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RDTE PROJECT NO. 1X141807D174
USAAVCOM PROJECT NO. 67-27 (66-06)
USAAVNTA PROJECT NO. 67-27 (66-06)

ENGINEERING FLIGHT TEST OF THE AH-1G HUEYCOBRA HELICOPTER EQUIPPED WITH THE XM-28 CHIN TURRET WITH TWIN XM-129, 40MM GRENADE LAUNCHER

PHASE B

PART 4

FINAL REPORT

JOHN R. MELTON
PROJECT ENGINEER

GARY C. HALL
MAJOR, TC
US ARMY
PROJECT OFFICER/PILOT

MARCH 1968

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

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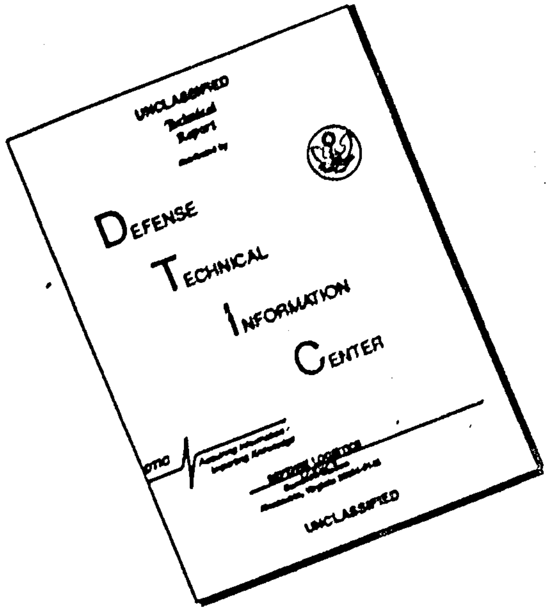

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ABSTRACT

Part 4 of the AH-1G helicopter Phase B test was conducted at Yuma Proving Ground, Yuma, Arizona from 9 January to 18 January 1968, by the US Army Aviation Test Activity, Edwards Air Force Base, California. Firing tests were conducted to determine the effects on the stability and control characteristics of the AH-1G helicopter caused by firing the twin XM-129, 40mm grenade launchers in the XM-28 chin turret. Firing the two XM-129 grenade launchers in the XM-28 turret does not cause any objectionable aircraft reactions which would restrict the flight envelope. The deficiencies detected during this test were; the lack of a usable 40mm ammunition loading tool for use with the XM-28/XM-129 subsystem and totally unacceptable ammunition reliability. The shortcomings were; obstruction of pilot's field of vision by N-9 sight, lack of an ammunition loading adapter for the entrance chute to the ammunition cans, insufficient bonding of the teflon guide rail coverings, excessive wear of the rear gun mounts, and flexible ammunition chuting breakage.

FOREWORD

During the conduct of the AH-1G helicopter Phase B, Part 4 test at Yuma, Arizona, maintenance of the helicopter and special instrumentation, and data reduction assistance were provided by the Bell Helicopter Company personnel under contract. US Army firing ranges, hangar, and office facilities were utilized at Yuma Proving Ground, Arizona.

TABLE OF CONTENTS

INTRODUCTION

Background 1
Test Objectives 1
Description 1
Scope of Test 2
Method of Test 4
Chronology 4

RESULTS AND DISCUSSION

General 4
Cockpit Evaluation 5
  Pilot's Cockpit 5
  Copilot/gunner's Cockpit 5
Firing Tests 5
Miscellaneous 7
  Subsystem Problems 7
  Ammunition Problems 8

CONCLUSIONS

General 9
Deficiencies and Shortcomings Affecting Mission
  Accomplishment 9

RECOMMENDATIONS 11

APPENDIXES

I. References 13
II. Test Data 14
III. Test Instrumentation 25
IV. Aircraft Dimensions and Design Data 26
V. AH-1G Operating Limitations 28
VI. Distribution 29

INTRODUCTION

BACKGROUND

1. The XM-28 chin turret portion of the Phase B testing on the AH-1G helicopter was scheduled to be conducted in three parts (ref 1 and 2, app I). The first test conducted in December 1967 was with twin XM-134 minigun 7.62 mm machine guns installed, Phase B, Part 3 (ref 3). The second test and the subject of this test report was with twin XM-129, 40 mm grenade launchers installed in the XM-28 turret, Phase B, Part 4. The test of the combination or "Hybrid" Configuration (one XM-134 minigun and one XM-129, 40 mm grenade launcher in the XM-28 turret) will be tested at a later date and submitted as Phase B, Part 5, under separate cover.

TEST OBJECTIVES

2. The objectives of this test were to provide flight test data to:

a. Assist in determining if the contractor's proposed flight envelope should be used by Army pilots for future service tests, logistical tests, or operational tests.

b. Define and allow early correction of helicopter and weapons system deficiencies.

c. Provide a basis for evaluation of changes incorporated to correct deficiencies.

d. Estimate the degree to which the helicopter and weapons system are suitable for the intended mission.

DESCRIPTION

3. The test aircraft, serial number 66-15283, was the thirty-ninth AH-1G Hueycobra, tactical helicopter produced by Bell Helicopter Company designed specifically for the armed role. It is a tandem, two-place, high speed conventional helicopter with a two-bladed door hinge type main rotor and conventional antitorque rotor. A three-axis stability and control augmentation system (SCAS) is used in lieu of the stabilizer bar to improve helicopter stability and handling qualities. The test helicopter is powered by a Lycoming T53-L-13 turboshaft engine rated at 1400 shaft horsepower (shp) at sea level (SL) standard day static conditions. The powerplant is derated to

1100 shp at 314 rpm rotor speed due to maximum torque limits of the helicopter main transmission. The distinctive features of the test helicopter are the narrow, 36 inch fuselage, the stub mid-wings with four external stores stations, and the integral XM-28 chin turret (see photo). The XM-28 chin turret on the test helicopter contained two XM-129, 40 mm grenade launchers as opposed to the original AH-1G chin turret, the TAT102A which contained only one 7.62 mm minigun. The XM-28 turret is designed to accomodate twin XM-134 miniguns, or twin XM-129 40 mm grenade launchers, or one minigun and one 40 mm grenade launcher. The turret can position the weapons 115-degrees left and right of the stow position. Weapon elevation is variable from 15 to 25 degrees, depending on the azimuth position of the turret. Weapon depression is 50 degrees at all azimuth positions. The armament configuration of the AH-1G is changed by varying wing stores and/or XM-28 turret weapons. The pilot can fire all weapons in the stowed position. The copilot/gunner operates the flexible turret and can also fire wing stores in an emergency by use of the pilot override switch. The flight control system is a positive mechanical type with conventional helicopter controls in the pilot's aft cockpit. The copilot/gunner's forward cockpit is provided with sidearm collective and cyclic controls. Control forces are reduced by hydraulic servo cylinders connected to the control system mechanical linkage. The hydraulic system is powered by dual transmission-driven pumps. A sychronized elevator is used to increase static longitudinal stability and lengthen center of gravity (C.G.) range. An electrically operated mechanical force trim system connected to the cyclic and directional controls is used to induce artificial control feel and positive control centering. Ausform armor protection is provided for the crew, engine fuel control, and engine compressor section. A complete aircraft description is included in reference 4 and 5, appendix I, and aircraft dimensions and design information are presented in appendix IV.

SCOPE OF TEST

4. This test program consisted of an investigation of the effects on the stability and control characteristics caused by firing the twin XM-129, 40 mm grenade launchers in the XM-28 chin turret. Both XM-129 grenade launchers were fired simultaneously at the test conditions shown in tables 1 and 2. Calibration of the standard airspeed system position error was not required for this test. The position error of the system on this aircraft was defined during the tests reported in reference 3, appendix I.

Table 1. Turret Positions.

Position Number	Turret Elevation	Turret Azimuth
1	Full up	90° left
2	Full up	Zero
3	Full up	90° right
4	Full down	90° right
5	Full down	Zero
6	Full down	90° left
7	Zero	90° left
8	Zero	Zero
9	Zero	90° right

Table 2. XM-28 Flight Test Conditions.

Airspeed KCAS	Turret Position from Table 1.
Hover	1, 2, 3, 7, 8, 9
65	1, 2, 3, 4, 6, 7, 8, 9
[illegible]	1, 2, 3, 4, 5, 6, 7, 8, 9
[illegible]	1, 2, 3, 4, 5, 6, 7, 8, 9

Test gross weight was between 8010 pounds and 8660 pounds.

Test center of gravity was between 197 inches and 201 inches.

Instrumentation pods were installed on outboard wing stores stations.

Density altitude was between 1160 feet and 2600 feet.

Rotor speed was 324 rpm.

Six flights were conducted for a total of 8.9 test hours during an elapsed calendar time of 10 days. The flight restrictions which governed these tests were obtained from a safety-of-flight release issued by US Army Aviation Materiel Command, (USAAVCOM), St. Louis, Missouri (ref 6, app I), and are presented in appendix V. Approximately 1941 rounds of 40 mm ammunition were expended during the test.

METHOD OF TEST

5. The method used in this test was a standard engineering flight test method and is described briefly in the Results and Discussion Section of this report.

CHRONOLOGY

Test helicopter received at Yuma, Arizona	10 January 1968
Test started	10 January 1968
Test completed	17 January 1968
Draft test report submitted	29 February 1968
Final test report forwarded	March 1968

RESULTS AND DISCUSSION

GENERAL

6. This section of the report presents a detailed discussion of the results of the test. The subjects covered are the cockpit evaluation, firing tests, subsystem problems and ammunition problems.

COCKPIT EVALUATION

Pilot's Cockpit

7. During this test program several contour flights were conducted in the nap-of-the-earth environment. From these flights it was determined that contour flight is very difficult due to obstruction of the pilot's forward field of vision by the N-9 pilot's sight. This characteristic has been noted in other flight regimes and it is especially undesirable for an armed aircraft in a tactical environment and would present a safety hazard during nap-of-the-earth operations. An investigation should be made of the feasibility of reducing the size of the pilot's sight and still permit satisfactory performance of its basic function. Previously noted deficiencies and shortcomings (requirement to arm weapons in order to drop smoke grenades and excessive length of pilot's head-phone jack cord) were still present (ref 3, app I).

Copilot/gunner's Cockpit

8. The copilot/gunner's cockpit is identical when equipped with the XM-28/XM-134 or the XM-129 weapons system. The comments made in reference 3, appendix I, concerning ease of copilot/gunner's sight use, sight interference with the copilot/gunner's right leg when the sight was stowed, and functional switches being mislocated were still applicable.

FIRING TESTS

9. Firing tests were conducted to determine the effect on the stability and control characteristics of the helicopter caused by firing the twin XM-129, 40 mm grenade launcher in the XM-28 turret. The helicopter was stabilized at the desired trim conditions and all flight controls held fixed as the weapons were fired. An oscillograph recorded angular rates and attitude changes caused by firing. All the firing reaction data presented in this report were obtained with both launchers firing.

10. Figures 1 through 3, appendix II, summarize the firing reaction about each aircraft axis as a function of airspeed and turret position. Pitch axis reactions were very small as shown in figure 1. The highest reaction recorded was 2.4 degrees per second (deg/sec) nose down. This rate was obtained in a hover with the turret at "full up" elevation. At increased airspeed, pitch reactions were smaller. Turret azimuth has a negligible effect upon aircraft

pitch reaction, however, turret elevation determined the direction of the pitch reaction. Full up elevation or stow position caused a nose down pitching, while full down elevation caused a nose up pitching. At no time were the magnitudes or characteristics of the pitch reactions objectionable to the pilot.

11. Roll axis reactions are summarized in figure 2, appendix II. There were no objectionable roll axis reactions caused directly by firing the XM-129,40 mm grenade launchers. Generally, these reactions were approximately one-half of those caused by the twin XM-134 miniguns firing at high rate for similar flight conditions. The maximum roll rate reaction recorded was 5.7 degrees per second (deg/sec) right. This rate was obtained in a hover, firing at 90-degrees right azimuth, and full up elevation. The magnitude of the roll reaction was primarily influenced by turret azimuth. Maximum roll rates were observed at 90-degrees left and right azimuth. The direction of the reaction was the same as the turret azimuth. Firing to the right caused a right roll. At zero azimuth the roll reaction was negligible.

12. The only objectionable roll reaction observed during this evaluation was incidental to the firing tests. At highspeeds and/or high power conditions, the AH-1G exhibits a tendency towards a roll oscillation with a frequency between approximately one-half to 1 cycles per second (cps) (ref 7, app I). Any disturbance from trim will initiate this roll oscillation. The disturbance from trim may be caused by a control input, external gust input, or a firing reaction. This oscillation increases the target tracking task of the copilot/gunner if it is left undamped. The pilot, with practice, is able to damp the roll oscillation with small periodic lateral cyclic inputs reducing the tracking error.

13. Yaw axis reactions are summarized in figure 3, appendix II. Yaw reactions were maximum at 90-degrees left and right turret azimuths, but were not objectionable at any conditions. At any turret azimuth, turret elevation had a negligible effect upon the yaw rate reaction. The maximum yaw rate recorded was 3.8 deg/sec left. This rate was obtained in a hover with the turret position 90-degrees right. The direction of the yaw reaction was always opposite the turret azimuth. Firing to the right caused a left yaw. The small yaw reaction should not present any target tracking problem to the copilot/gunner.

14. The firing reactions about each axis in terms of maximum rates were smaller when firing the XM-129 grenade launchers than when firing the XM-134 miniguns at high rate of fire. Although reactions

from either system were not objectionable, at some conditions they would initiate the basic aircraft roll oscillation (para 12). The characteristics of the two systems, however, resulted in a considerably different feel in the aircraft. When the twin XM-134 miniguns were fixed, the reaction was a uniform thrust, causing a smooth, small disturbance of aircraft trim. The firing reaction from the XM-129, 40 mm grenade launchers was characterized by a dull pounding, with each round perceptible to the crew. The launchers each had a slightly different firing rate so that during a single firing run, a beat frequency was observed. That is, they would fire alternately and then gradually become "inphase" and then returned to firing alternately. Paragraph 15 of this report discusses a minor potential problem concerning the target tracking task during this "beating."

15. Target tracking during firing was more difficult with the XM-129, 40 mm grenade launcher than with the XM-134 minigun. With both subsystems the aircraft rates about all axes which resulted from firing with the flight controls fixed were low. However, the 40 mm grenade launcher imposed considerable shock on the sighting system that was not present with the miniguns. It was not within the scope of this test program to measure the tracking error while firing the 40 mm grenade launcher. It is believed that for firing bursts longer than approximately two seconds, the tracking error may become significant because of the "beat" between the two different firing frequencies. When the launchers are firing together, the frequency of firing approximates the natural frequency of the sight and gunner, as a dynamic system, so that sight restraint or target tracking requires conscious attention from the copilot/gunner. If the firing load level survey disclosed acceptable structural loads during this condition, it should be considered a minor problem.

MISCELLANEOUS

Subsystem Problems

16. One major and four minor problems were encountered with the armament subsystem:

a. Ammunition loading tool: The ammunition loading tool provided with the XM-28 is for the XM-5 armament subsystem and is totally inadequate for use with the XM-28. Without an adequate loading tool, the 40 mm ammunition cannot be loaded into the XM-28 in the field. This is a major problem and steps must be taken to provide an adequate 40 mm loading tool for all XM-28 armament subsystems.

b. Ammunition loading adapter: A fluted ammunition loading adapter is needed in the entrance chute to the ammunition drum to keep ammunition properly aligned during loading operations. Considerable difficulty is encountered from the links hanging on the sharp edge of the entrance chute causing misalignment of ammunition and possible feed system jams.

c. Ammunition bay guide rails: The teflon covering on the guide rails of the ammunition bay on the test aircraft was beginning to separate making it difficult to slide the loaded ammunition drums into their compartment. Adequate bonding of the guide rail teflon covering should be provided.

d. Rear gun mounts: It was noted that the rear gun mounts were excessively worn after firing only 3000 rounds. This is an excessively short life for this component. Worn mounts could cause unacceptable dispersion patterns and reduced accuracy.

e. Flexible chute breakage: Flexible chute breakage was encountered due to the pounding of the ammunition in the flexible chuting near the launchers during recoil and counter coil of the guns. This continual pounding weakens the flexible chuting and could cause damage to the internal arming mechanism of the high explosive rounds. A study should be conducted to determine a means of eliminating or reducing the pounding of the ammunition in the flexible chutes during subsystem operation.

Ammunition Problems

17. Numerous problems were encountered with the 40 mm ammunition during this test. The current reliability of 40 mm ammunition used during the test was unacceptable and must be corrected prior to its use in the field. Three major problems encountered were ammunition link separation and looseness, rifling band separations and hangfires. Each is discussed briefly below:

a. Ammunition link separations and looseness: The spot weld holding the ammuntiion link together is inadequate causing the link to break resulting in a stoppage (jam of the feed system). Attempts to fire 40 mm ammunition as it comes from the factory without crimping the links on each round with a crimping tool has proven unsuccessful because the links are not tight enough on the round. The round slides out of position when subjected to the flexures required in the chuting of the XM-28 resulting in a feed system jam. The crimping process may contribute to the link separation problem by weakening the spot weld.

b. Rifling band separations: On numerous occasions the rotating band, which fits into the rifling grooves in the barrel, to impart a spin to the projectile, has separated from the 40 mm round and remained in the gun barrel causing a jam. Scoring of the barrel was noted and the barrel was replaced. No further rifling band separations occurred during this limited test. It is possible that the crimping process may contribute to a weakening of the rifling band bonding if the crimping tool applies pressure to the band.

c. Hangfires: During this test program, numerous hangfires occurred. Practice ammunition was used for this test. A hangfire occurs when ignition of the propellent is delayed after the primer is struck by the firing pin. This condition could result in explosions within the turret and possible aircraft damage and serious personnel injuries when using high explosive (HE) ammunition. High explosive ammunition is not believed to be safe for use with this armament subsystem. HE ammunition will not be used until tests are conducted to determine that HE 40 mm rounds will not detonate, unless inertial arming has occurred at a safe distance from the aircraft, or a definite means of preventing hangfires has been devised.

CONCLUSIONS

GENERAL

18. The following conclusions were reached upon completion of firing tests of the XM-28/XM-129 installation on the AH-1G helicopter:

a. The firing reactions of the XM-129,40 mm grenade launcher on the AH-1G helicopter are small. No firing flight restrictions exist for stability and control reasons within the flight envelope of the aircraft (para 10, 11, 12 and 13).

b. Target tracking accuracy may be impaired by launchers firing simultaneously during long firing bursts (para 15).

DEFICIENCIES AND SHORTCOMINGS AFFECTING MISSION ACCOMPLISHMENT

19. Corrections of the following deficiencies are mandatory for acceptance of the aircraft weapon system:

a. An adequate ammunition loading tool was not provided with the XM-28/XM-129 system (para 16a).

b. The ammunition provided for this test was extremely unreliable. Ammunition problems caused frequent malfunctions of the subsystem (para 17).

20. Corrections of the following shortcomings are desirable for improved operation and mission capabilities.

a. The AH-1G exhibits a basic aircraft roll oscillation at high speed and/or high power conditions (para 12).

b. The design of the loading entrance chute to the ammunition drum caused delays in ammunition loadings (para 16b).

c. The system for sliding the loaded ammunition drums into the ammunition bay caused delays in ammunition loadings (para 16c).

d. The rear gun mounts of the test turret were excessively worn after only approximately 3000 rounds and required replacement. Excessive wear of this component can result in decreased system accuracy (para 16d).

e. The flexible ammunition chute near the turret separated at several spot welds because of pounding of the ammunition within the chute (para 16e).

f. The large size of the pilot's fixed sight caused restriction of forward vision during contour flying (para 7).

g. The following comments in reference 3, appendix I, remain valid for this test:

(1) Adequate production airspeed system not yet defined.

(2) Sight interferes with the copilot/gunner's right leg when stowed.

(3) Unguarded functional switches located on sight rather than armament control panel.

(4) Lack of static droop stops permits mast damage.

(5) Rotor head inspection difficult.

(6) Tail rotor 90-degree gear box inspection difficult and time consuming.

(7) Fire warning system lacking.

(8) Insufficient nonskid material on stub wings for a safe work deck.

(9) Oil cooler inlet panel removal time consuming.

(10) The XM-20 smoke gernade dispensor can only be operated when the master arm switch is in the ARMED position.

(11) The cord for pilot's head-phone jack is too long and can become entangled around collective pitch control.

RECOMMENDATIONS

21. It be determined whether the ammunition used during this evaluation was representative of service ammunition. If found to be representative, the reliability of the 40 mm ammunition must be improved.

22. Tests should be conducted under controlled conditions to determine whether the high explosive head would detonate when jammed in the barrel and then struck by the next round or when a hangfire occurs.

23. An appropriate XM-28/XM-129 ammunition loading tool must be provided with each production weapon system.

24. The roll oscillation of the AH-1G at high speed and/or high power conditions be reduced or eliminated. This should be accomplished without adversely affecting the lateral control response characteristics of the aircraft.

25. The loading entrance chute to the ammunition drum be redesigned to allow faster loading or a fluted adapter provided as a special tool.

26. The ammunition drum guide rails into the aircraft ammunition bay be improved.

27. The rear gun mounts be improved to provide longer service life.

28. The flexible ammunition chute near the turret be improved to provide longer life and the pounding of ammunition in the chute during subsystem operation be reduced or eliminated.

29. The size of the pilot's fixed sight be reduced to improve forward vision during contour flying.

30. The following recommendations, which are applicable to this evaluation, from reference 3, appendix I, are listed below:

a. A representative production airspeed system position error be defined by sampling production AH-1G aircraft.

b. The flex-sight stow system be improved.

c. All turret functional switches be relocated to the armament control panel.

d. Static droop stops be provided to prevent mast scoring.

e. Steps and hand holds be provided to facilitate rotor head inspection.

f. The tail rotor 90-degree gear box fairing be secured with quick-release fasteners.

g. A reliable engine fire warning system be provided.

h. Increased nonskid material be used on the wings to provide a safe work area.

i. The oil cooler inlet panel be secured with quick-release fasteners.

j. The XM-20 smoke dispenser be rewired to allow operation both in the SAFE and ARMED positions of the master arm switch.

k. The cord on the pilot's head-phone jack be shortened.

APPENDIX I

REFERENCES

1. Letter, AMSAV-E(EF) to CO, USAAVNTA, SAVTE-P, subject: "US Army Aviation Test Activity Participation in the AH-1G/XM-28 Airworthiness Qualification Program," 20 October 1967.

2. Unclassified message, AMSAV-E(EF)-11-1368 to SAVTE-P, subject: "AH-1G/XM-28 Airworthiness Qualification Program," 15 November 1967.

3. USAAVNTA Final Test Report, "Engineering Flight Test of the AH-1G (Hueycobra) Helicopter Equipped with the XM-28 Chin Turret with Twin XM-134 Miniguns, Phase B, Part 3," March 1968.

4. Report No. 209-947-016 "Detail Specification for Model AH-1G Helicopter," Bell Helicopter Company, 11 July 1966.

5. TM-55-1520-221-10 "Operator's Manual, Army Model AH-1G Helicopter, Headquarters, Department of the Army," April 1967.

6. Unclassified message, AMSAV-EF - 1-1309, CO USAAVCOM to CO USAAVNTA, subject: "Safety of Flight Release for AH-1G/XM-23 with XM-129," 5 January 1968.

7. USAAVNTA Final Test Report "Engineering Flight Test of the AH-1G (Hueycobra) Helicopter, Phase B, Part 1," January 1968.

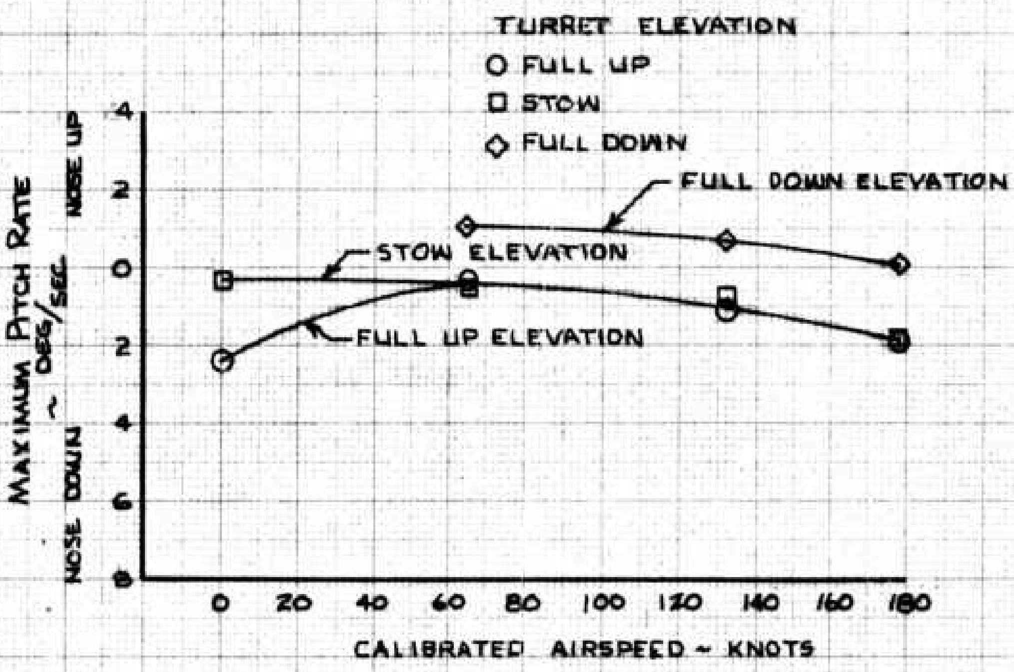
APPENDIX II TEST DATA

FIGURE NO. 1
SUMMARY OF PITCH AXIS REACTIONS DURING XM-28 (TWO XM-129 LAUNCHERS) FIRING
AH-1G USA S/N 66-15283

AVG. GROSS WEIGHT	AVG. C.G. STATION	AVG. DENSITY ALTITUDE	ROTOR SPEED	CONFIGURATION
8350 LBS.	198.1 IN.	3045 FT.	324 R.P.M.	INSTRUMENTATION PODS OUTBOARD

NOTES:

1. TURRET IN STOW (ZERO DEGREES) AZIMUTH
2. BOTH LAUNCHERS FIRING WITH FLIGHT CONTROLS FIXED



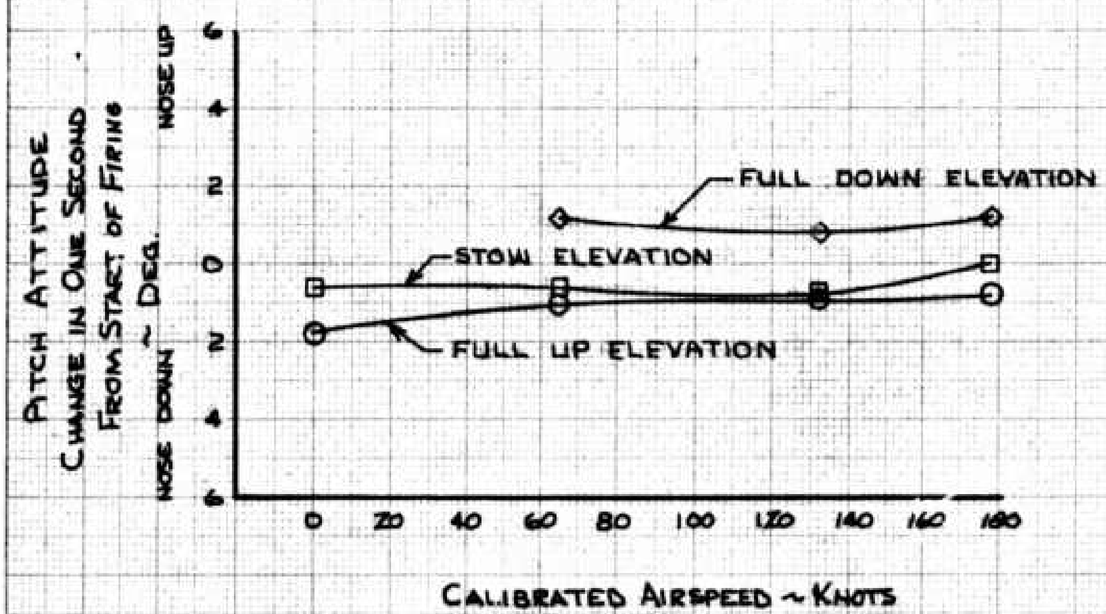


FIGURE No. 2

SUMMARY OF ROLL AXIS REACTIONS DURING XM-28 (TWO XM-129 LAUNCHERS) FIRING

AH-1G USA S/N 66-152[illegible]

AVG. GROSS WEIGHT	AVG C.G STATION	AVG DENSITY ALTITUDE	ROTOR SPEED	CONFIGURATION
8170 LBS.	198.1 IN.	3045 FT.	324 RPM	INSTRUMENTATION PODS OUTBOARD

NOTES:

1. BOTH LAUNCHERS FIRING WITH FLIGHT CONTROLS FIXED
2. Ø SLASHED SYMBOL DENOTES FULL UP TURRET ELEVATION
3. FLAGGED SYMBOL DENOTES FULL DOWN TURRET ELEVATION
4. O OPEN SYMBOL DENOTES STOW TURRET ELEVATION

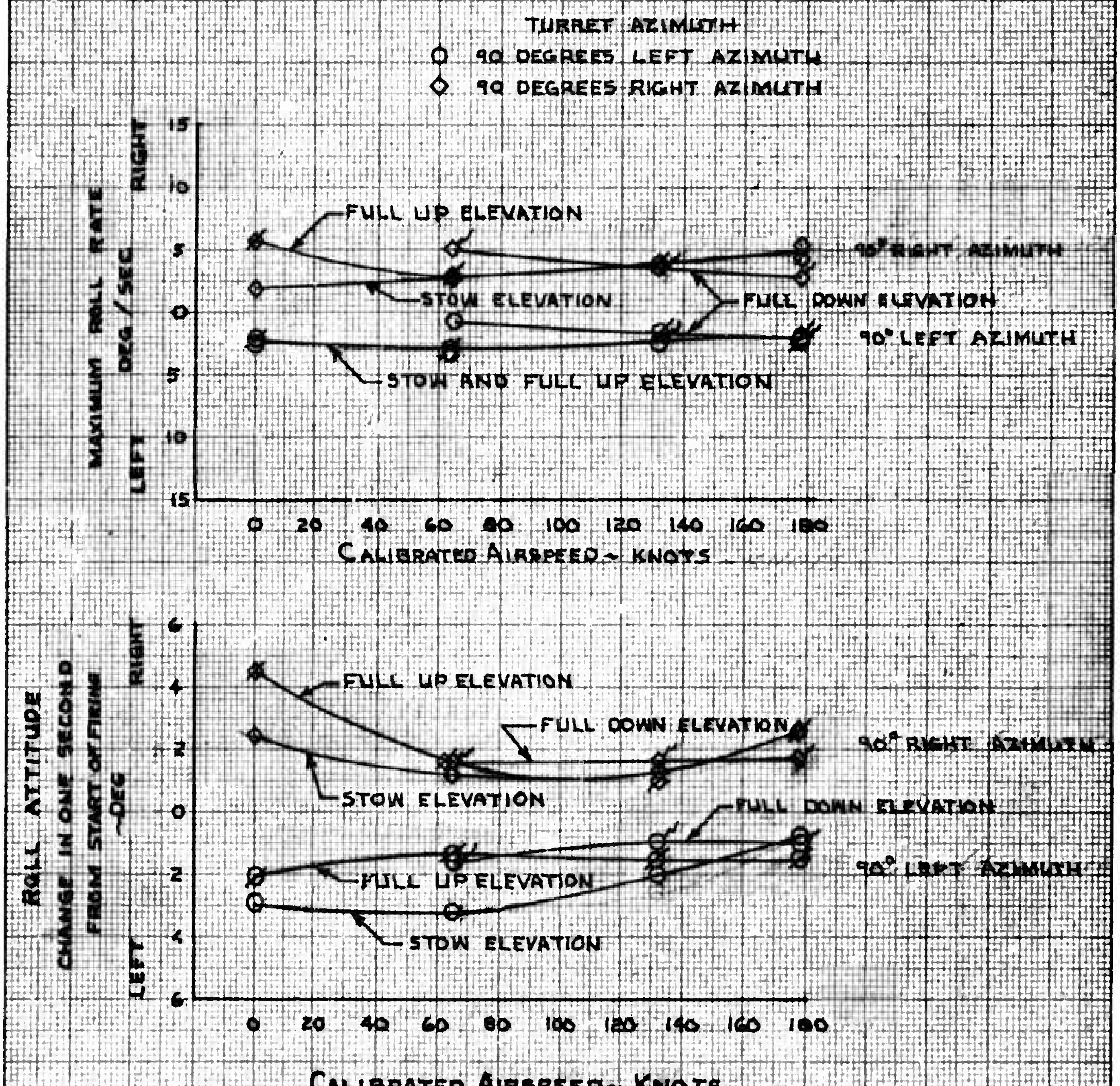


Figure No. 3
Summary of Yaw Axis Reactions During XM-28 (Two XM-129 Launchers) Firing
AH-1G USA S/N 66-15283

AVG. GROSS WEIGHT	AVG. C.G. STATION	AVG. DENSITY ALTITUDE	ROTOR SPEED	CONFIGURATION
8170 LBS.	193.1 IN.	3045 FT	324 RPM	INSTRUMENTATION PODS OUTBOARD

NOTES:

1. BOTH LAUNCHERS FIRING WITH FLIGHT CONTROLS FIXED
2. Ø SLASHED SYMBOL DENOTES FULL UP TURRET ELEVATION
3. FLAGGED SYMBOL DENOTES FULL DOWN TURRET ELEVATION
4. O OPEN SYMBOL DENOTES STOW TURRET ELEVATION

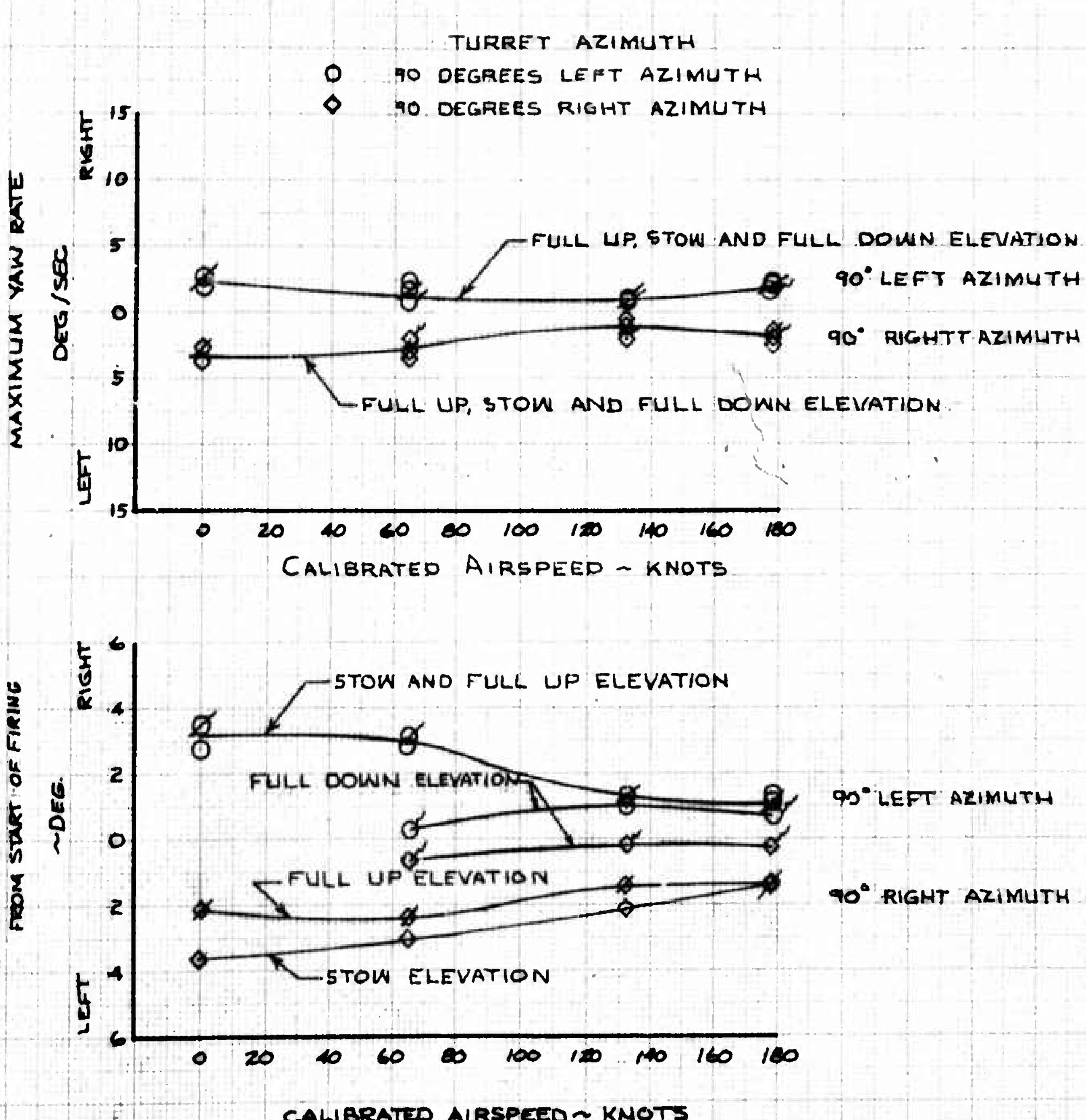
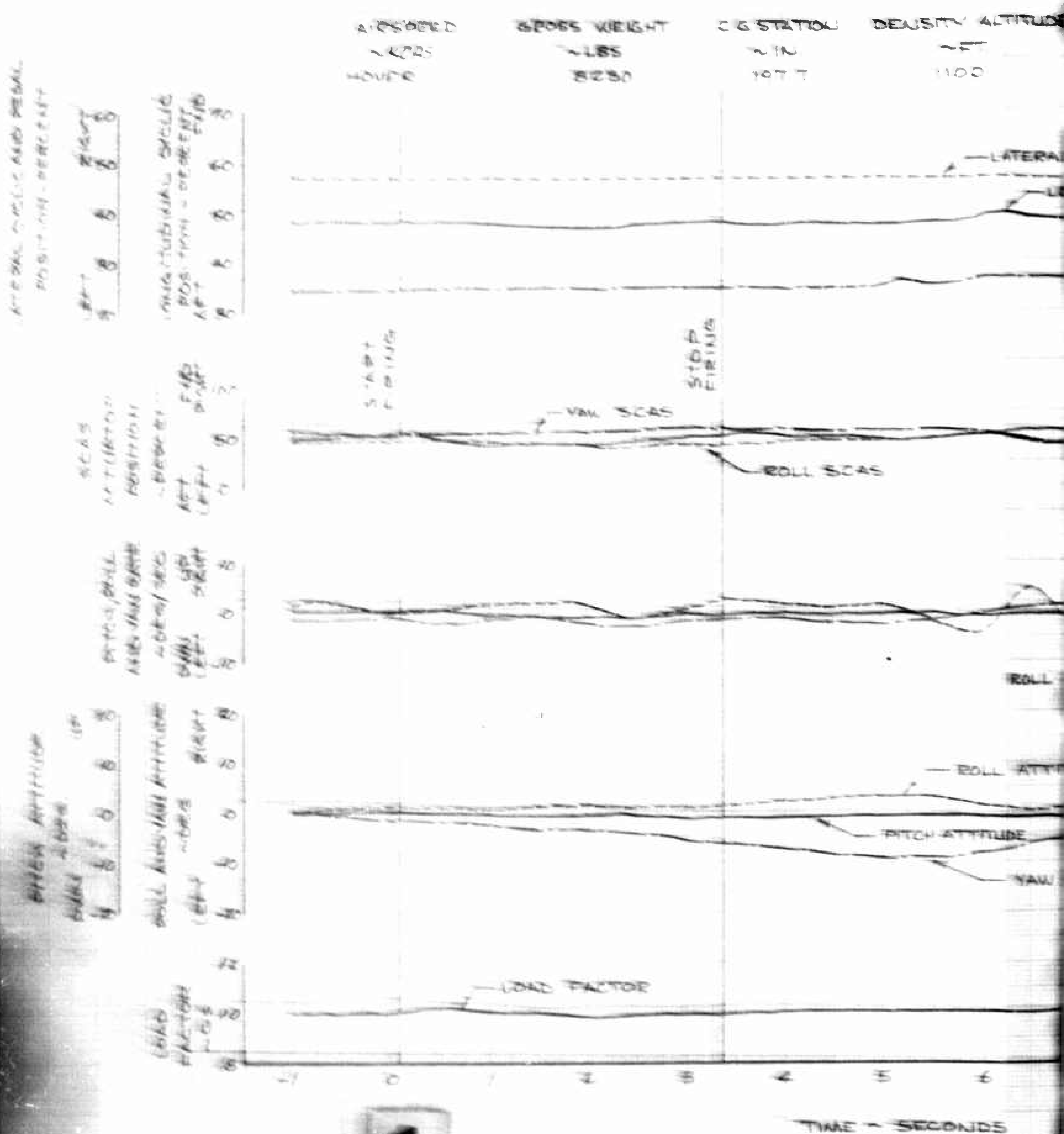


FIGURE No. 4

XM-28 (TWO XM-129 LAUNCHERS) FIRING

AH-1G USA S/N 66-15283



HERS) FIRING

15283

TION	DENSITY ALTITUDE	ROTOR SPEED	CONFIGURATION
J.	~FT.	~R.P.M.	
.7	1100	37.4	INSTRUMENTATION PODS OUTBOARD

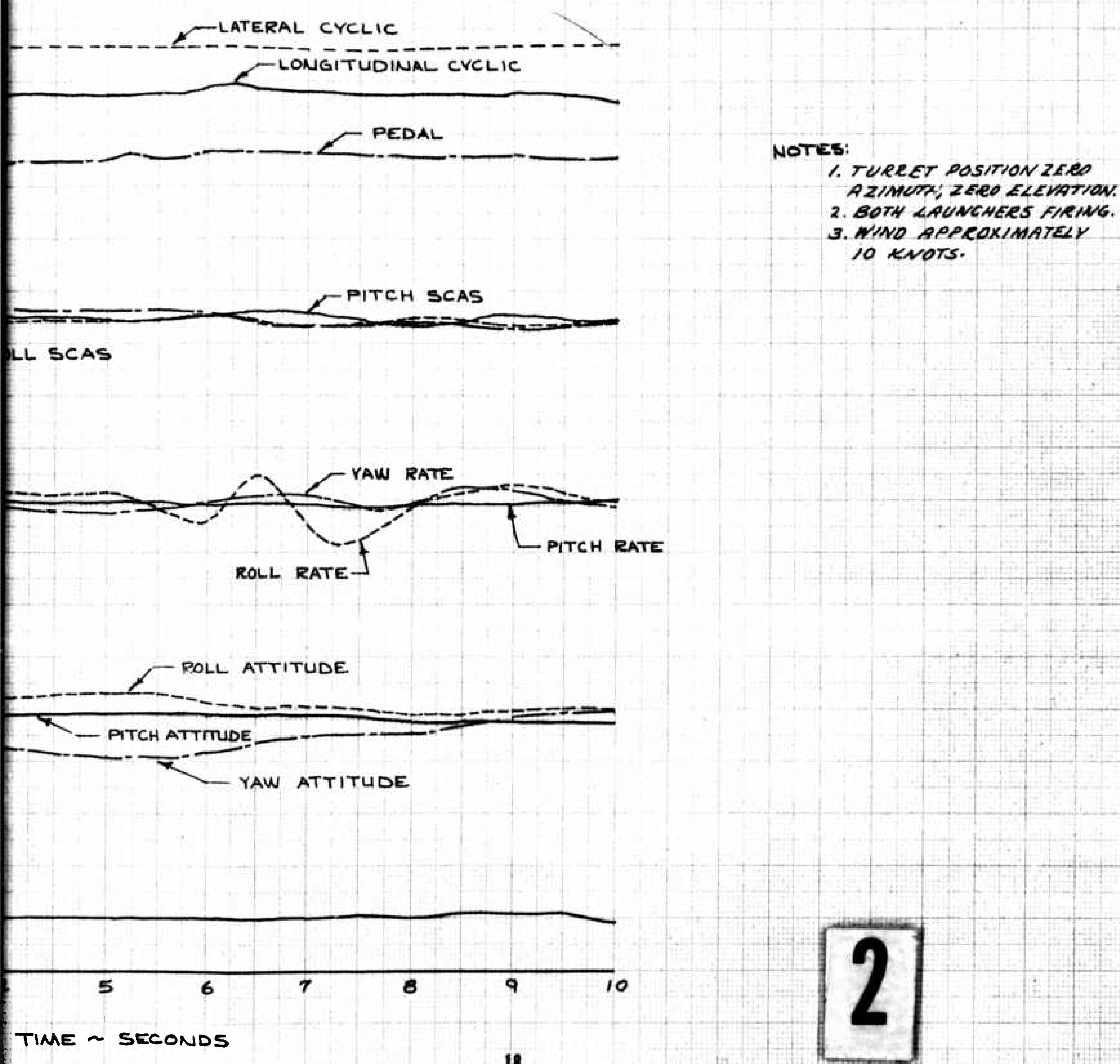
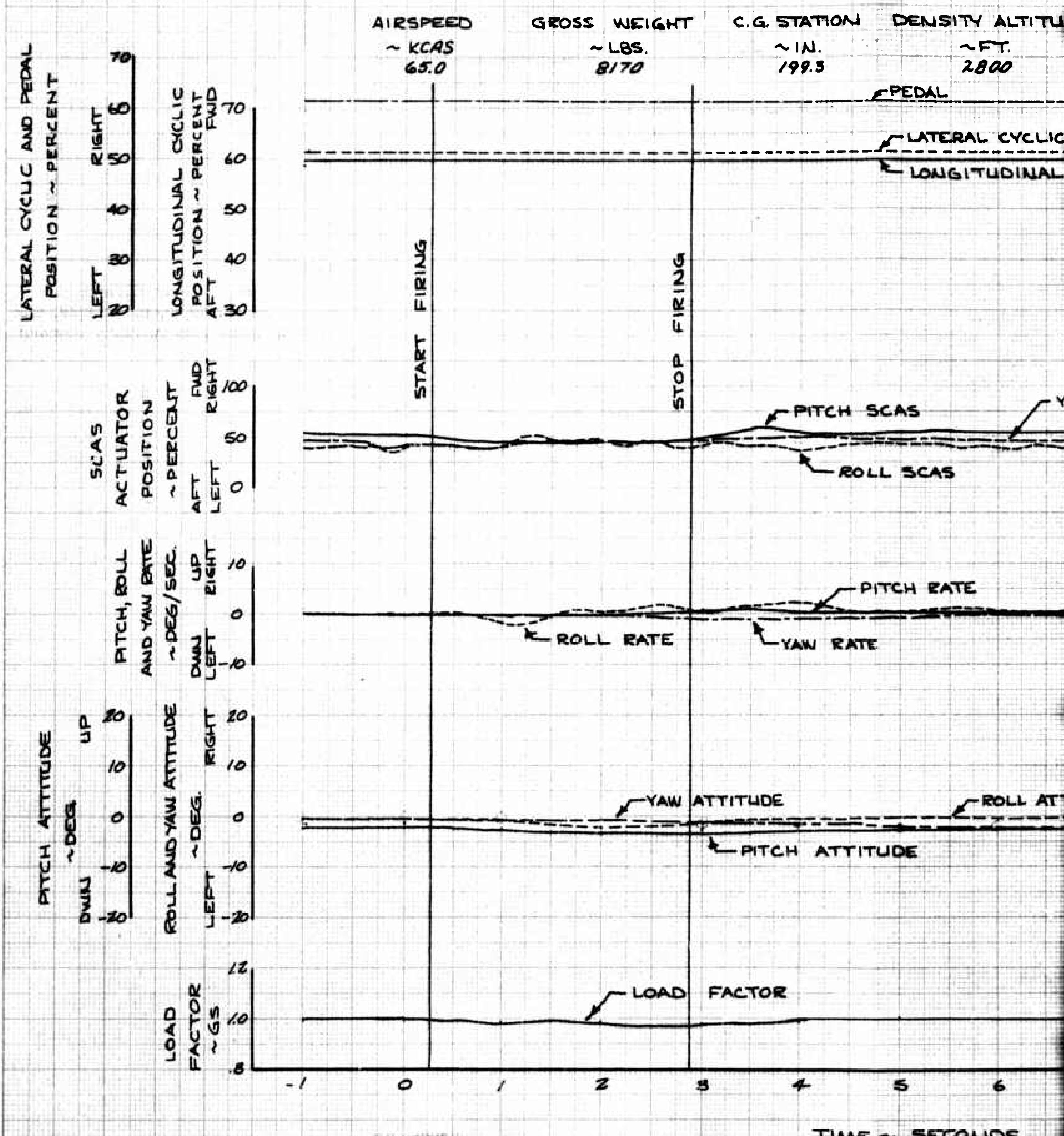


FIGURE No. 5
XM-28 (TWO XM-129 LAUNCHERS) FIRING
AH-1G USA S/N 66-15283



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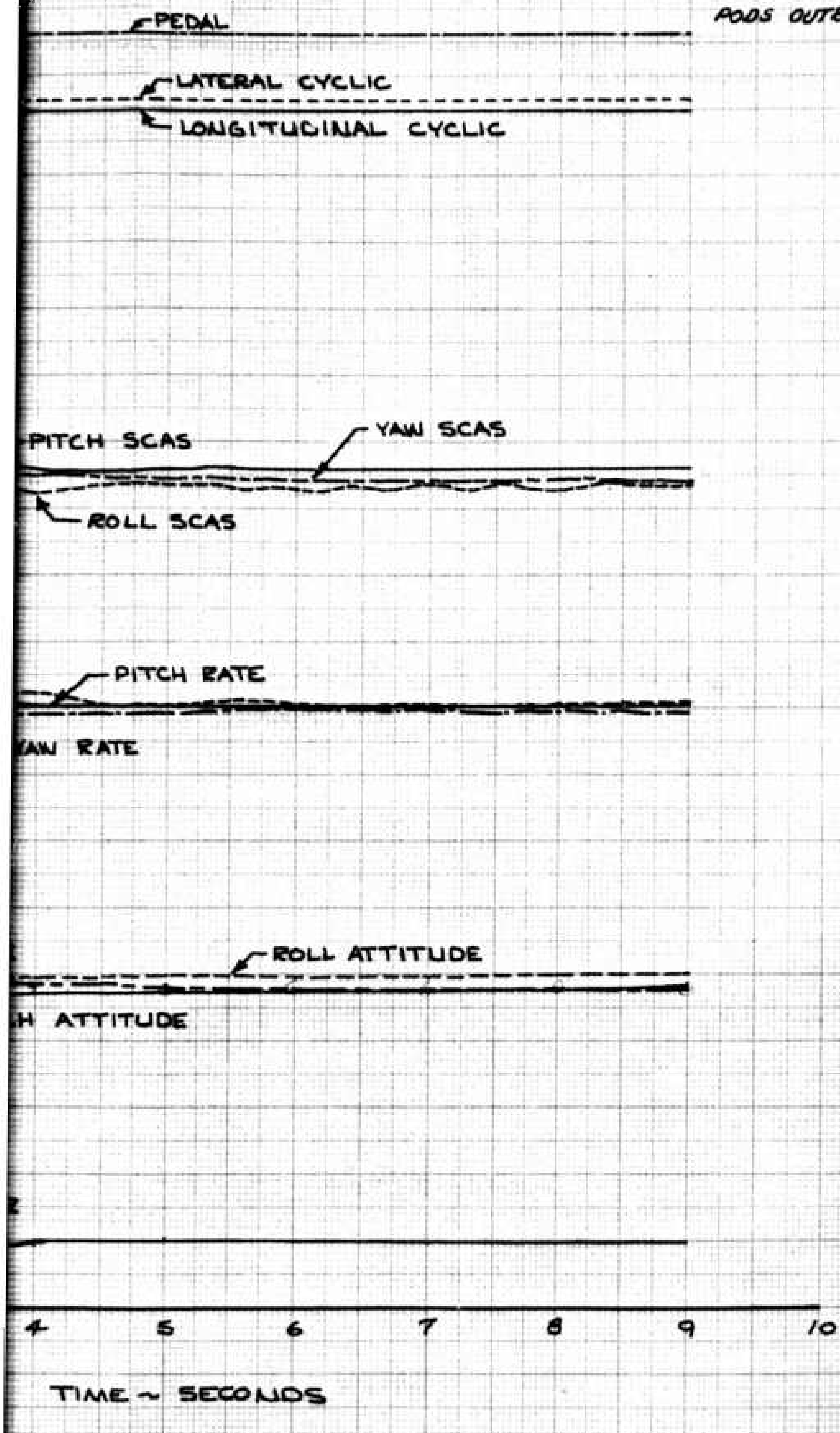
CHERS) FIRING
-15283

ATION	DENSITY ALTITUDE	ROTOR SPEED	CONFIGURATION
IN.	~FT.	~R.P.M.	
99.5	2800	324	INSTRUMENTATION PODS OUTBOARD



NOTES:

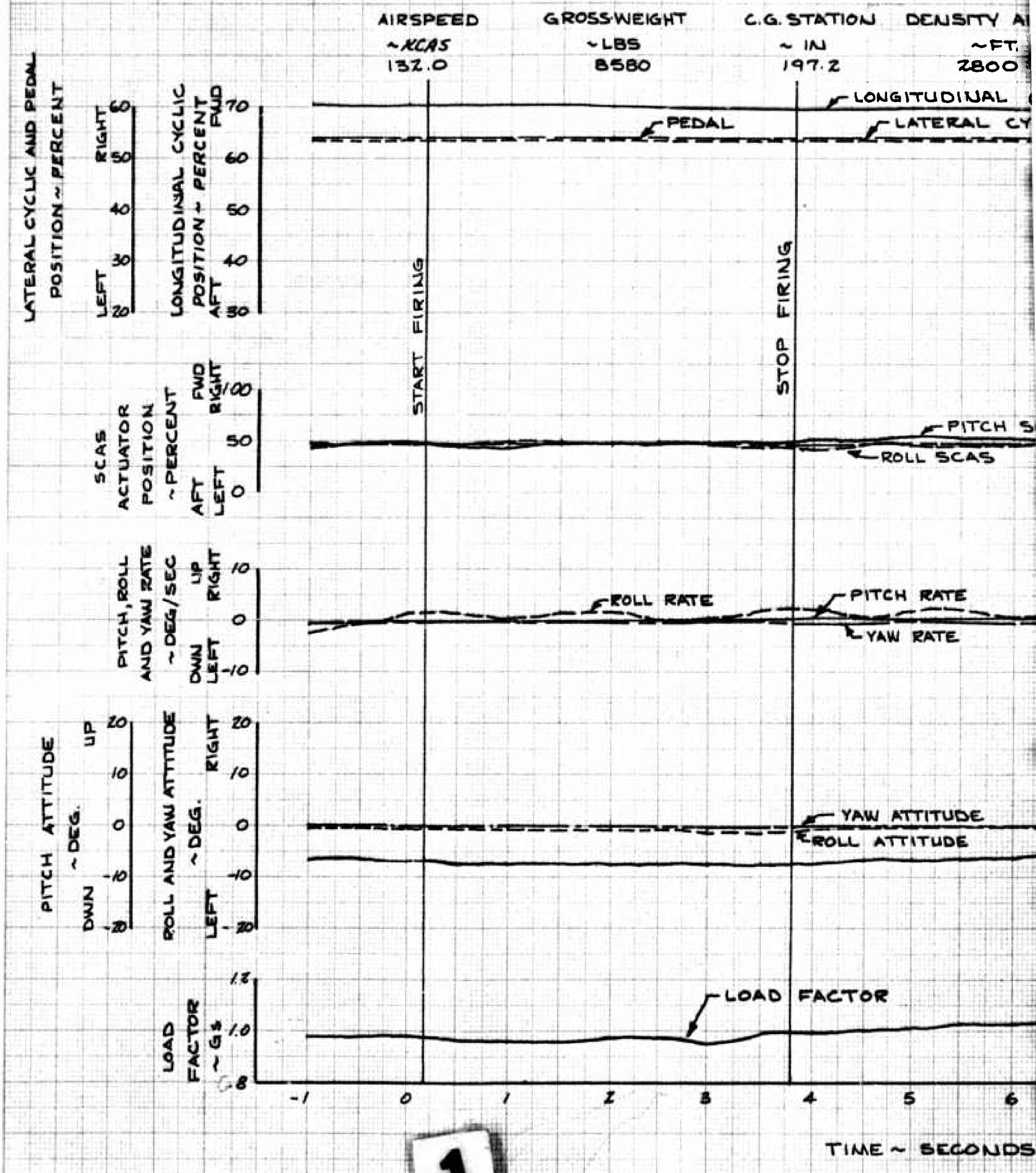
1. TURRET POSITION ZERO AZIMUTH, ZERO ELEVATION.
2. BOTH LAUNCHERS FIRING.

2

FIGURE NO. 6

XM-28 (TWO XM-129 LAUNCHERS) FIRING

AH-1G USA S/N 66-15283



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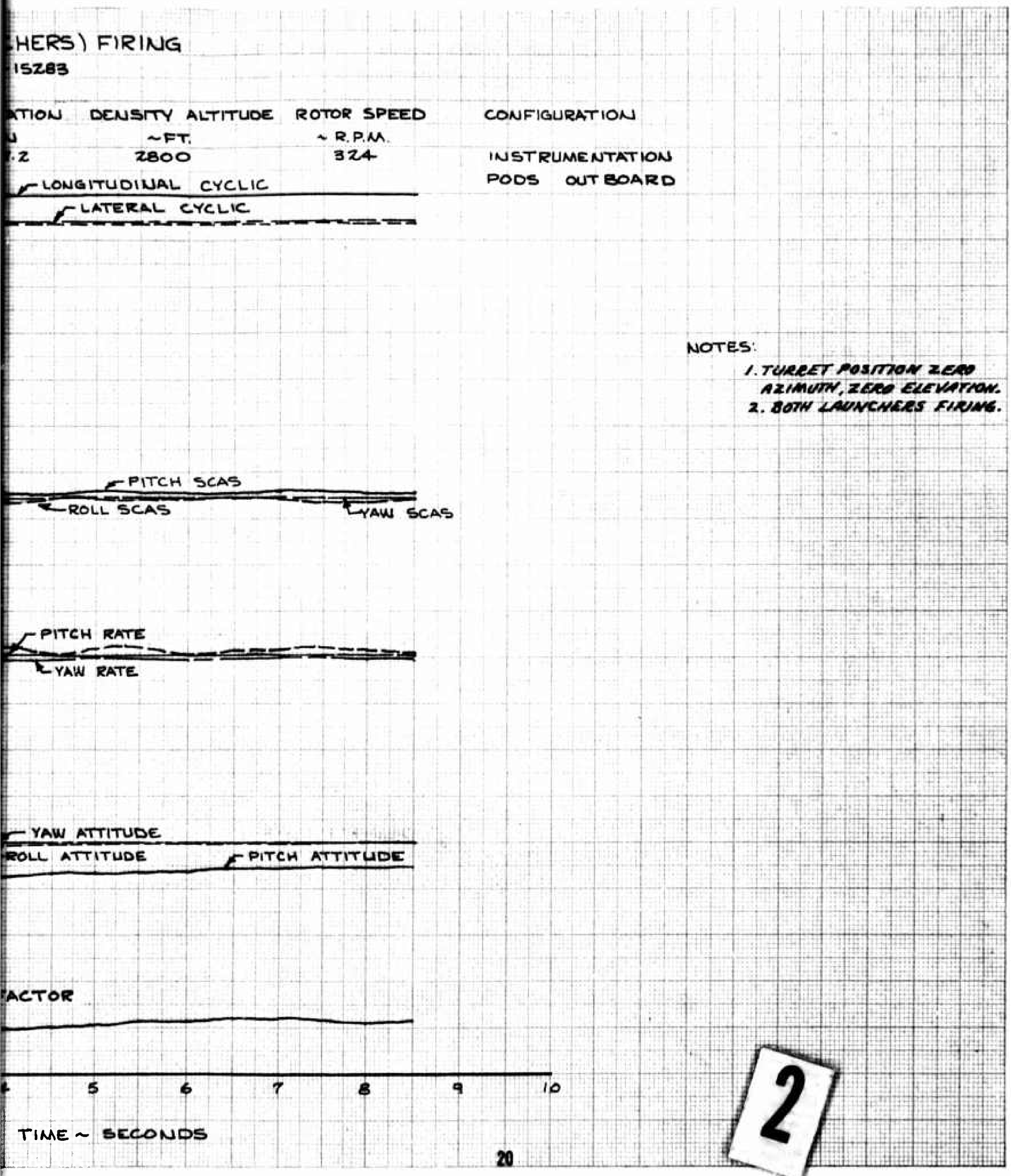
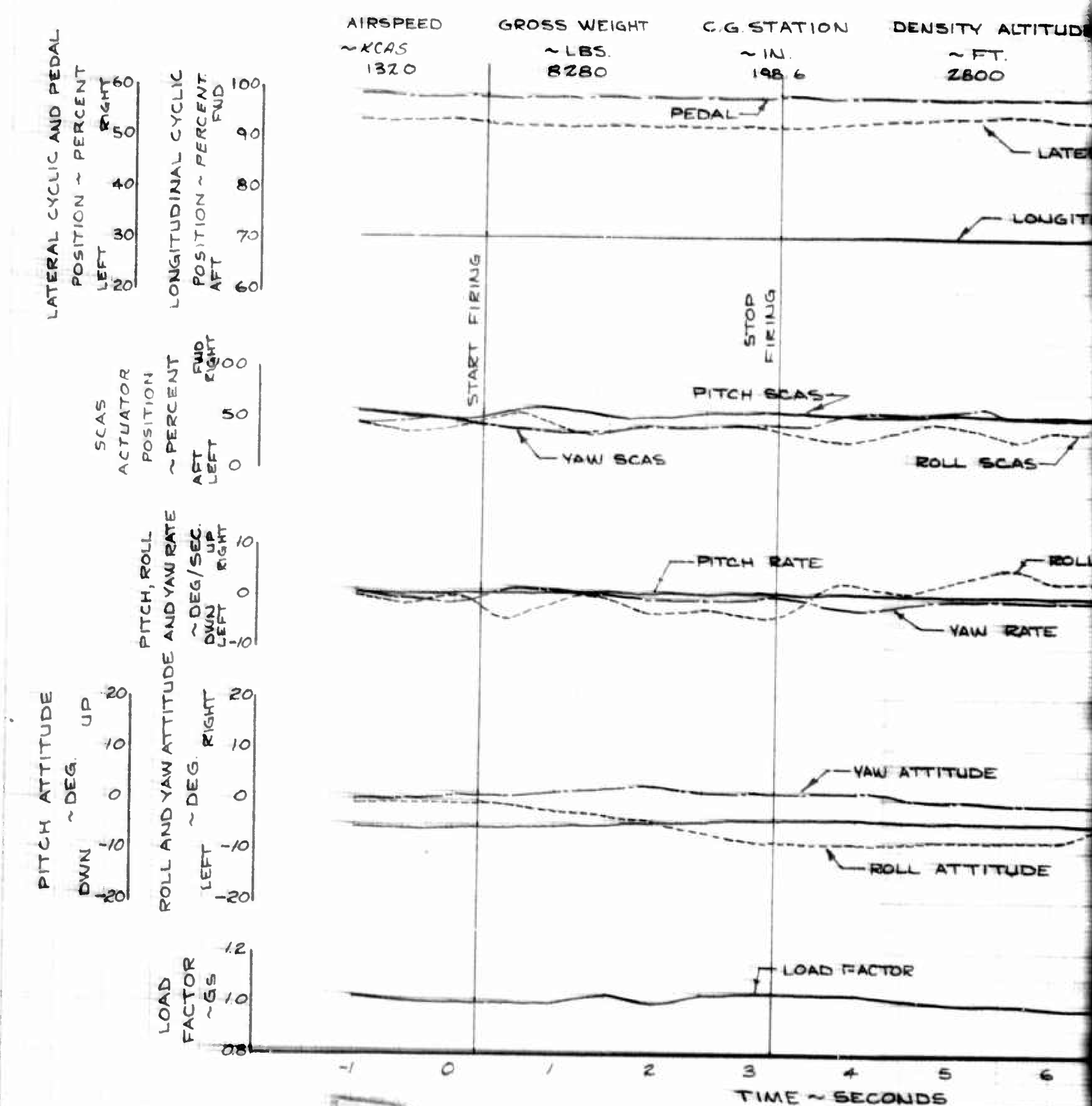


HERS) FIRING
15283
TION DENSITY ALTITUDE ROTOR SPEED
~FT. ~R.P.M.
.2 2800 324
CONFIGURATION
INSTRUMENTATION PODS OUTBOARD
LONGITUDINAL CYCLIC
LATERAL CYCLIC
NOTES:
1. TURRET POSITION ZERO AZIMUTH, ZERO ELEVATION.
2. BOTH LAUNCHERS FIRING.
PITCH SCAS
ROLL SCAS
YAW SCAS
PITCH RATE
YAW RATE
YAW ATTITUDE
ROLL ATTITUDE
PITCH ATTITUDE
ACTOR
4 5 6 7 8 9 10
TIME ~ SECONDS
2

FIGURE No: 7

XM-28 (TWO XM-129 LAUNCHERS) FIRING

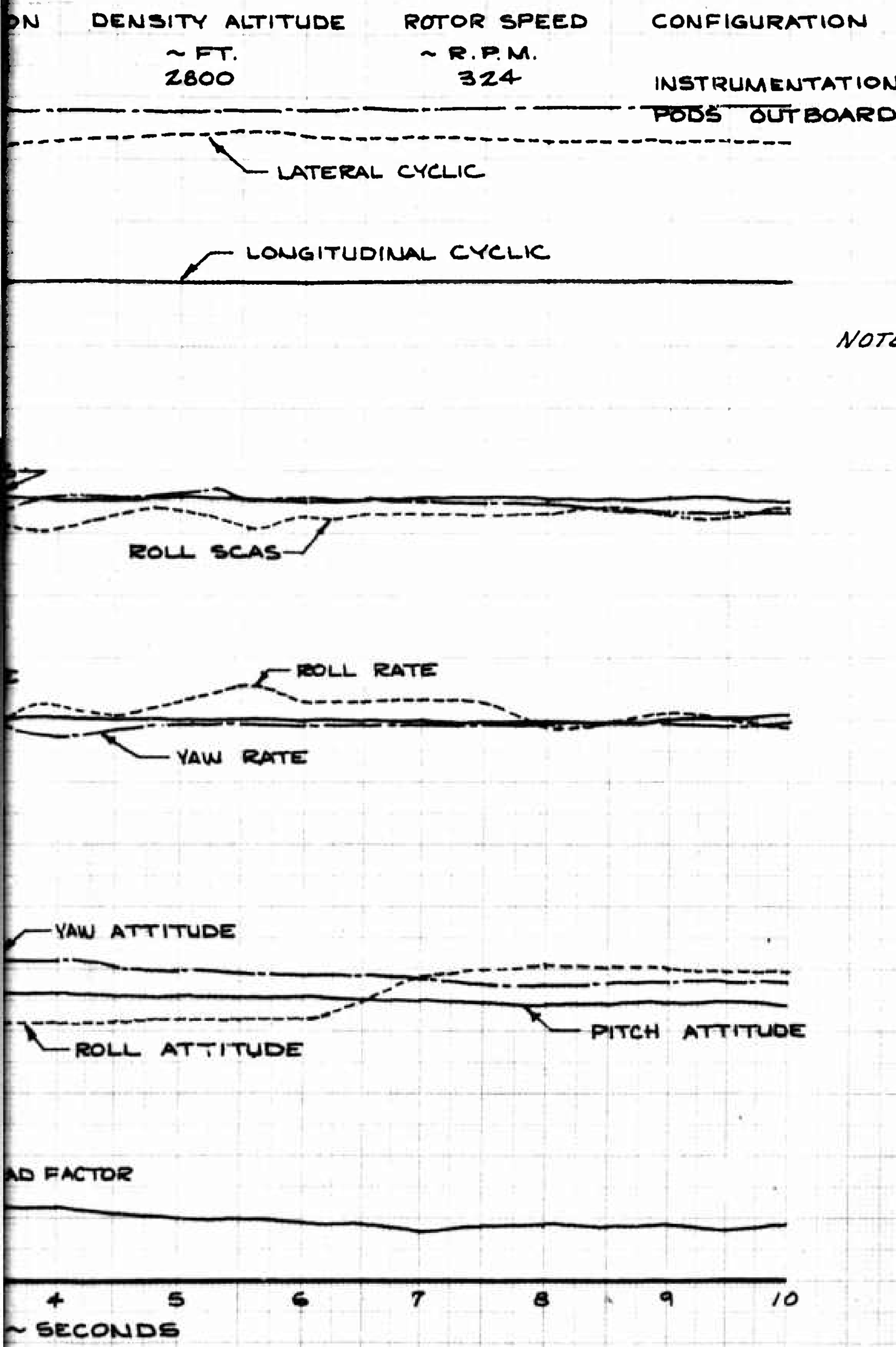
AH-1G USA S/N 66-15283



E No: 7

) LAUNCHERS) FIRING

S/N 66-15283



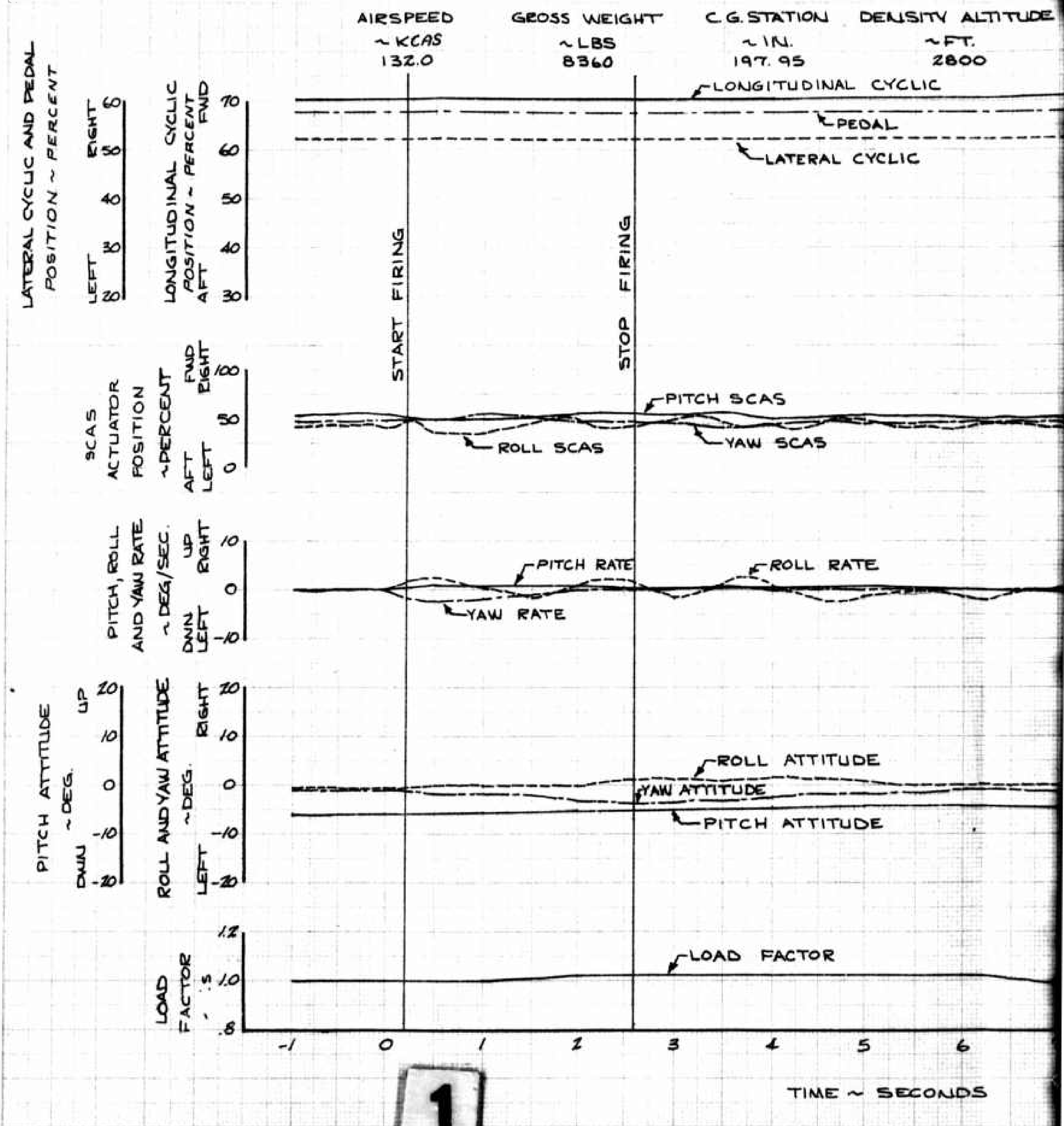
NOTES:

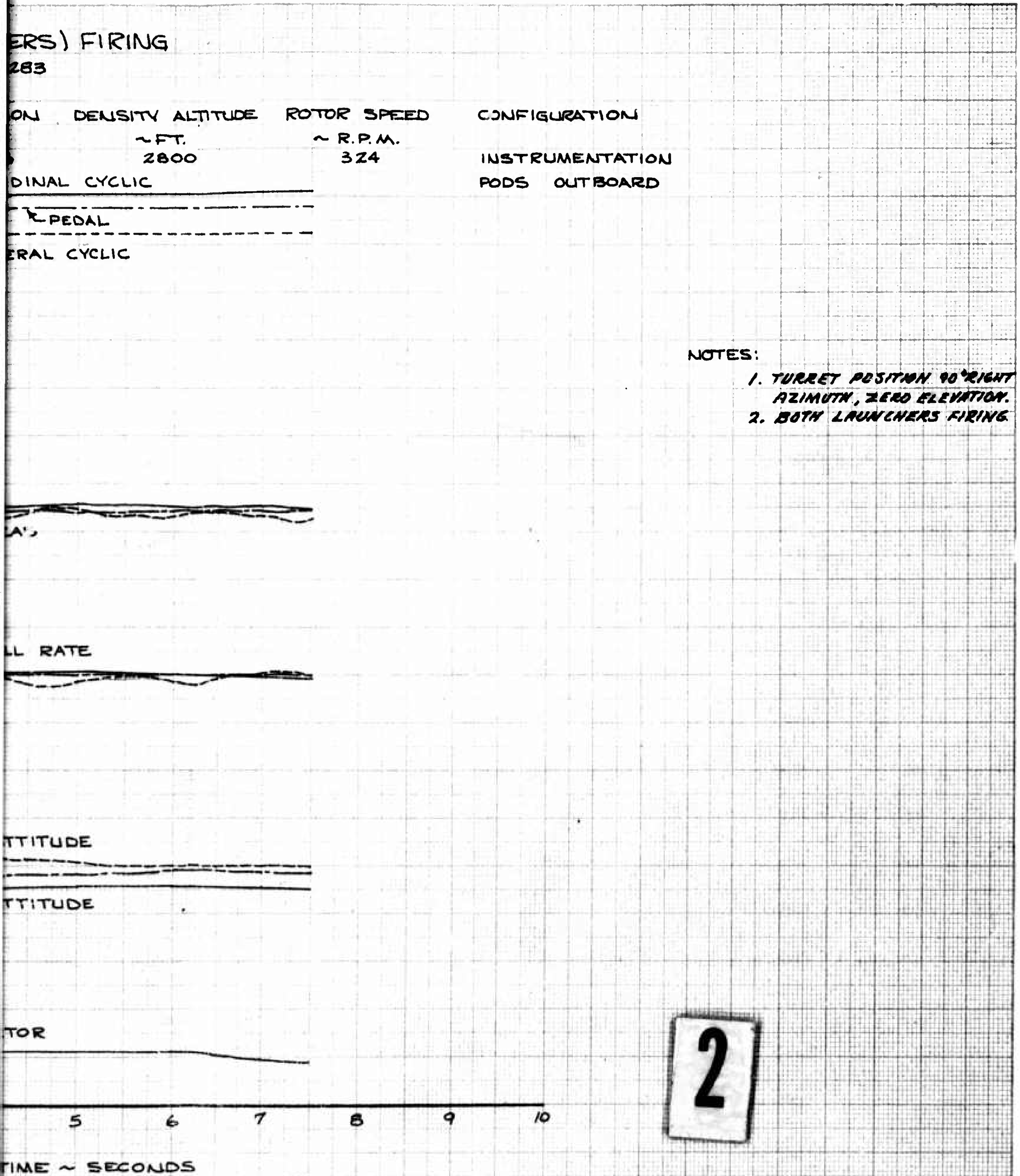
1. TURRET POSITION 90° LEFT AZIMUTH, ZERO ELEVATION.

2. BOTH LAUNCHERS FIRING.

2

FIGURE No. 8
XM-28 (TWO XM-129 LAUNCHERS) FIRING
AH-1G USA S/N 66-15283





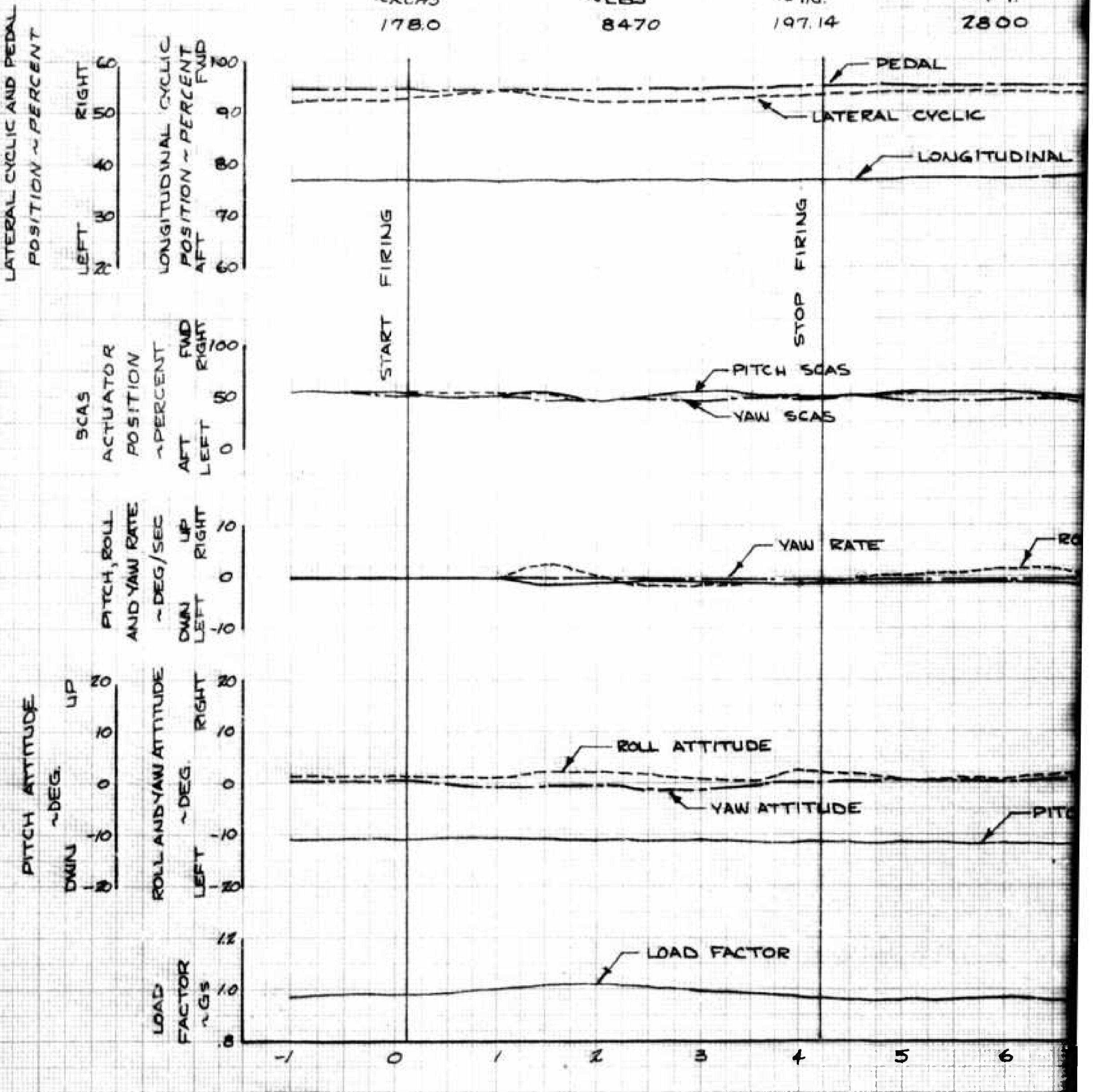
ERS) FIRING
283
ON DENSITY ALTITUDE ~FT. 2800
ROTOR SPEED ~R.P.M. 324
CONFIGURATION
INSTRUMENTATION PODS OUTBOARD
DINAL CYCLIC
PEDAL
ERAL CYCLIC
NOTES:
1. TURRET POSITION 90° RIGHT AZIMUTH, ZERO ELEVATION.
2. BOTH LAUNCHERS FIRING
LL RATE
TTITUDE
TTITUDE
TOR
5
6
7
8
9
10
TIME ~ SECONDS
2

FIGURE No. 9

XM-28 (TWO XM-129 LAUNCHERS) FIRING

AH-1G USA S/N 66-15283

AIRSPEED ~KCAS	GROSS WEIGHT ~LBS	C.G. STATION ~IN.	DENSITY ALTITUDE ~FT.
178.0	8470	197.14	2800



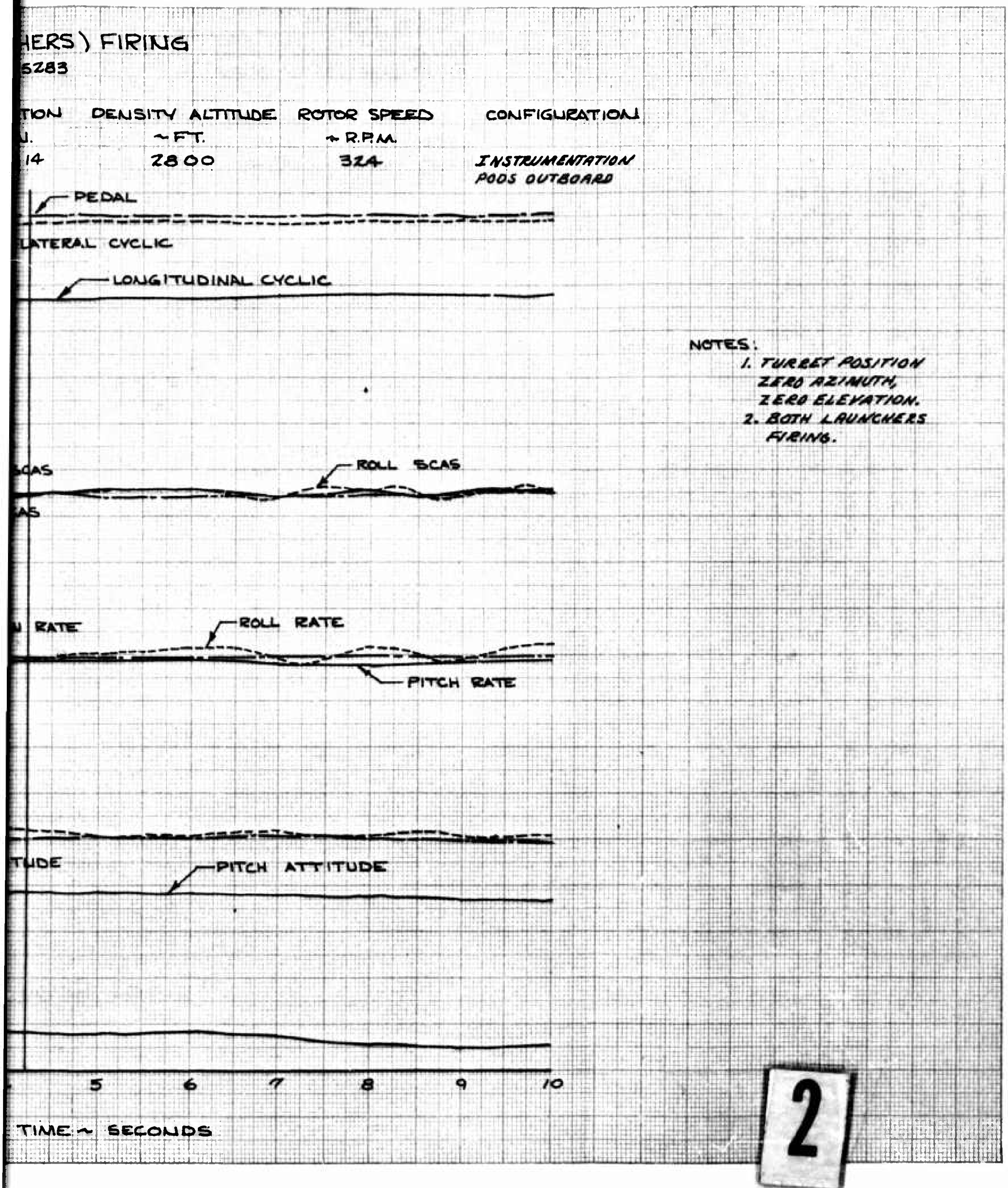
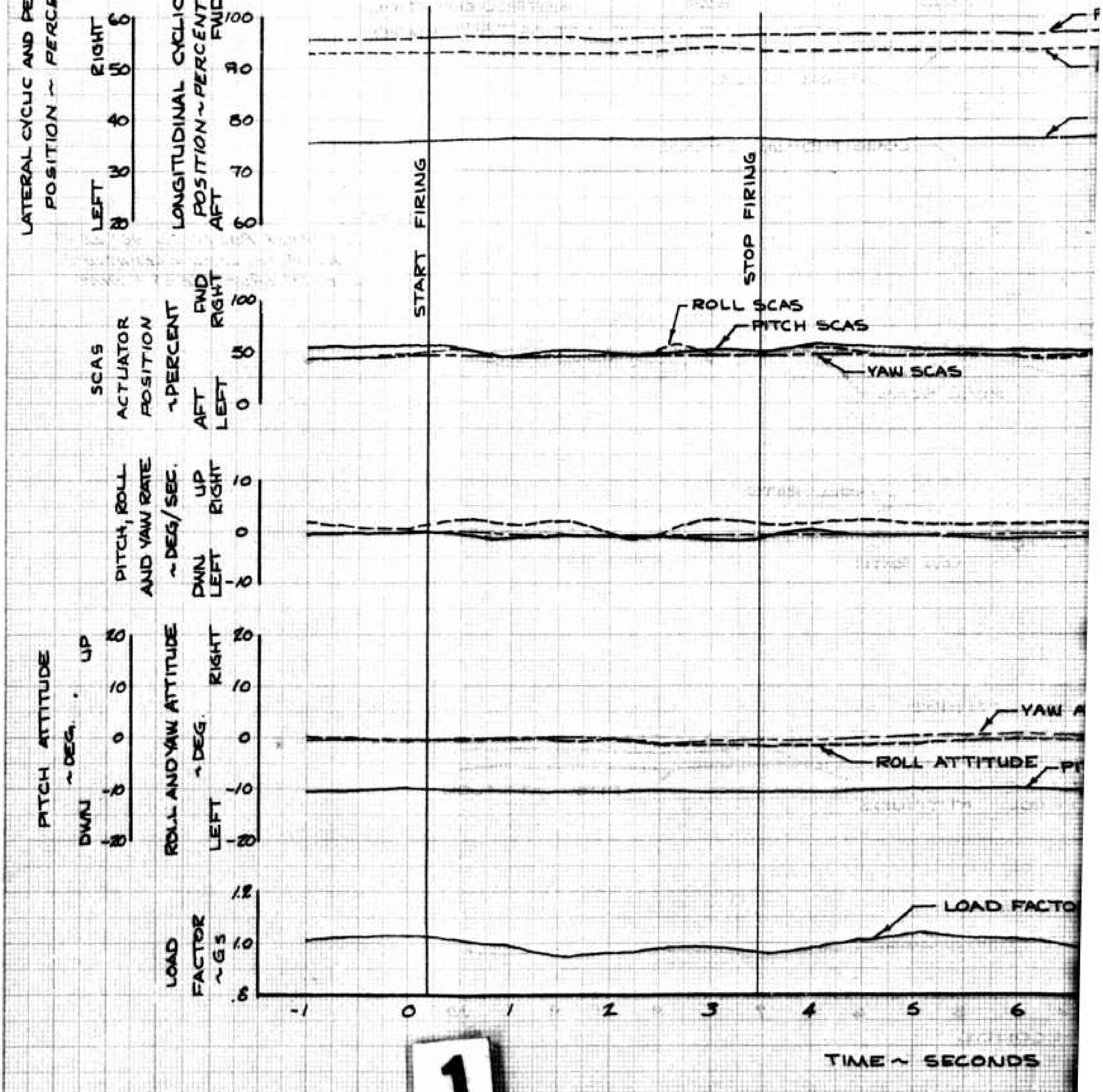

HERS) FIRING
5283
TION DENSITY ALTITUDE ROTOR SPEED CONFIGURATION
N. ~FT. ~R.P.M.
14 2800 324 INSTRUMENTATION PODS OUTBOARD
PEDAL
LATERAL CYCLIC
LONGITUDINAL CYCLIC
NOTES:
1. TURRET POSITION ZERO AZIMUTH, ZERO ELEVATION.
2. BOTH LAUNCHERS FIRING.
SCAS
ROLL SCAS
AS
RATE
ROLL RATE
PITCH RATE
TUDE
PITCH ATTITUDE
5
6
7
8
9
10
TIME ~ SECONDS
2

Figure No. 10
XM-28 (TWO XM-129 LAUNCHERS) FIRING
AH-1G USA S/N 66-15283

AIRSPEED ~KCAS	GROSS WEIGHT ~LBS	C.G. STATION ~IN.	DENSITY ALTITUDE ~FT.
178.0	8390	197.3	2800



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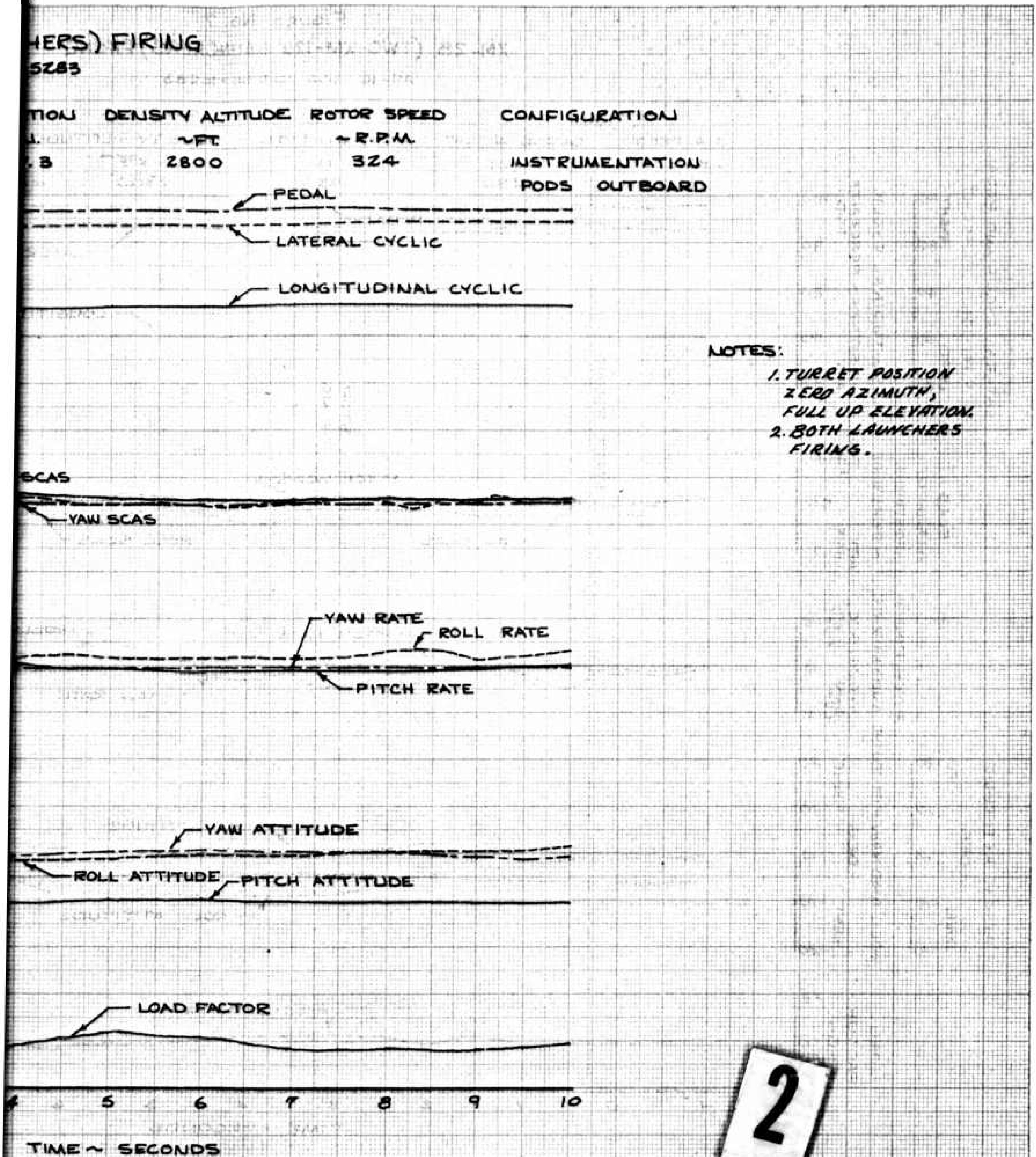
HERS) FIRING
5283
TION DENSITY ALTITUDE ROTOR SPEED CONFIGURATION
~FT. ~R.P.M.
.3 2800 324 INSTRUMENTATION
PODS OUTBOARD
PEDAL
LATERAL CYCLIC
LONGITUDINAL CYCLIC
NOTES:
1. TURRET POSITION
ZERO AZIMUTH,
FULL UP ELEVATION.
2. BOTH LAUNCHERS
FIRING.
SCAS
YAW SCAS
YAW RATE
ROLL RATE
PITCH RATE
YAW ATTITUDE
ROLL ATTITUDE
PITCH ATTITUDE
LOAD FACTOR
4 5 6 7 8 9 10
TIME ~ SECONDS

APPENDIX III TEST INSTRUMENTATION

Serial No. 66-15283

Flight test instrumentation was installed in the test helicopter by the contractor prior to the start of this evaluation. This instrumentation provided data from the pilot's panel, copilot/gunner's panel, and oscillograph. The following instrumentation was calibrated by the contractor and approved by the USAAVNTA flight test engineer. The flight test instrumentation was maintained by the contractor throughout the test program. The following parameters were included in the instrumentation package:

a. Pilot's Panel

Standard system airspeed
Standard system altimeter
Collective stick position
Normal acceleration
Oscillograph counter
Sensitive rotor tachometer

b. Engineer's Panel

Standard system airspeed
Standard system altitude
Turret azimuth
Turret elevation
Oscillograph counter
Free air temperature

c. Oscillograph

Longitudinal cyclic stick position
Lateral cyclic stick position
Collective stick position
Directional control position
C.G. vertical accelerometer
Pitch, roll, and yaw attitudes
Pitch, roll, and yaw rates
Copilot/gunner's vertical acceleration
Altitude
Delta torque
Linear rotor speed
Turret position
Longitudinal, lateral, and directional SCAS actuator position

APPENDIX IV

AIRCRAFT DIMENSIONS AND DESIGN DATA

Overall Dimensions:

Aircraft length (rotors turning)	52 ft 11.65 in.
Fuselage length	44 ft 5.20 in.
Maximum fuselage width (including stub wings)	10 ft 11.60 in.
Maximum fuselage width (without stub wings)	3 ft 0 in.
Width of skid gear	7 ft 0 in.
Minimum rotor ground clearance (without flexure)	7 ft 10.00 in.

Main Rotor:

Rotor diameter	44 ft 0 in.
Cord	2 ft 3 in.
Airfoil	symmetrical special 0009 1/3%
Twist	.455 deg/ft
Disc area	1520.4 ft^2
Blade area	49.5 ft^2 per blade
Solidity ratio	0.0651
Preconing angle	2.75 deg
Collective pitch travel	7.29 deg
Longitudinal cyclic travel	$\pm$14 deg
Lateral cyclic travel	$\pm$10 deg

Aircraft Weights:

Empty weight	5516 lb
Test gross weight range	8010 lb to 8660 lb
Design gross weight	6600 lb
Maximum gross weight	9500 lb

APPENDIX V
AH-1G OPERATING LIMITATIONS

1. Limit Airspeed (V_L):

   Hog or alternate configuration - 180 KCAS below 3000 feet density altitude. Decrease 8 KCAS per 1000 feet above 3000 feet.

   All other configurations - 190 KCAS below 4000 feet density altitude. Decrease 8 KCAS per 1000 feet above 4000 feet.

2. Gross Weight - Center of Gravity Envelope:

   Forward limit - Below 7000 lb, fuselage station (F.S.) 190, linear decrease from F.S. 190 at 7000 lb to F.S. 192.1 at 9500 lb.

   Aft limit - Below 7650 lb, F.S. 201. Linear decrease from F.S. 201 at 7650 lb to F.S. 200 at 9500 lb.

3. Sideslip Limits: 5 degrees at 190 KCAS. Linear increase to 20 degrees at 60 KCAS.

4. RPM Limits (steady state):

   Power on - 6600 to 6400 engine rpm
   324 to 314 rotor rpm

   Power off - 304 to 339 rotor rpm
   transient lower limit 250 rotor rpm

   Power on during dives and maneuvers 319 to 324 rpm

5. Temperature and Pressure Limits:

Engine oil temperature	93° C
Transmission oil temperature	110° C
Engine oil pressure	25 - 100 psi
Transmission oil temperature	5 - 20 psi

6. T53L-13 Engine Limits - Installed:

Normal rated (maximum continous)	625° C
Military rated (30 minute limit)	645° C
Starting and acceleration (5 second limit)	675° C
Maximum for starting and acceleration	760° C
Torque pressure	50 psi

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

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

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ENGINEERING FLIGHT TEST OF THE AH-1G (HUEYCOBRA) HELICOPTER EQUIPPED WITH THE XM-28 CHIN TURRET WITH TWIN XM-129, 40 mm GRENADE LAUNCHERS, PHASE B, PART 4

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
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John R. Melton, Project Engineer

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13. ABSTRACT

Part 4 of the AH-1G helicopter Phase B test was conducted at Yuma Proving Ground, Yuma, Arizona from 9 January to 18 January 1968, by the US Army Aviation Test Activity, Edwards Air Force Base, California. Firing tests were conducted to determine the effects on the stability and control characteristics of the AH-1G helicopter caused by firing the twin XM-129, 40mm grenade launchers in the XM-28 chin turret. Firing the two XM-129 grenade launchers in the XM-28 turret does not cause any objectionable aircraft reactions which would restrict the flight envelope. The deficiencies detected during this test were; the lack of a usable 40mm ammunition loading tool for use with the XM-28/XM-129 subsystem and totally unacceptable ammunition reliability. The shortcomings were; obstruction of pilot's field of vision by N-9 sight, lack of an ammunition loading adapter for the entrance chute to the ammunition cans, insufficient bonding of the teflon guide rail coverings, excessive wear of the rear gun mounts, and flexible ammunition chuting breakage.

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Security Classification

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
AH-1G helicopter Phase B Control characteristics XM-129, 40mm grenade launchers XM-28 chin turret						

Security Classification

SUPPLEMENTARY

INFORMATION

DEPARTMENT OF THE ARMY
U.S. ARMY AVIATION SYSTEMS TEST ACTIVITY
Edwards Air Force Base, California 93523

SAVTE-AS 4 March 1969

SUBJECT: Change Number 1 to the USAAVNTA Project 67-27 (66-06) Final Report.

SEE DISTRIBUTION

1. In accordance with unclassified message 12-1331 from AMSAV-R-FT, subject: AH-1G Phase B Test Reports - Control Positions, 13 December 1968, the following pen and ink changes will be made:

Engineering Flight Test of the AH-1G (HUEYCOBRA) Helicopter with the XM-28, 40mm Grenade Launchers, Phase B, Part 4, March 1968, appendix IV (pg 26).

Was:	Main Rotor:	
	Collective pitch travel	7.29 deg
	Longitudinal cyclic travel	±14 deg
	Lateral cyclic travel	±10 deg
Now:	Main Rotor:	
	Collective:	
	Pitch full travel	8.63 in.
	Stick:	
	Longitudinal full travel	9.29 in.
	Lateral full travel	9.29 in.
	Tail Rotor:	
	Directional:	
	Pedal full travel	5.86 in.

2. After the above change has been posted, this letter will be filed with the subject report.

FOR THE COMMANDER:

1 Incl
Distribution

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CPT, INF
Acting Adjutant