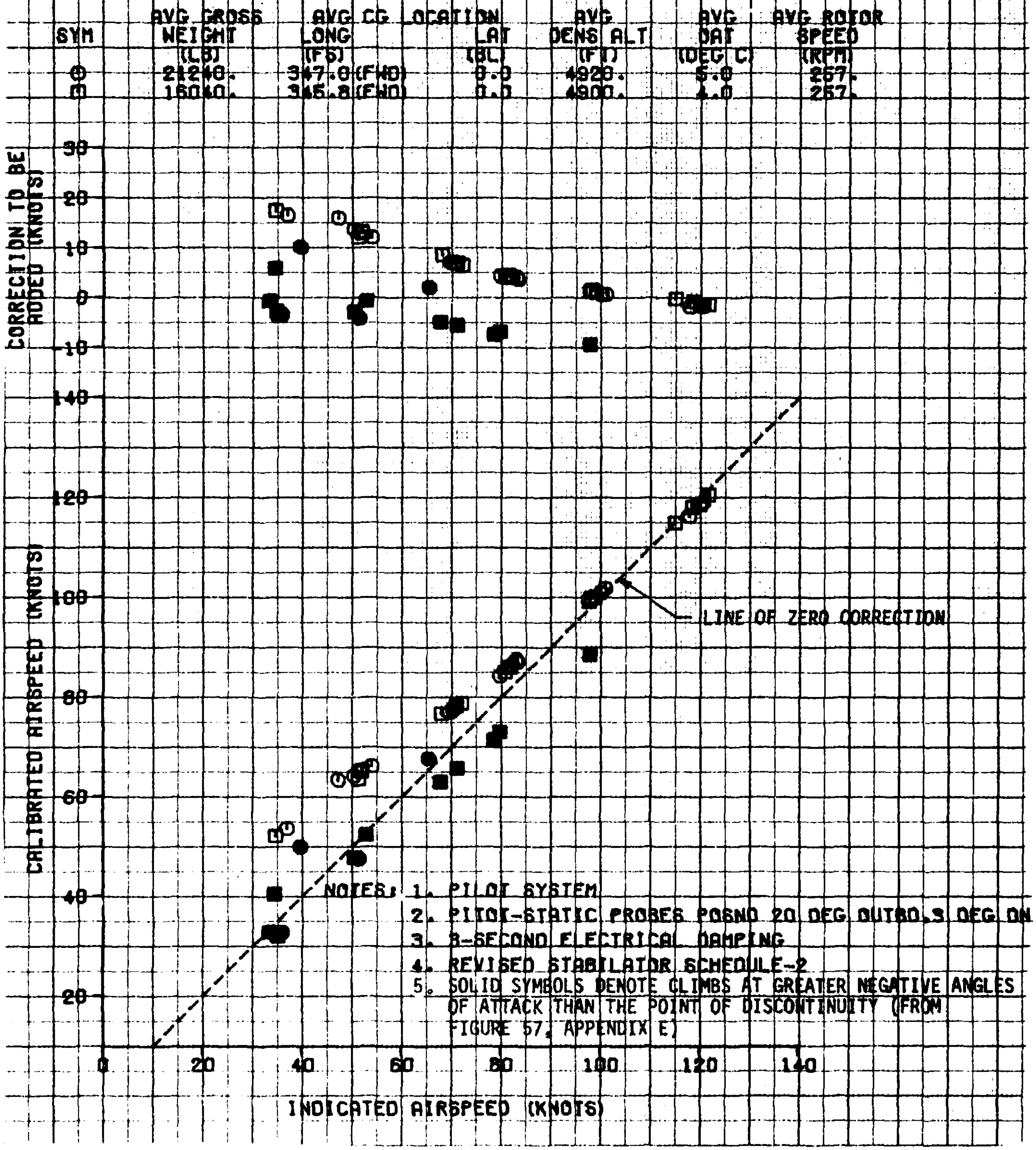


FIGURE 54
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

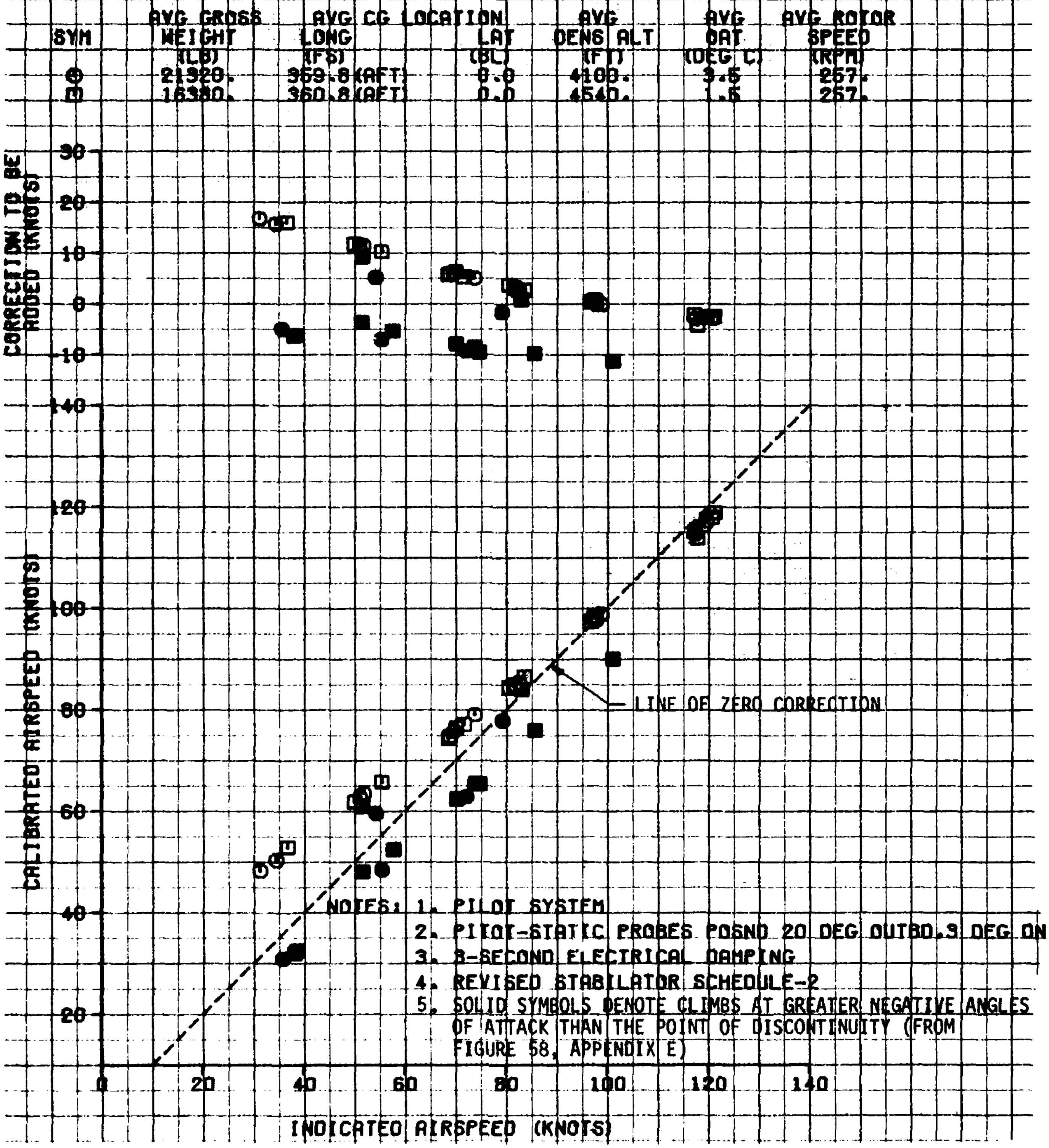
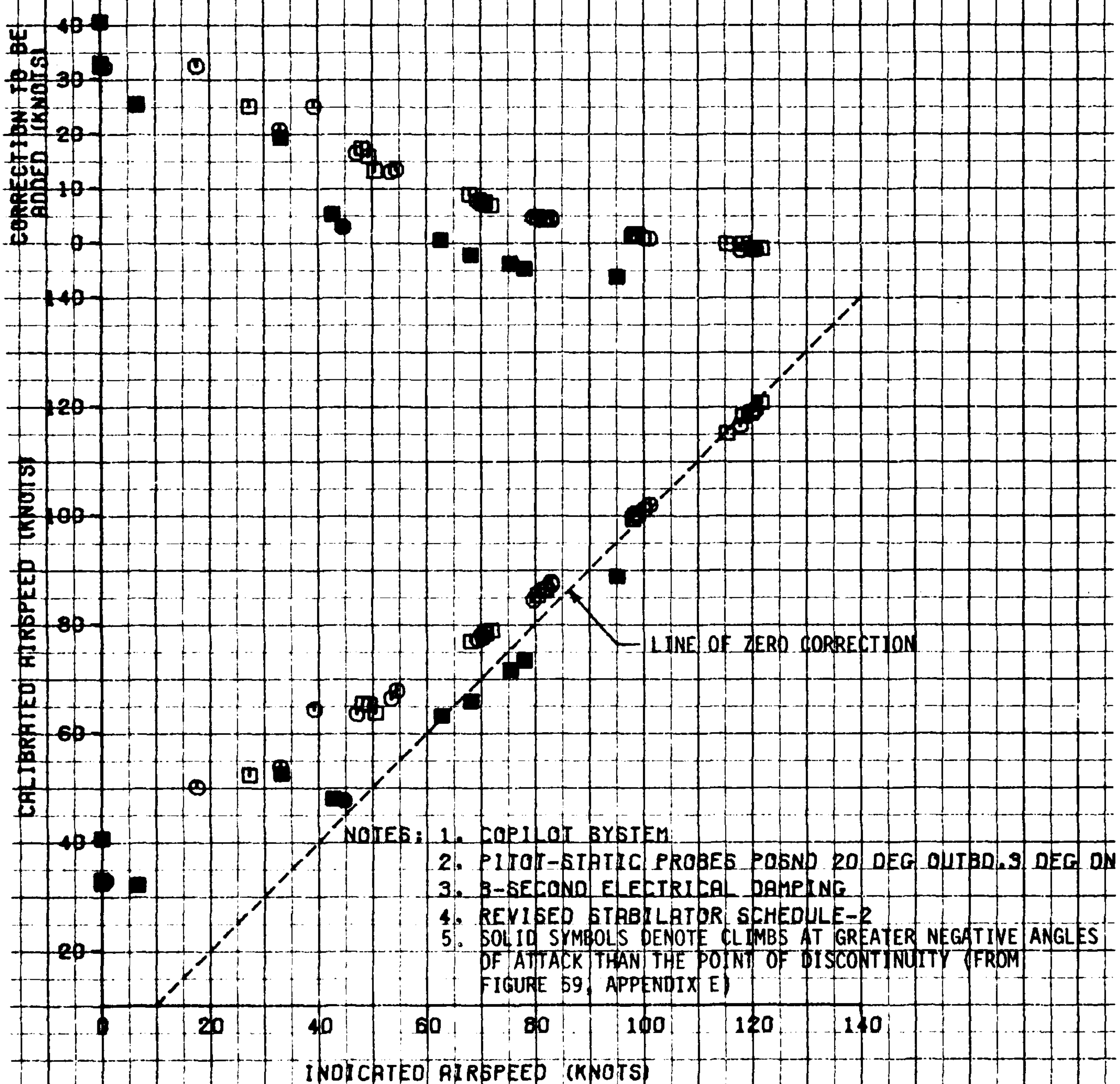


FIGURE 55
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)
⊕	21240.	347.0(FWD)	0.0	4920.	6.0	257.
◫	16040.	345.8(FWD)	0.0	4900.	4.0	257.



NOTES:
1. COPILOT SYSTEM
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD.3 DEG DN
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
5. SOLID SYMBOLS DENOTE CLIMBS AT GREATER NEGATIVE ANGLES OF ATTACK THAN THE POINT OF DISCONTINUITY (FROM FIGURE 59, APPENDIX E)

FIGURE 56
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

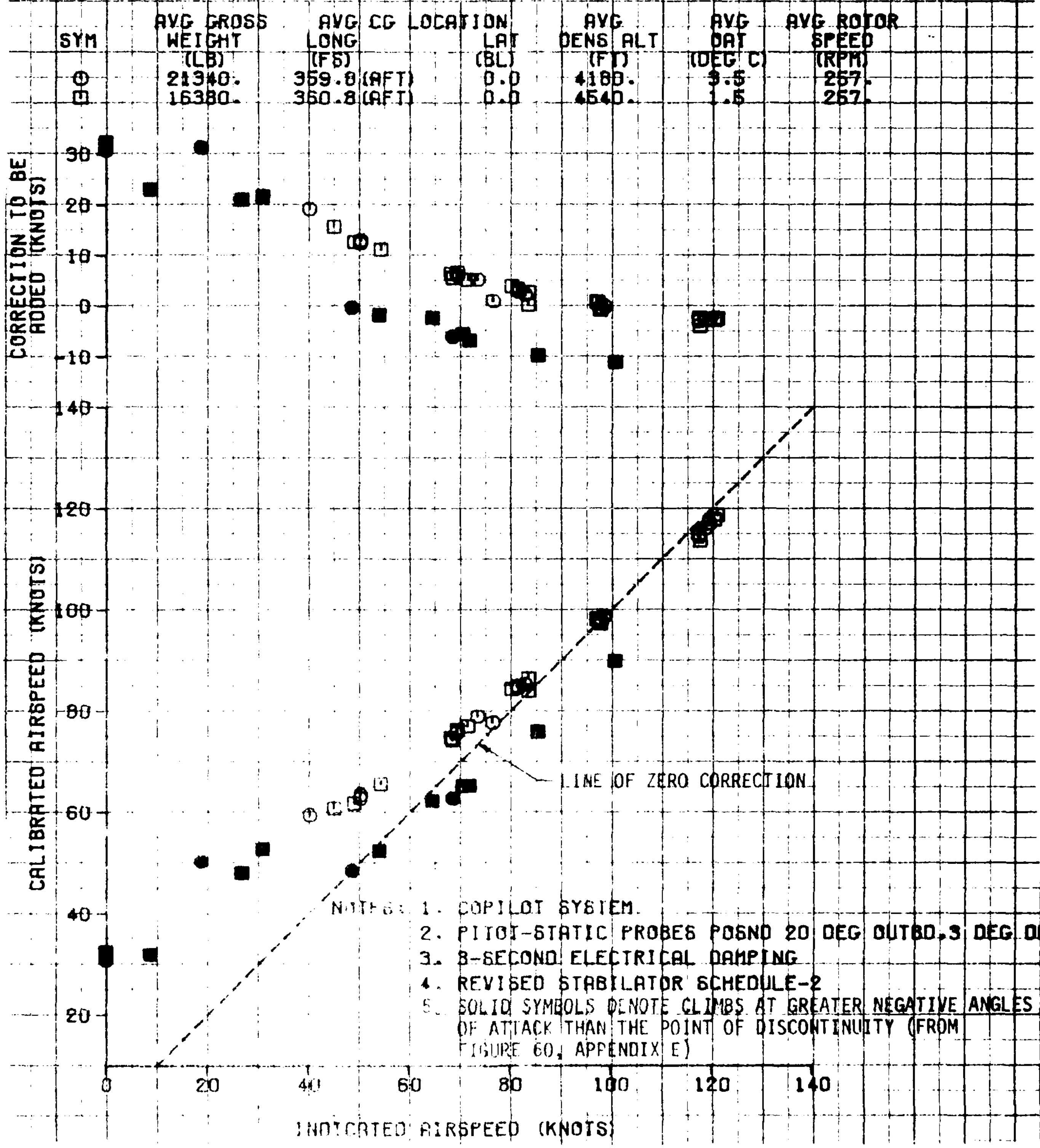


FIGURE 57
AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	ROTOR SPEED (RPM)
○	21360.	347.1(FWD)	0.0	5160.	5.0	258.
□	16920.	346.8(FWD)	0.0	3840.	6.0	258.

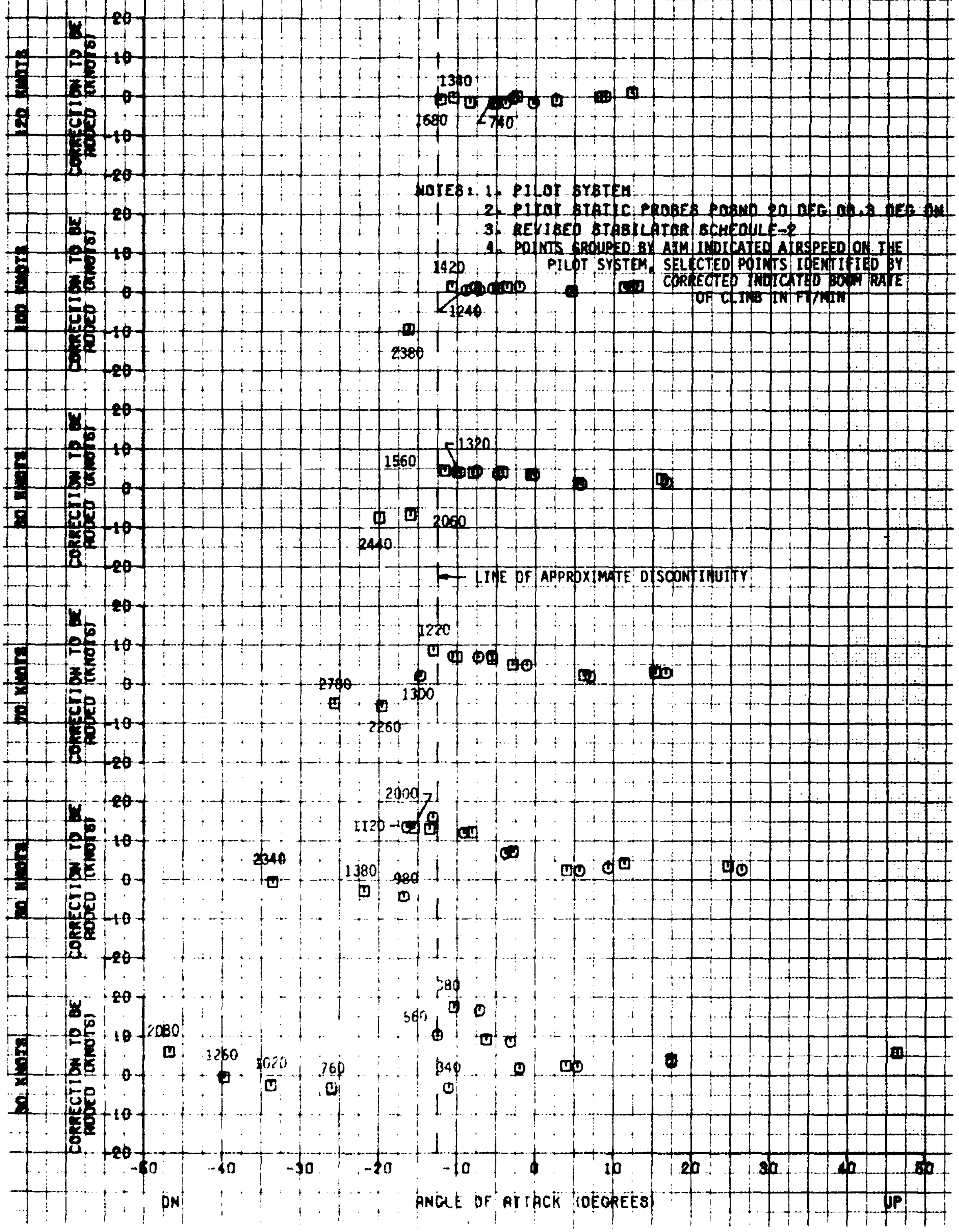
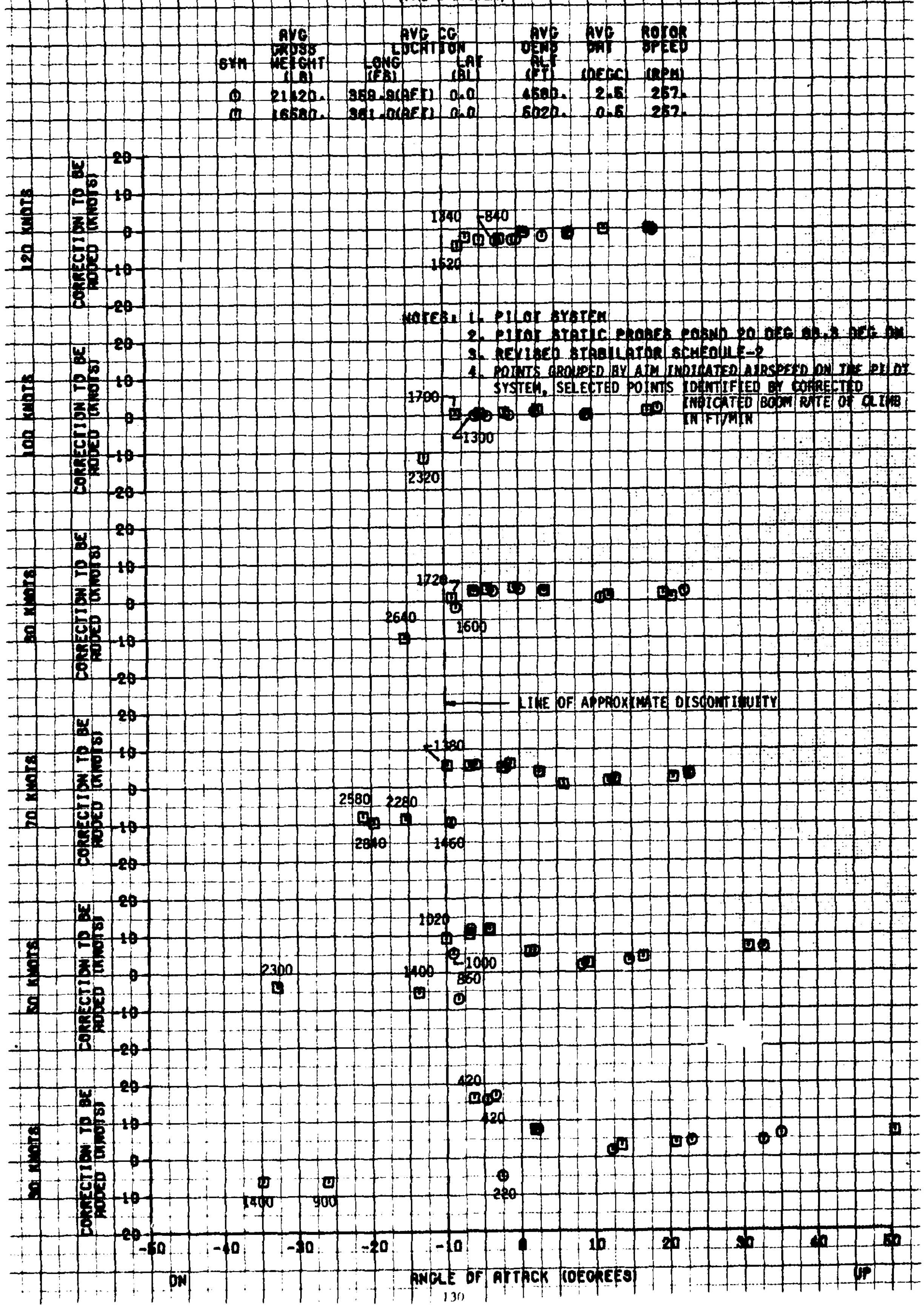


FIGURE 58
AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)



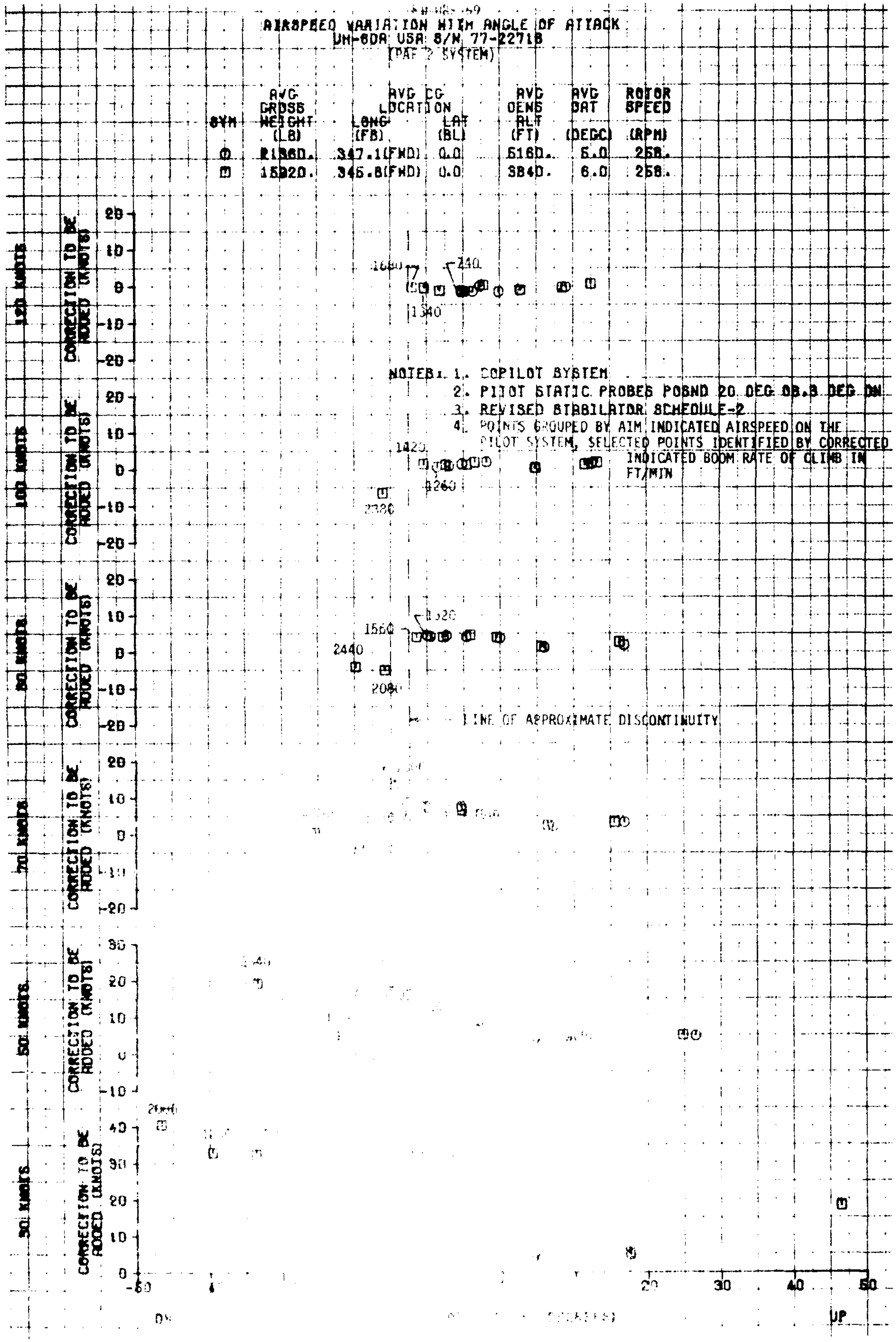

AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22718
(PAF 2 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
ROTOR SPEED (RPM)
21360. 347.1(FWD) 0.0 5160. 5.0 258.
15920. 346.8(FWD) 0.0 3840. 6.0 258.
NOTES: 1. COPILOT SYSTEM
2. PITOT STATIC PROBES POSND 20 DEG OR 8 DEG DN
3. REVISED STABILATOR SCHEDULE-2
4. POINTS GROUPED BY AIM INDICATED AIRSPEED ON THE PILOT SYSTEM, SELECTED POINTS IDENTIFIED BY CORRECTED INDICATED BOOM RATE OF CLIMB IN FT/MIN
LINE OF APPROXIMATE DISCONTINUITY
120 KNOTS
100 KNOTS
80 KNOTS
70 KNOTS
50 KNOTS
30 KNOTS
CORRECTION TO BE ADDED (KNOTS)
DN
UP

FIGURE 50
AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22718
(PAE 2 SYSTEM)

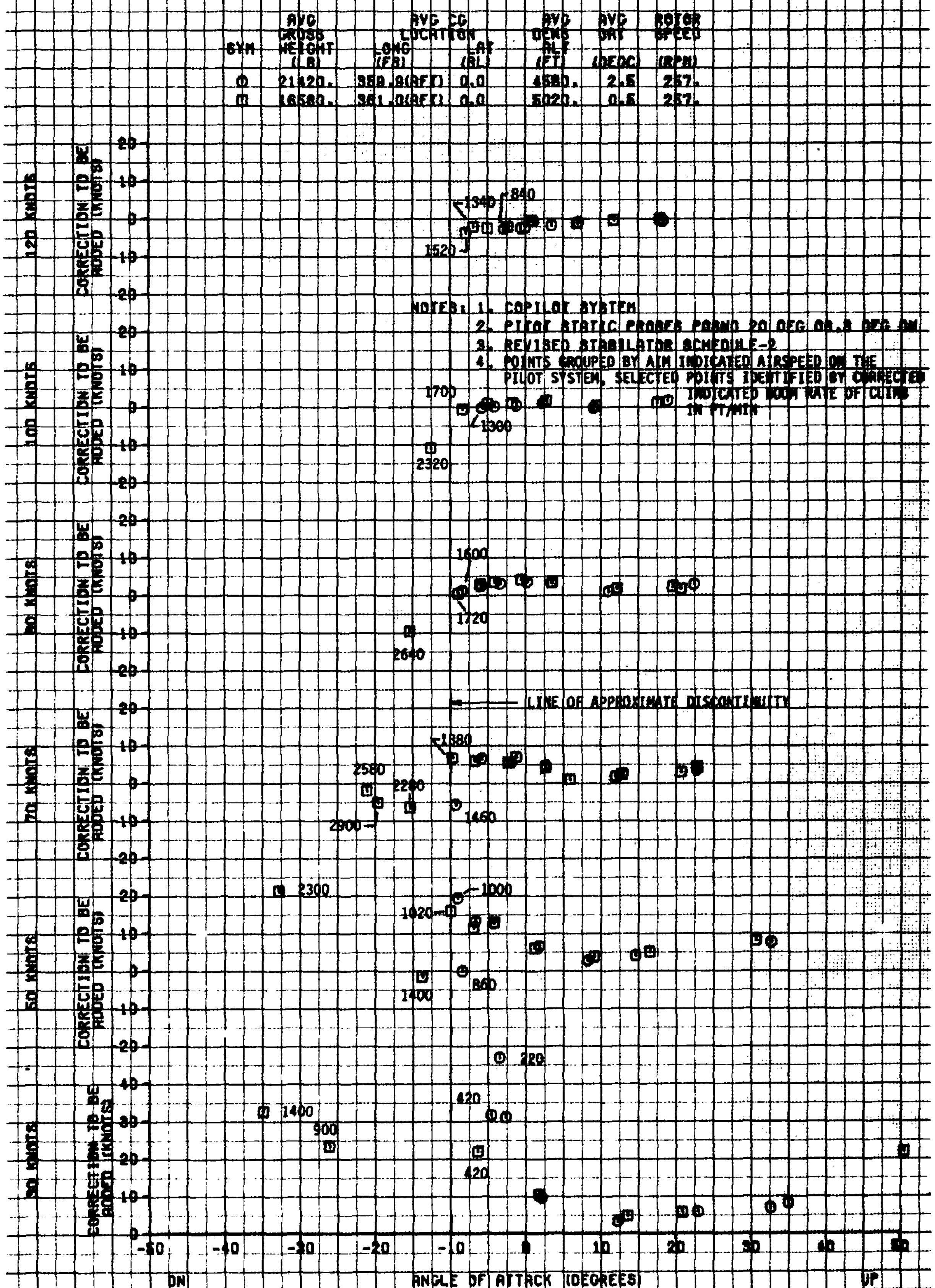
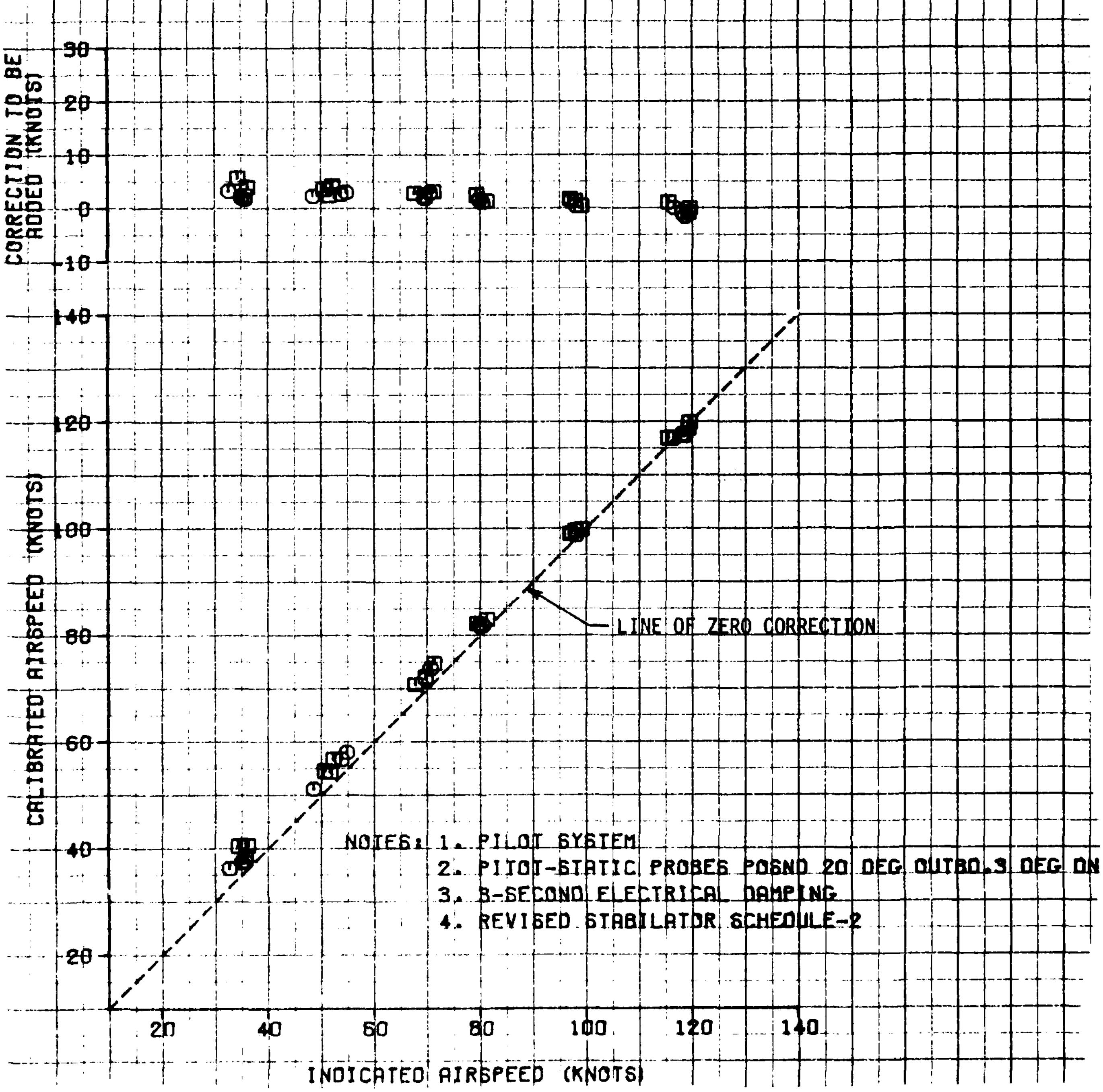


FIGURE 61
SHIP SYSTEM AIRSPEED CALIBRATION IN DESCENDING FLIGHT
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)
○	21240.	347.0(FWD)	0.0	4540.	5.0	259.
□	16060.	345.8(FWD)	0.0	4500.	4.5	258.



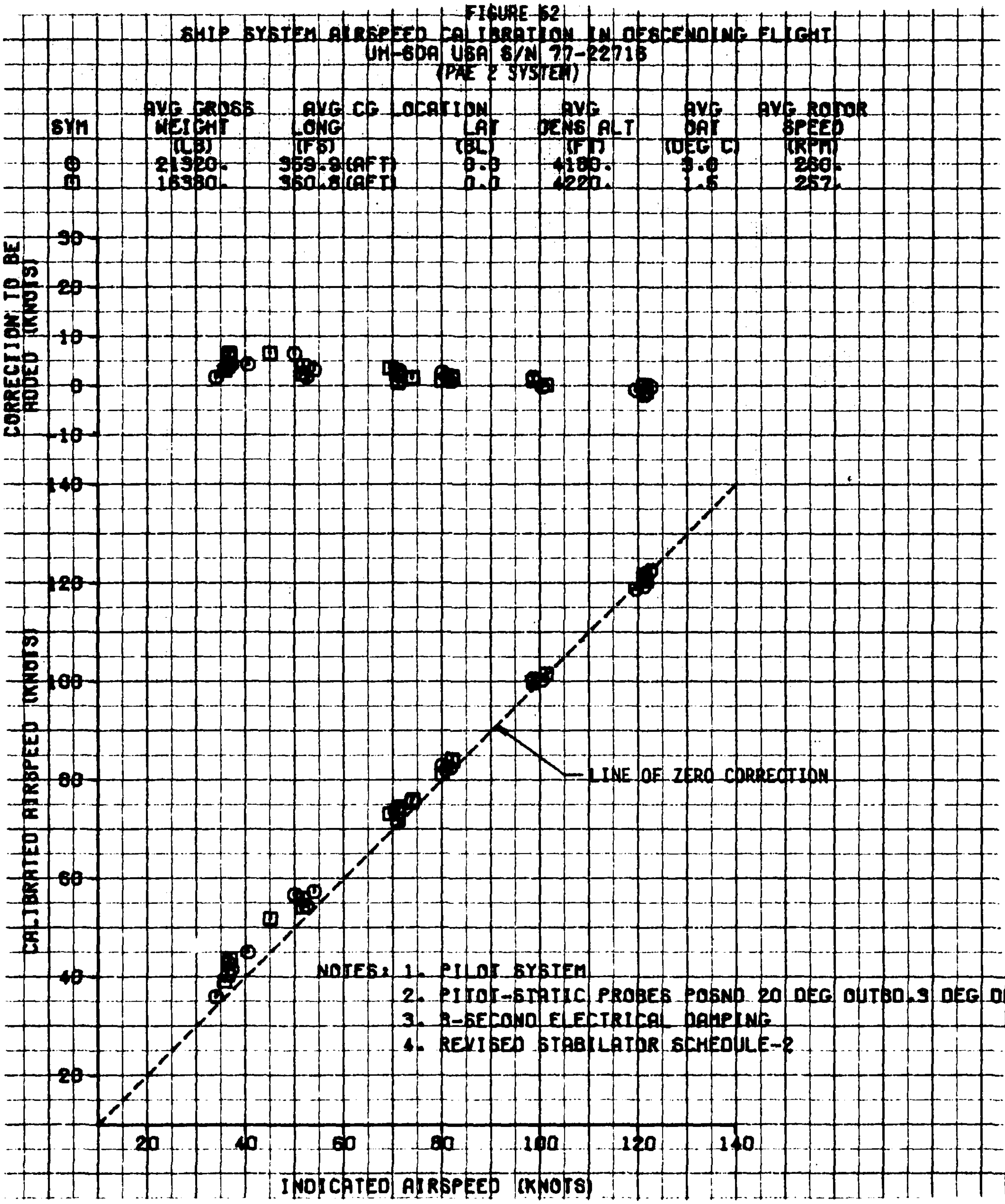
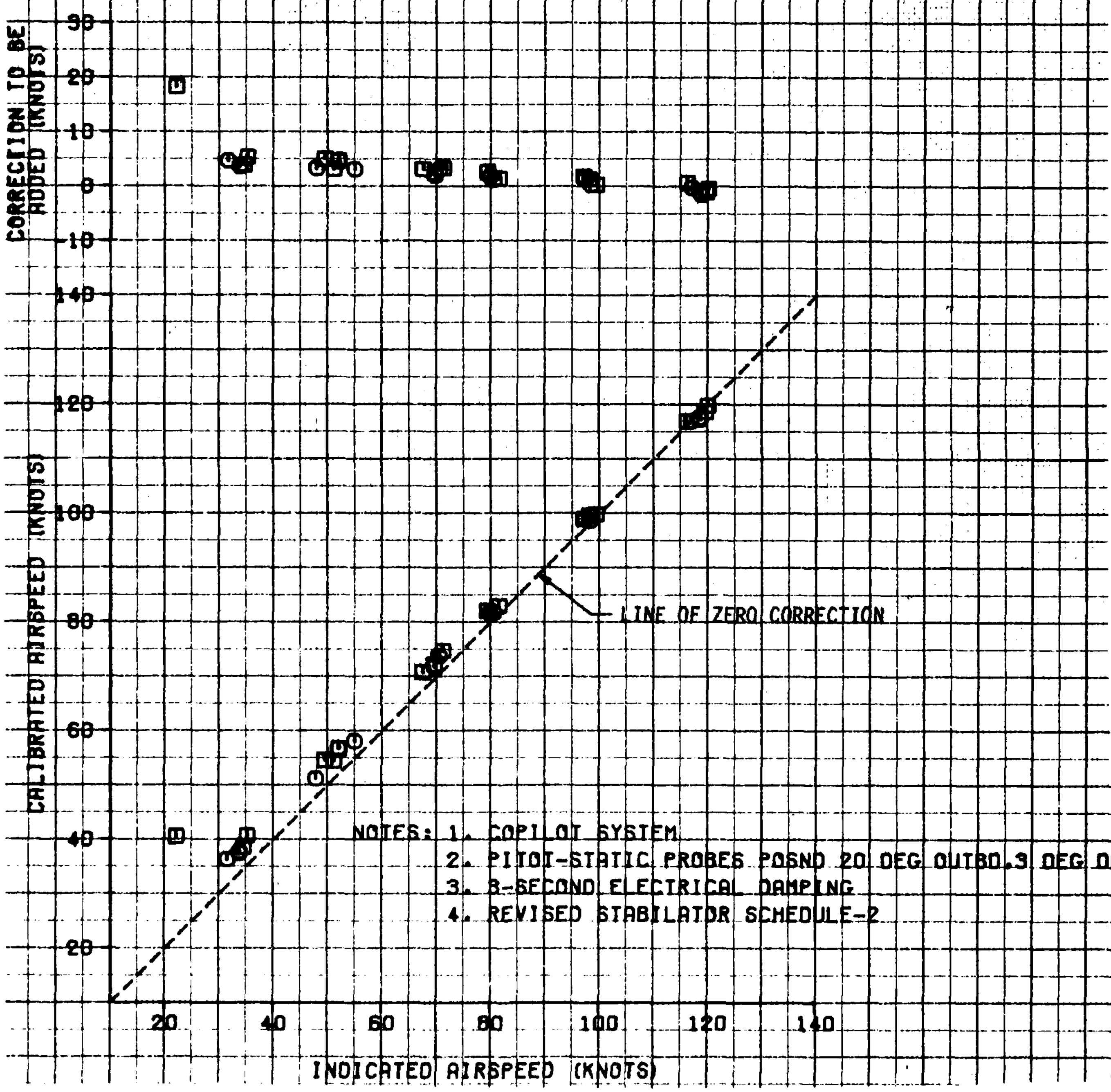


FIGURE 62
SHIP SYSTEM AIRSPEED CALIBRATION IN DESCENDING FLIGHT
UH-60A USA S/N 77-22716
(PAE 2 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
21920. 359.9(AFT) 0.0 4180. 3.0 260.
16380. 360.8(AFT) 0.0 4220. 1.5 257.
CORRECTION TO BE ADDED (KNOTS)
30
20
10
0
-10
CALIBRATED AIRSPEED (KNOTS)
140
120
100
80
60
40
20
LINE OF ZERO CORRECTION
NOTES: 1. PILOT SYSTEM
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD,3 DEG DN
3. 3-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2
20
40
60
80
100
120
140
INDICATED AIRSPEED (KNOTS)

FIGURE 53
SHIP SYSTEM AIRSPEED CALIBRATION IN DESCENDING FLIGHT
UH-60A USA S/N 77-22718
(PAE 2 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)
○	21240.	347.0(FWD)	0.0	4540.	5.0	259.
□	16060.	345.8(FWD)	0.0	4500.	4.5	258.



NOTES: 1. COPILOT SYSTEM
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD,3 DEG ON
3. 8-SECOND ELECTRICAL DAMPING
4. REVISED STABILATOR SCHEDULE-2

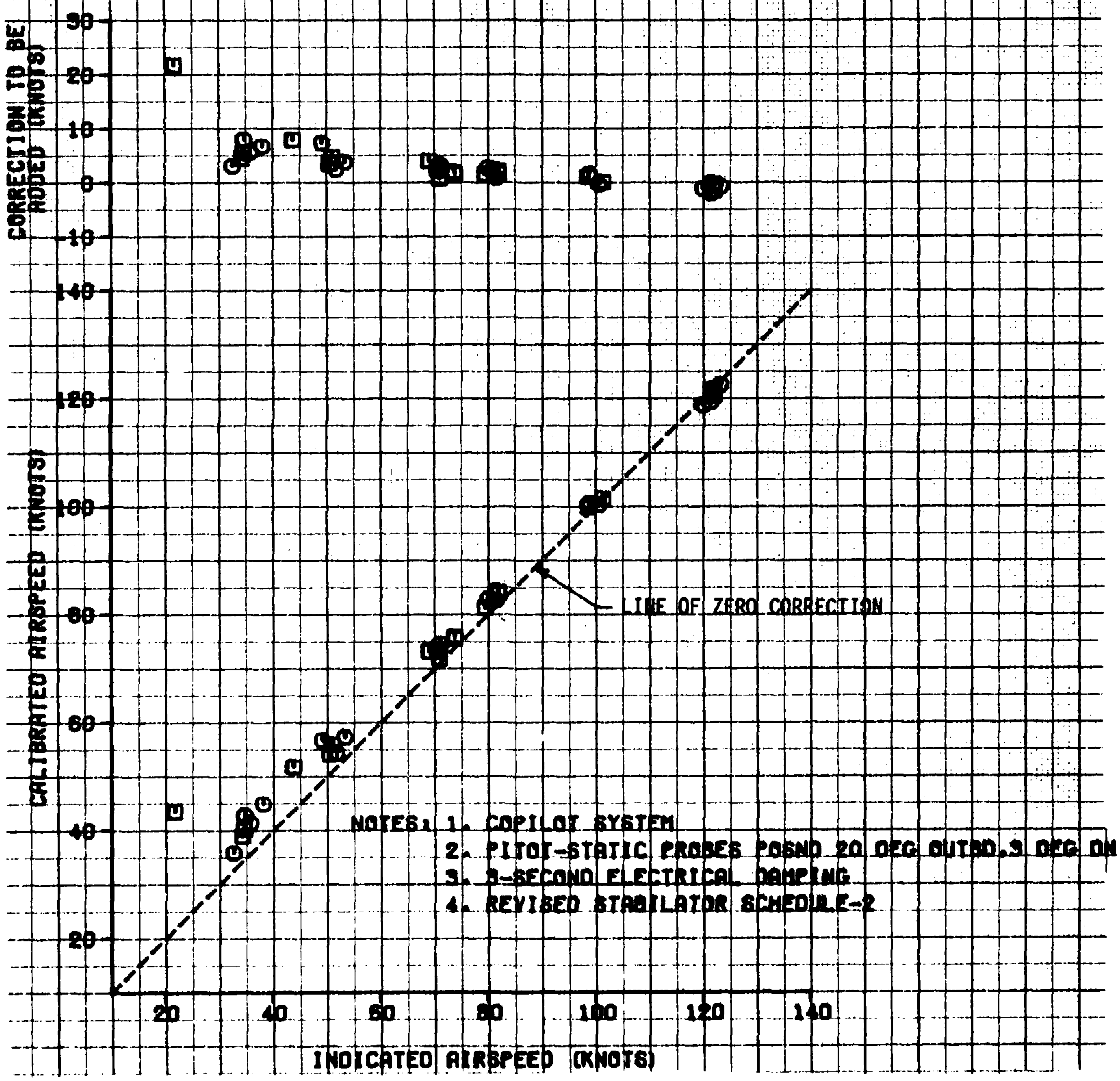
FIGURE 64

SHIP SYSTEM AIRSPEED CALIBRATION IN DESCENDING FLIGHT

UH-60A USA S/N 77-22718

(PAE 2 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)
⊖	21320.	359.9 (AFT)	0.0	4180.	3.0	260.
⊡	16380.	360.8 (AFT)	0.0	4220.	1.5	257.



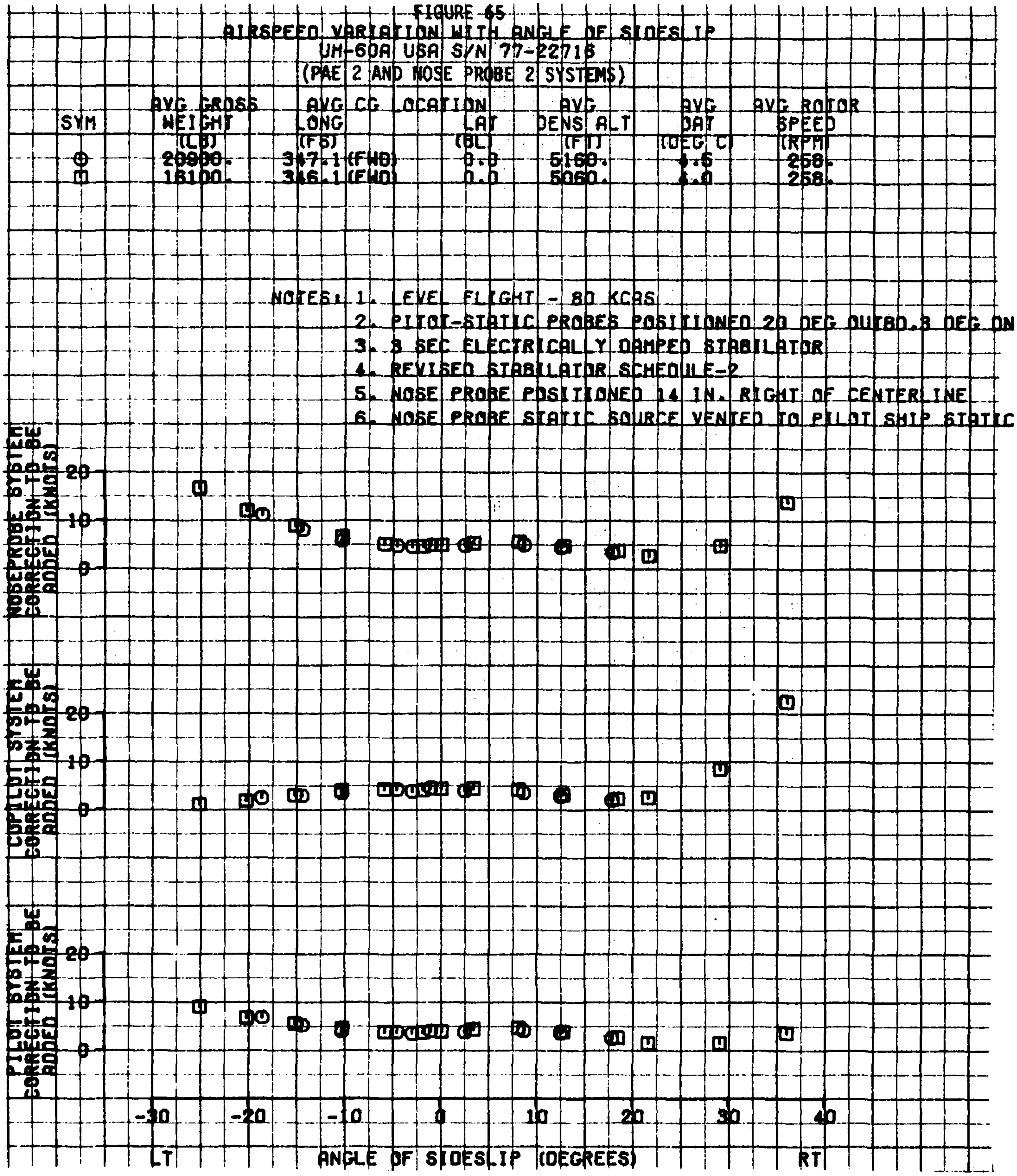
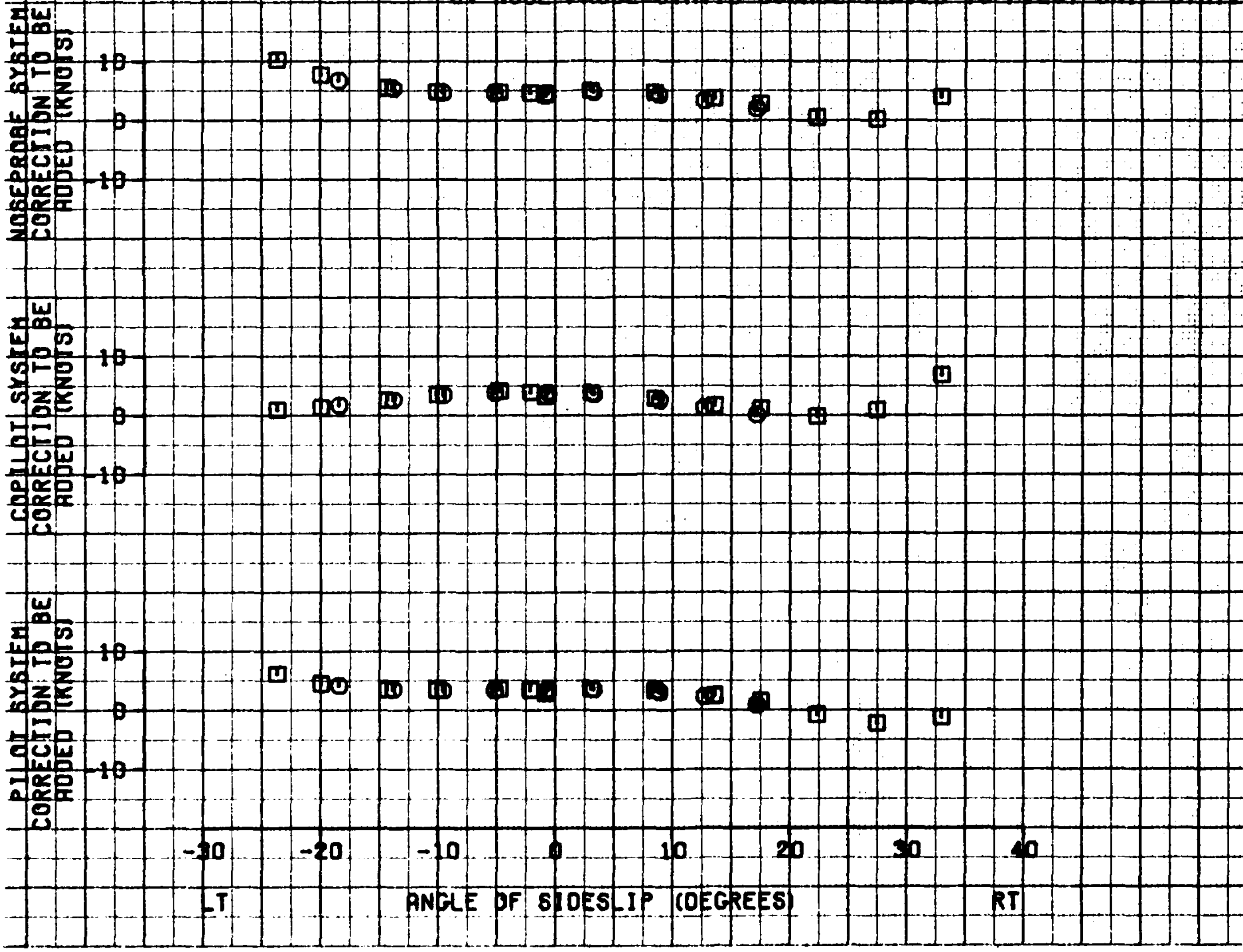


FIGURE 65
AIRSPEED VARIATION WITH ANGLE OF SIDESLIP
UH-60A USA S/N 77-22716
(PAE 2 AND NOSE PROBE 2 SYSTEMS)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION LONG (FS) LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
20900. 347.1 (FWD) 0.0 5160. 4.5 258.
18100. 346.1 (FWD) 0.0 5060. 4.0 258.
NOTES: 1. LEVEL FLIGHT - 80 KCAS
2. PITOT-STATIC PROBES POSITIONED 20 DEG OUTBD,3 DEG DN
3. 3 SEC ELECTRICALLY DAMPED STABILATOR
4. REVISED STABILATOR SCHEDULE-2
5. NOSE PROBE POSITIONED 14 IN. RIGHT OF CENTERLINE
6. NOSE PROBE STATIC SOURCE VENTED TO PILOT SHIP STATIC
NOSEPROBE SYSTEM CORRECTION TO BE ADDED (KNOTS)
COPILOT SYSTEM CORRECTION TO BE ADDED (KNOTS)
PILOT SYSTEM CORRECTION TO BE ADDED (KNOTS)
20
10
0
-30
-20
-10
0
10
20
30
40
LT
ANGLE OF SIDESLIP (DEGREES)
RT

FIGURE 66
AIRSPEED VARIATION WITH ANGLE OF SIDESLIP
UH-60A USA S/N 77-22716
(PAE 2 AND NOSE PROBE 2 SYSTEMS)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)
○	21000.	359.8(AFT)	0.0	4720.	2.5	258.
□	16000.	360.6(AFT)	0.0	4560.	1.5	257.

NOTES:
1. LEVEL FLIGHT - 80 KCAS
2. PITOT-STATIC PROBES POSITIONED 20 DEG OUTBD,8 DEG DN
3. 8 SEC ELECTRICALLY DAMPED STABILATOR
4. REVISED STABILATOR SCHEDULE-2
5. NOSE PROBE POSITIONED 14 IN. RIGHT OF CENTERLINE
6. NOSE PROBE STATIC SOURCE VENTED TO PILOT SHIP STATIC



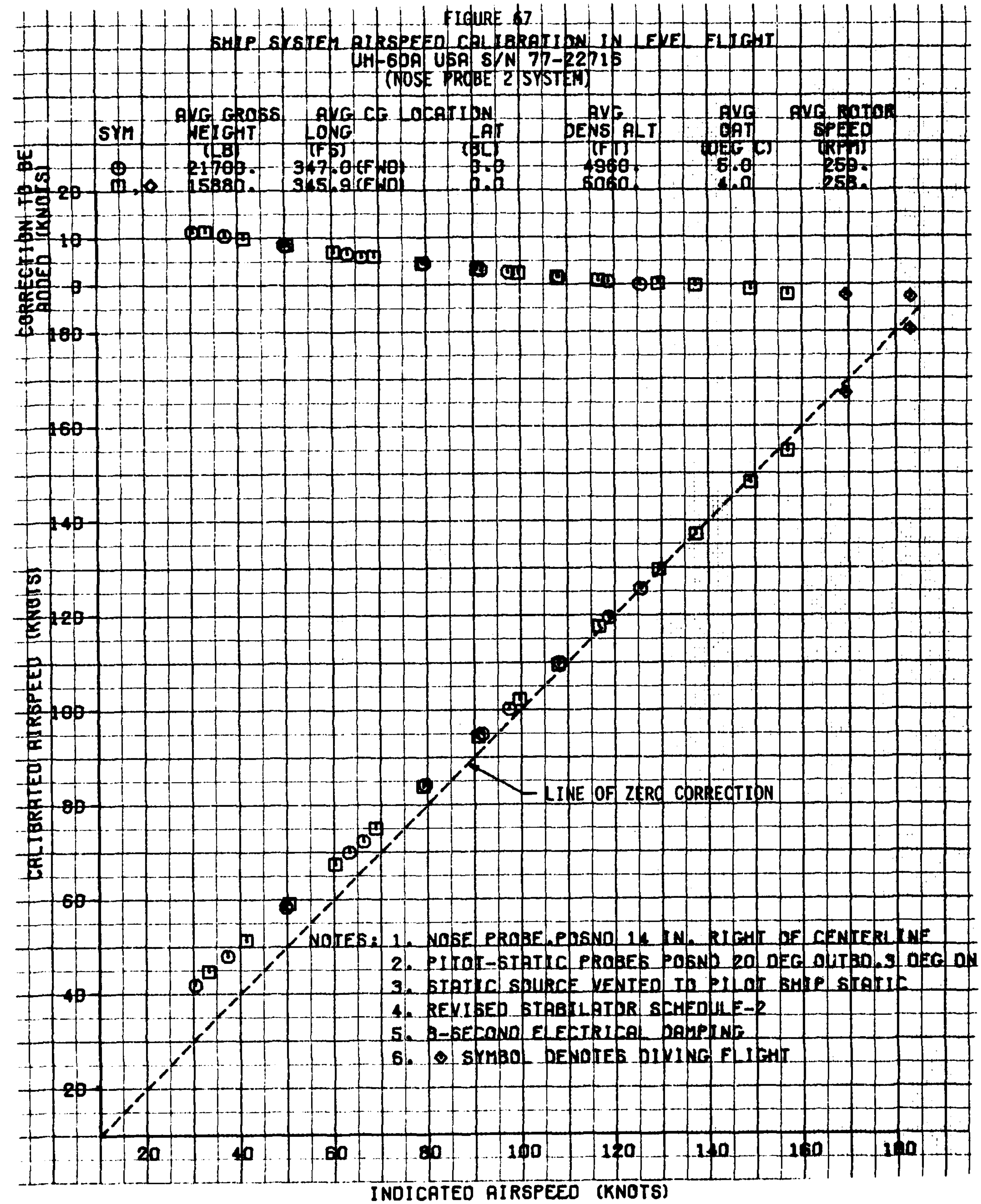


FIGURE 67
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22716
(NOSE PROBE 2 SYSTEM)
SYM | AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | LAT (BL) | AVG DENS ALT (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM)
⊕ 21700. 347.0(FWD) 0.0 4960. 6.0 259.
□, ◇ 15880. 345.9(FWD) 0.0 6060. 4.0 258.
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. NOSE PROBE POSNO 14 IN. RIGHT OF CENTERLINE
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD,3 DEG DN
3. STATIC SOURCE VENTED TO PILOT SHIP STATIC
4. REVISED STABILATOR SCHEDULE-2
5. 3-SECOND ELECTRICAL DAMPING
6. ◇ SYMBOL DENOTES DIVING FLIGHT

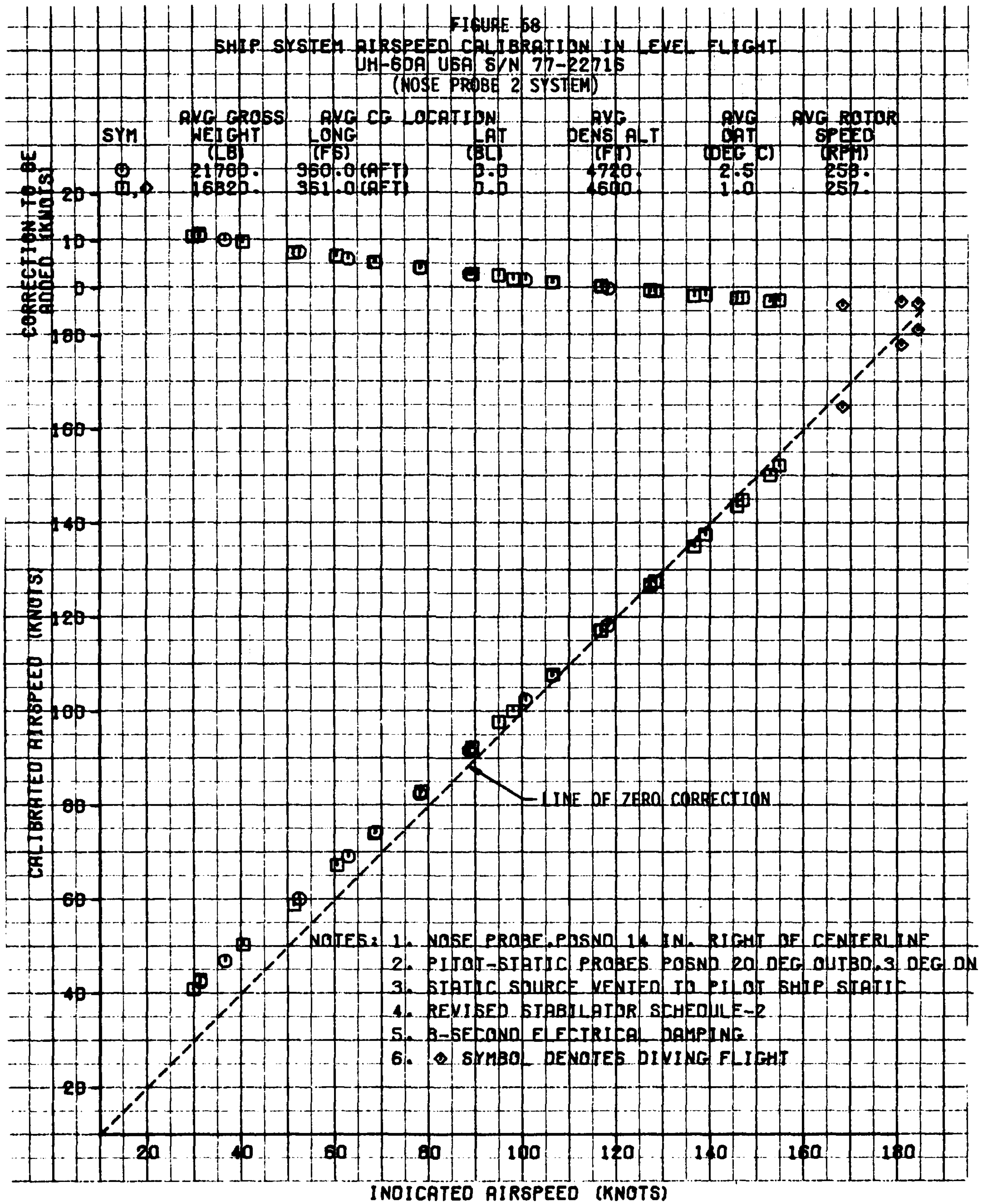


FIGURE 58
SHIP SYSTEM AIRSPEED CALIBRATION IN LEVEL FLIGHT
UH-60A USA S/N 77-22716
(NOSE PROBE 2 SYSTEM)

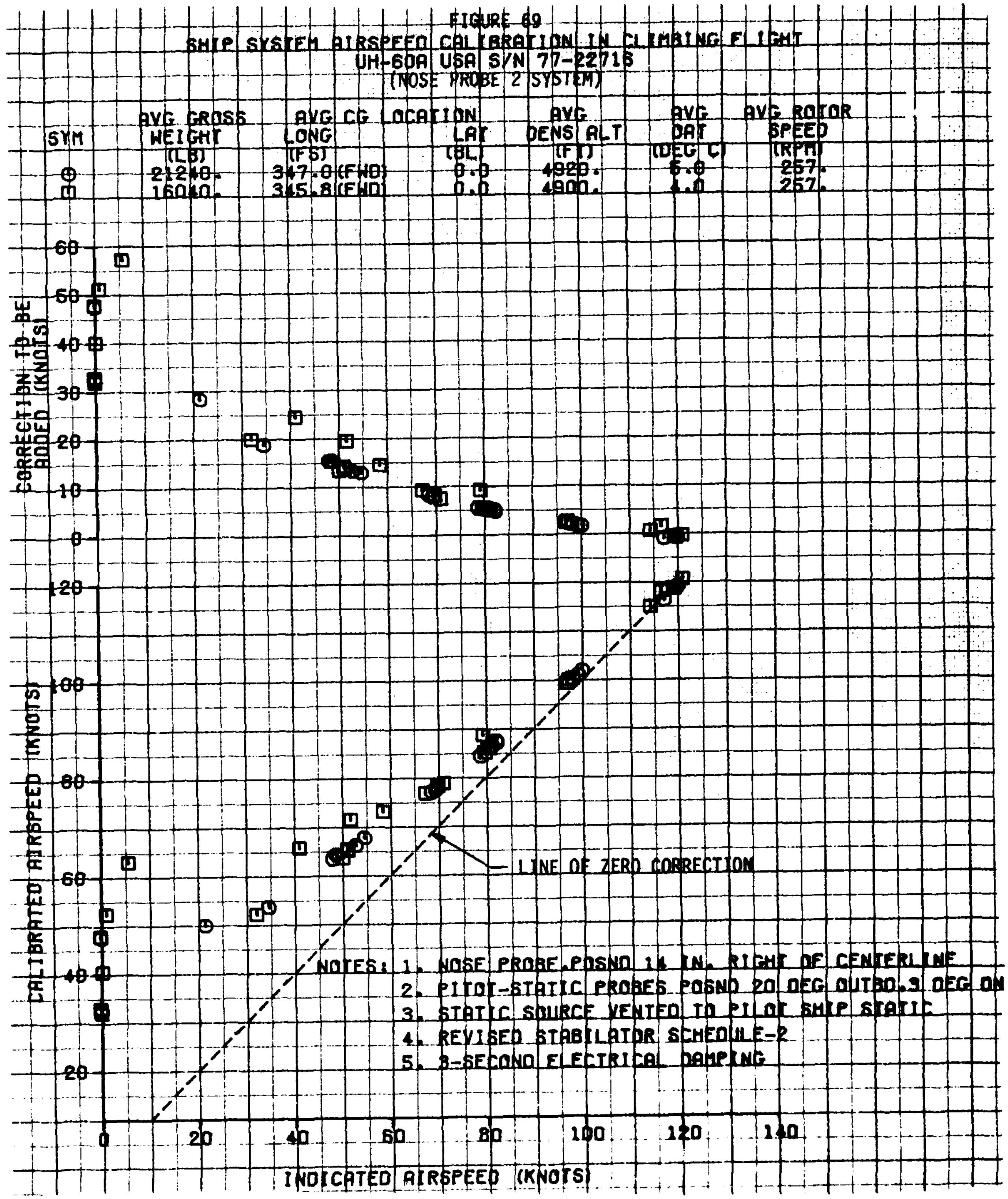


FIGURE 69
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(NOSE PROBE 2 SYSTEM)
SYM | AVG GROSS WEIGHT (LB) | AVG CG LOCATION LONG (FS) | LAT (BL) | AVG DENS ALT (FT) | AVG OAT (DEG C) | AVG ROTOR SPEED (RPM)
○ 21240. 347.0(FWD) 0.0 4920. 6.0 257.
□ 16040. 345.8(FWD) 0.0 4900. 4.0 257.
CORRECTION TO BE ADDED (KNOTS)
CALIBRATED AIRSPEED (KNOTS)
INDICATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. NOSE PROBE POSND 14 IN. RIGHT OF CENTERLINE
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD 3 DEG DN
3. STATIC SOURCE VENTED TO PILOT SHIP STATIC
4. REVISED STABILATOR SCHEDULE-2
5. 3-SECOND ELECTRICAL DAMPING

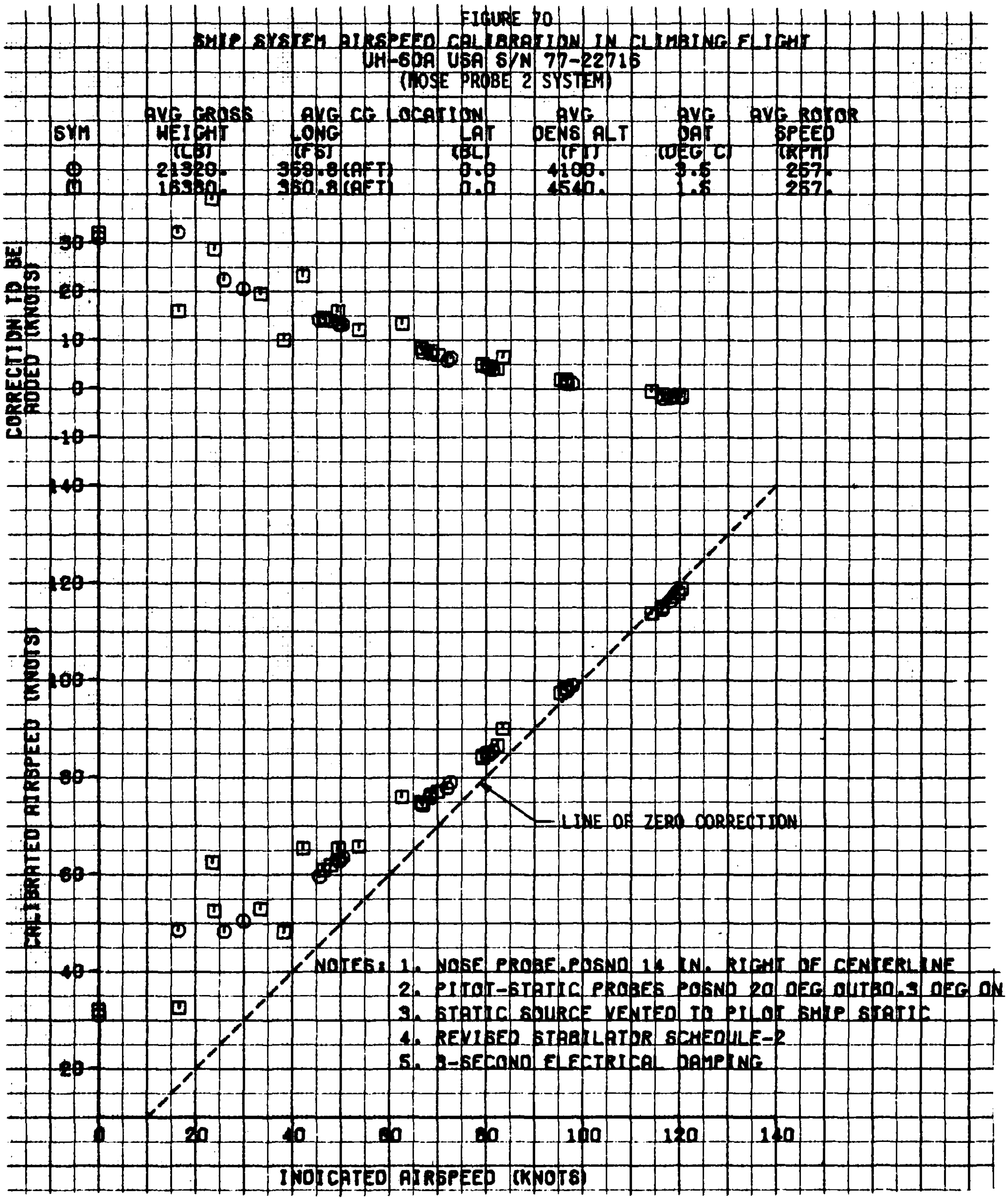


FIGURE 70
SHIP SYSTEM AIRSPEED CALIBRATION IN CLIMBING FLIGHT
UH-60A USA S/N 77-22716
(NOSE PROBE 2 SYSTEM)

FIGURE 71
AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22718
(NOSE PROBE 2 SYSTEM)

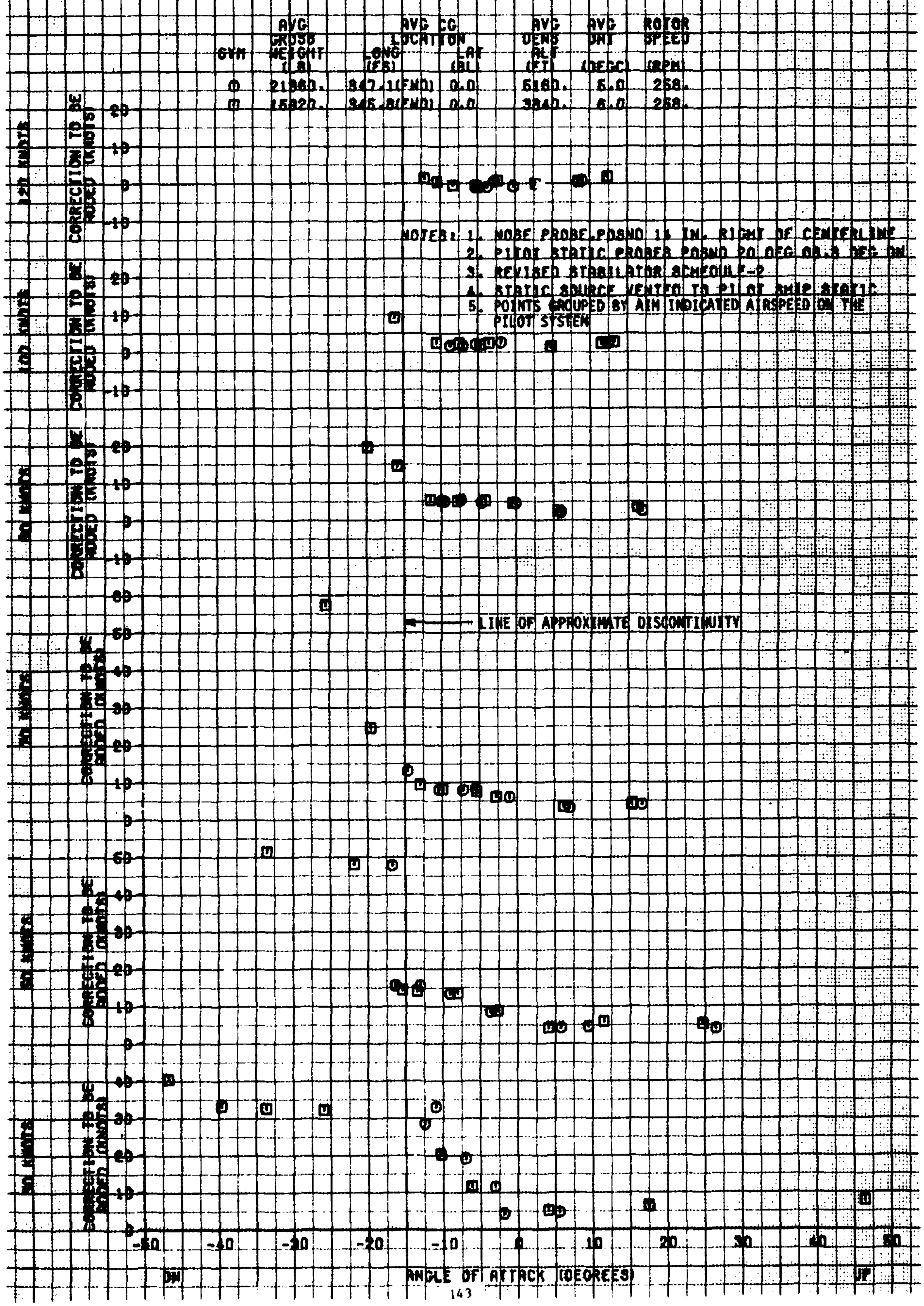


FIGURE 72
AIRSPEED VARIATION WITH ANGLE OF ATTACK
UH-60A USA S/N 77-22716
(NOSE PROBE 2 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	AVG CG LOCATION LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	ROTOR SPEED (RPM)
○	21420.	359.9(AFT)	0.0	4580.	2.5	257.
□	16580.	361.0(AFT)	0.0	6020.	0.5	257.

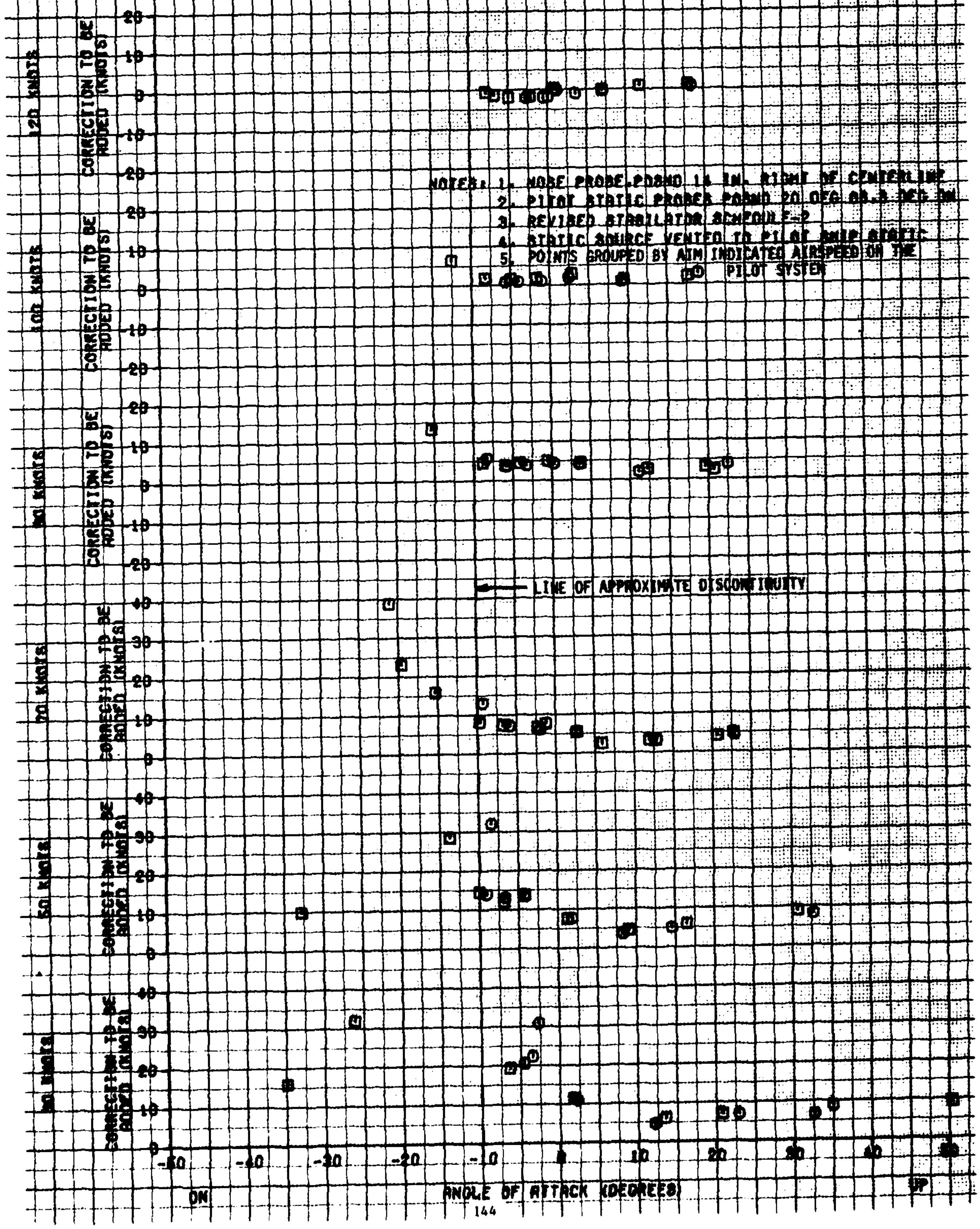


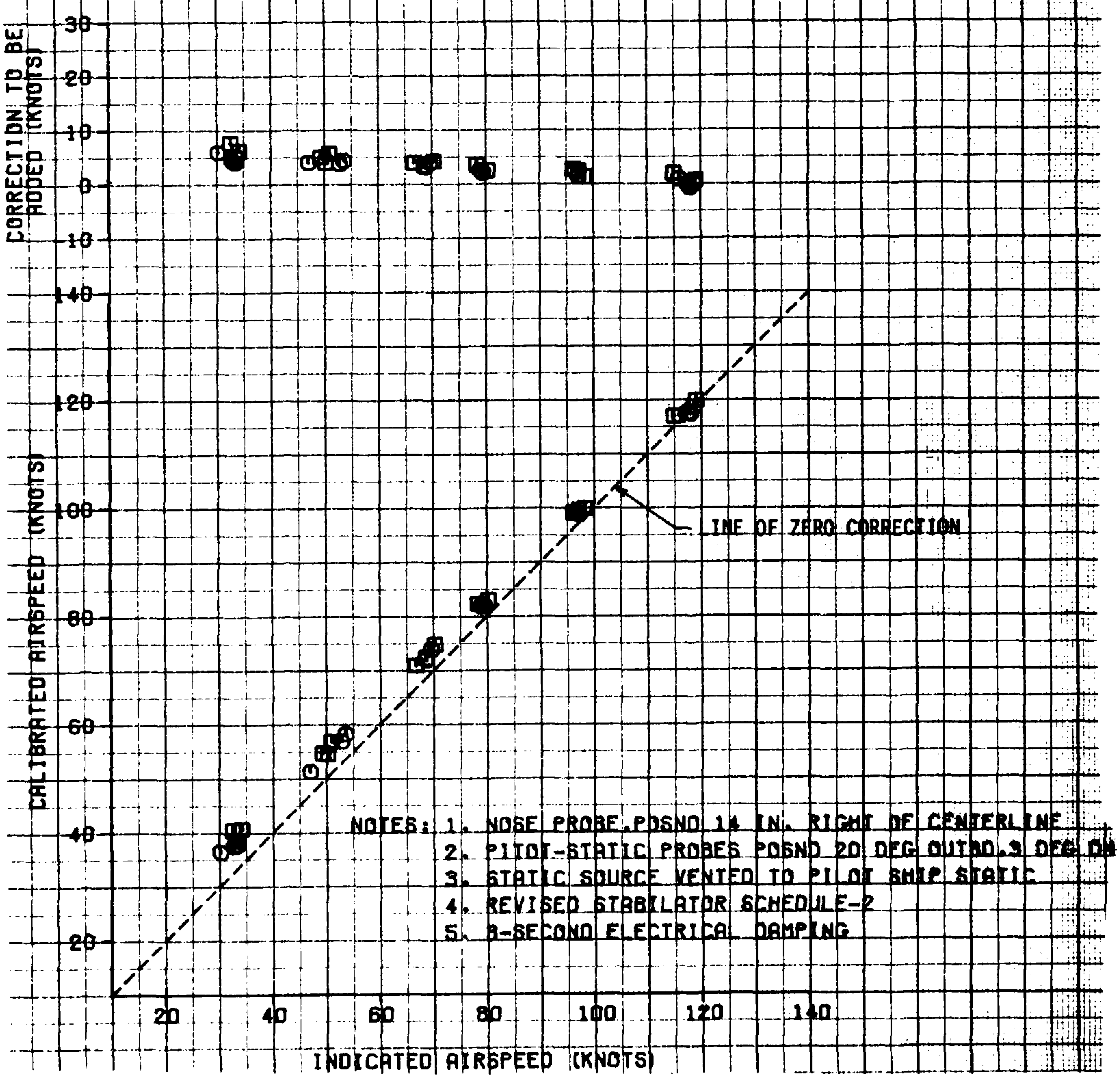
FIGURE 73

SHIP SYSTEM AIRSPEED CALIBRATION IN DESCENDING FLIGHT

UH-60A USA S/N 77-22716

(NOSE PROBE 2 SYSTEM)

SYM	AVG GROSS WEIGHT (LB)	AVG CG LOCATION LONG (FS)	LAT (BL)	AVG DENS ALT (FT)	AVG OAT (DEG C)	AVG ROTOR SPEED (RPM)
⊕	21240.	347.0 (FWD)	0.0	4540.	5.0	259.
◫	16060.	345.8 (FWD)	0.0	4500.	4.5	258.



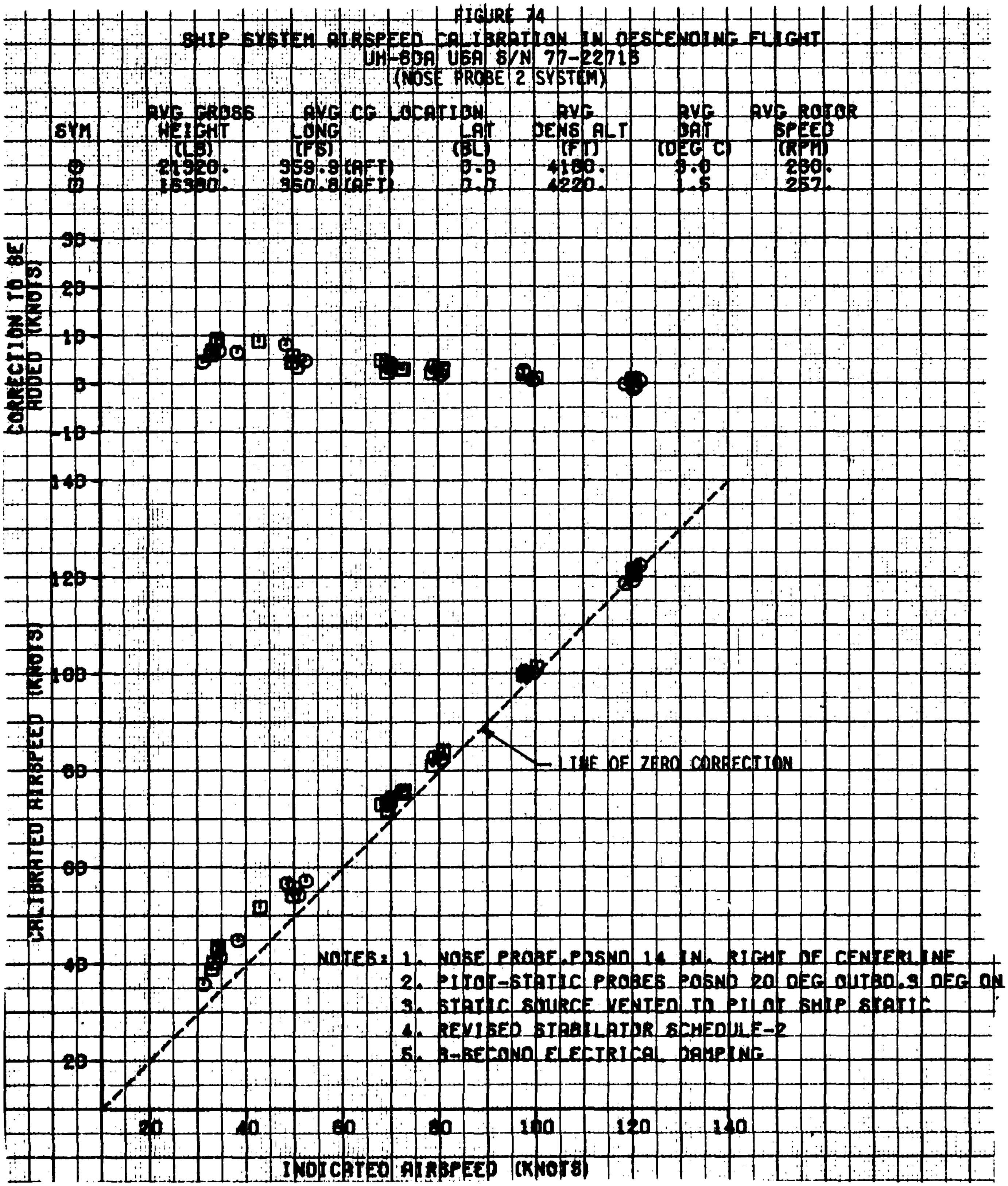


FIGURE 74
SHIP SYSTEM AIRSPEED CALIBRATION IN DESCENDING FLIGHT
UH-60A USA S/N 77-22718
(NOSE PROBE 2 SYSTEM)
SYM
AVG GROSS WEIGHT (LB)
AVG CG LOCATION
LONG (FS)
LAT (BL)
AVG DENS ALT (FT)
AVG OAT (DEG C)
AVG ROTOR SPEED (RPM)
21920. 359.9(AFT) 0.0 4180. 3.0 260.
16380. 360.8(AFT) 0.0 4220. 1.5 257.
CORRECTION TO BE ADDED (KNOTS)
30
20
10
0
-10
140
120
100
80
60
40
20
CALIBRATED AIRSPEED (KNOTS)
LINE OF ZERO CORRECTION
NOTES: 1. NOSE PROBE POSND 14 IN. RIGHT OF CENTERLINE
2. PITOT-STATIC PROBES POSND 20 DEG OUTBD,3 DEG ON
3. STATIC SOURCE VENTED TO PILOT SHIP STATIC
4. REVISED STABILATOR SCHEDULE-2
5. 3-SECOND ELECTRICAL DAMPING
20
40
60
80
100
120
140
INDICATED AIRSPEED (KNOTS)

DISTRIBUTION

HQDA (DALO-SMM, DALO-AV, DALO-RO, DAMO-HRS, DAMA-PPM-T, DAMA-RA, DAMA-WSA, DACA-FA)	8
US Army Materiel Command (AMCDE-SA, AMCOA-E, AMCDE-I, AMCDE-P, AMCOA-SA, AMCSM-WA AMCOA-ST)	7
US Army Training and Doctrine Command (ATTG-U, ATCD-T, ATCD-ET, ATCD-B)	4
US Army Aviation Systems Command (AMSAV-ED, AMSAV-EI, AMSAV-EL, AMSAV-EA, AMSAV-EP, AMSAV-ES, AMSAV-O, AMSAV-MC, AMSAV-ME)	11
US Army Test and Evaluation Command (DRSTE-CT-A, DRSTE-TO-O)	2
US Army Logistics Evaluation Agency (DALO-LEI)	1
US Army Materiel Systems Analysis Agency (DRXSY-R, DRXSY-MP)	2
US Army Operational Test and Evaluation Agency (CSTE-ASD-E)	1
US Army Armor Center (ATZK-CD-TE)	1
US Army Aviation Center (ATZQ-D-T, ATZQ-TSM-A, ATZQ-TSM-S, ATZO-TSM-U)	4
US Army Combined Arms Center (ATZLCA-DM)	1
US Army Safety Center (IGAR-TA, IGAR-Library)	2
US Army Research and Technology Laboratories (AVSCOM) (SAVDL-AS, SAVDL-POM (Library))	2
US Army Research and Technology Laboratories/Applied Technology Laboratory (SAVDL-ATL-D, SAVDL-Library)	2
US Army Research and Technology Laboratories/Aeromechanics Laboratory (AVSCOM) (SAVDL-AL-D)	1

US Army Research and Technology Laboratories/Proplusion Laboratory (AVSCOM) (SAVDL-PL-D)	1
Defense Technical Information Center (DDR)	12
US Military Academy, Department of Mechanics (Aero Group Director)	1
MTMC-TEA (MTT-TRC)	1
ASD/AFXT, ASD/ENF	2
US Naval Post Graduate School, Department Aero Engineering (Professor Donald Layton)	1
Assistant Technical Director for Projects, Code: CT-24 (Mr. Joseph Dunn)	2
6520 Test Group (ENML/Stop 238)	1
Commander, Naval Air Systems Command (AIR 5115B, AIR 5301)	3
Project Manager, BLACK HAWK (DRCPM-BH)	5
US Army Aviation Development Test Activity (STEBG-CT)	2
US Army Infantry Center (ATSH-TSM-BH)	2
US Army Materiel Systems Analysis Agency (DRXSY-AAM)	2
US Amy Operational Test and Evaluation Agency (CSTE-TM-AV)	2
General Electric (Mr. Koon)	2
Sikorsky Aircraft Division, United Technologies Corporation (Mr. Richard Connor)	5