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RDTE PROJECT NO.
USAAVSCOM PROJECT NO. 69-01
USAASTA PROJECT NO. 69-01

AIRWORTHINESS AND FLIGHT CHARACTERISTICS TEST

AH-1G HELICOPTER WITH STABILIZED NIGHT SIGHT (SNS)

PHASE II

FINAL REPORT

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PROJECT ENGINEER

MARVIN W. BUSS
PROJECT OFFICER/PILOT

AUGUST 1970

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

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ABSTRACT

The Phase II airworthiness and flight characteristics test of the AH-1G helicopter with the stabilized night sight (SNS) installed was conducted by the US Army Aviation Systems Test Activity. The tests were conducted to evaluate the flight envelope of the AH-1G with the SNS installed for significant changes in the structural loads, handling qualities and performance due to this modification. The effects of weapons firing on the SNS system were also evaluated. The structural loads, handling qualities and performance of the AH-1G were not significantly changed by the SNS installation. The published AH-1G flight envelope is satisfactory for the SNS modified aircraft with one exception: due to the aircraft's reactions following sudden engine failure, the engine torque should be limited to less than 35 pounds per square inch, indicated, for all dives to airspeeds greater than 150 KCAS. Four deficiencies require correction before further testing in instrument flight conditions or in a combat environment: the lack of adequate, reliable attitude information for instrument flight; the excessive reflections in the canopy of the cockpit and instrument lights; the lack of a visual display or indication to the pilot of the relative position of targets sighted and tracked by the gunner with the SNS; and the directional control pedal interference. Three shortcomings were found. The correction of these shortcomings would improve mission performance.

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INTRODUCTION

BACKGROUND

1. The stabilized night sight (SNS) was developed as a subsystem to improve the night tactical capability of several weapon systems. The SNS system for the AH-1G was designed and developed by Itek Corporation, Optical Systems Division, for the US Army Mobility Equipment Research and Development Center. The airworthiness and flight characteristics (A&FC) of the AH-1G helicopter with the SNS installed were evaluated in two phases of testing. Phase I tests were conducted by the US Army Aviation Systems Test Activity (USAASTA) with the mock-up SNS installed on AH-1G, S/N 66-15293. These tests revealed a potential problem in the rotor and controls due to loads. Since only the nonrotating control boost tubes were instrumented to provide rotor and control stress data, the Phase I tests were terminated when higher than expected loads were recorded. Measurement of the actual loads in the rotor and controls was required before the AH-1G flight envelope could be fully evaluated with the SNS modified aircraft. The test aircraft was returned to Itek Corporation for further modification and installation of the functioning SNS equipment. An instrumented main rotor blade, drag brace, and pitch link along with a slip ring assembly were obtained from Bell Helicopter Company (BHC). The test plan for Phase II was revised to incorporate those items not completed during Phase I (refs 1 and 2, app I).

TEST OBJECTIVES

2. The objectives of the test program were:

a. To determine the A&FC of the AH-1G with an operational SNS installed.

b. To evaluate the flight envelope for the AH-1G with an SNS installed.

c. To obtain control and rotor blade load data both in the standard AH-1G nose and the SNS nose configurations.

d. To determine the effect of weapons firing on the SNS installation.

DESCRIPTION

3. The testing was accomplished with AH-1G, S/N 66-15293. The aircraft was a standard production AH-1G with the XM28 weapon system installed prior to modification for the SNS installation. The modification involved removing the standard AH-1G nose forward of fuselage station (FS) 46 and installing additional attachment structure between FS 61 and FS 46. The structural modifications provided six attachment points at FS 46 for installation of the SNS nose. The power supply and electronic control boxes for the SNS were located in the tail boom radio equipment bay. The SNS control head for the pilot's cockpit was located on the right console forward of the light control panel. The gunner's SNS control was located on the instrument panel at the top of the signal distribution panel. One hundred pounds of shot ballast were required in the tail boom at FS 470, the stinger attachment area, to maintain an acceptable center of gravity (cg) range. The main wiring bundle for the SNS was routed internally down the right side of the aircraft. The XM28 turret was modified to reduce the up elevation of the weapons when pointed forward from 17.5 to 13 degrees. The airspeed system was modified by relocating the pitot probe to the top left side of the fuselage aft of the pilot's canopy.

4. The SNS nose (photo 1) with all components installed weighed approximately 305 pounds. The major components were: the basic viewing device, a 9-foot fiber optic rope, a laser, azimuth and elevation gimbals with servos and resolvers. The electronics package installed in the tail boom consisted of three boxes weighing approximately 55 pounds. The SNS was designed to provide a visual aiming capability for the XM28 weapon system in night or low visibility conditions. The SNS azimuth range was ±60 degrees, and the elevation range was +15 to -30 degrees. The eyepiece of the fiber optic rope was attached to the standard gunner sighting station. The XM28 weapons and the SNS were controlled by the gunner through movement of the sighting station. A stowage position for the SNS was provided. This position of the sight completely closed the opening for the optic lens and laser.

5. The aircraft was instrumented to record all stability and control parameters, some performance parameters and forward cockpit vibration. Strain gage data were recorded for one rotor blade, one drag brace, one pitch link, the nonrotating control boost tubes and horizontal stabilizer loads. The instrument panels in both cockpits were modified to include test instruments. The oscillograph recorder was located in the ammunition bay. A list of the test instrumentation appears in appendix II.

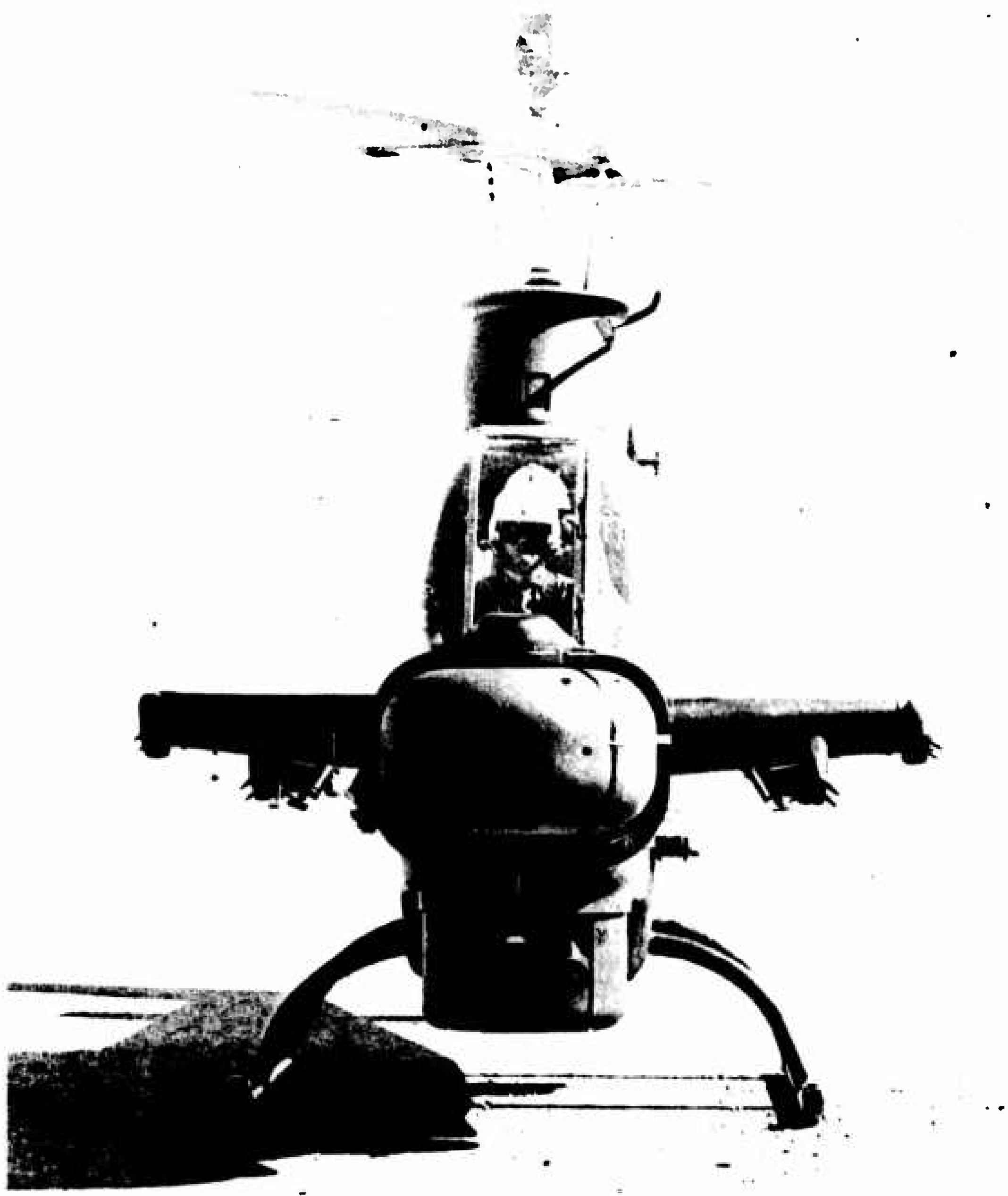


Photo 1. Stabilized Night Sight Installation.

SCOPE OF TEST

6. The scope of the Phase II tests was limited to establishing the A&FC of the AH-1G with the SNS installed. Since Phase I tests indicated a potential rotor and control load problem due to this modification, the first priority was to establish these load values and trends. The handling characteristics and performance evaluations were abbreviated to complete the testing and to provide data for the flight release by 14 November 1969, 6 weeks after receipt of the aircraft. The wide scope of information and data required limited testing to two configurations at two gross weights, one cg position and one test altitude for the entire airspeed and maneuver envelope. No evaluation of the total weapon system performance and capabilities was included in these tests.

7. Twenty productive test flights were made during this test program. Flight time was 23.2 hours. Two of these flights were made on the firing range at Fort Irwin, California; the remainder were flown in the vicinity of Edwards Air Force Base, California.

METHOD OF TEST

8. Rotor and control loads were determined from oscillograph records of the strain gage parameters for each predetermined flight condition of airspeed and maneuver. Tests were conducted to increase the airspeed, maneuver rates and load factors in predetermined increments following an analysis of the data from the preceding conditions.

9. Handling characteristics were evaluated qualitatively and quantitatively by comparing data from tests with the standard AH-1G nose configuration and that of the SNS nose configuration. In addition, a comparison was made of the stability and control test results of the Phase II program with those from the Phase D stability and control tests of the standard AH-1G (ref 3, app I). The handling qualities evaluation included tests to determine the static longitudinal and directional stability, dihedral effects, dynamic stability, controllability and aircraft reactions to sudden engine failure Standard test techniques were used for each of the tests described.

10. The effect of the SNS modification on level flight performance was determined by accomplishing three speed-power polars in both the standard AH-1G nose and the SNS nose configurations.

11. The test airspeed system and the modified standard airspeed system were calibrated between 40 and 130 knots calibrated airspeed (KCAS) using a trailing bomb pitot-static system and between 90 and 180 KCAS using the calibrated pace aircraft technique.

CHRONOLOGY

12. The chronology of the Phase II test program is as follows:

Test directive received	18 March 1969
Test plan submitted	15 September 1969
Test aircraft received	3 October 1969
Flight testing commenced	21 October 1969
Preliminary letter report and data submitted	14 November 1969
Flight testing completed	17 November 1969
Aircraft delivered to Sharpe Army Depot	21 November 1969
Draft report submitted	January 1970

RESULTS AND DISCUSSION

STRUCTURAL LOADS TESTS

13. The results of the Phase II structural loads tests showed essentially no increase in control or rotor loads due to the SNS modification.

14. The Phase II structural loads tests were conducted with the standard AH-1G nose and also with the SNS nose installed in two configurations: the clean wing at 7520 pounds and the heavy scout (two XM159 rocket pods and two XM18 minigun pods) at 9240 pounds. Comparisons were made between the Phase II data and data obtained from BHC report number 209-090-041 (flight loads survey) (ref 4, app I) in two configurations: the clean wing at 6500 pounds and the hog (four XM159 rocket pods) at 9500 pounds, respectively. All BHC data were obtained with the standard AH-1G nose. The Phase I data used for comparison were obtained with both the standard AH-1G nose and the mock-up SNS installed in two configurations: the clean wing at 7560 pounds and the hog at 9270 pounds, respectively. The Phase II data were obtained at a 5000-foot density altitude (H_D) with a mid cg and a rotor speed of 324 rpm. The Phase I and BHC data used for comparison were at the same conditions. All Phase II loads data with the SNS installed were obtained with the SNS in the stowed position.

15. Eighteeen parameters of loads data were recorded, reduced and plotted during the Phase II tests. To reduce the time and cost of publishing this report, all stress data obtained are not presented in this report since some showed essentially no deviation from published BHC data. The stress data for the lateral control boost tube (although its fatigue life is not critical for the operating loads recorded) are presented since the loads (with and without the SNS installation) are higher than the loads indicated by BHC data (para 19). The remaining data presented are those data considered essential to determine the fatigue life of critical components by the US Army Aviation Systems Command (USAAVSCOM) and BHC structures engineers present during the conduct of the tests.

16. The loads data obtained in stabilized level flight and 1.0g dives (figs. 1 through 12, app III) indicate the following:

a. The loads data at 7520 pounds in the clean configuration were the same with the SNS installed as with the standard AH-1G nose installed.

b. At 9240 pounds, the only loads affected by the SNS installation were the beamwise bending moments at blade station 110. At blade station 110, the data indicated an increase in the mean bending moment of approximately 2500 inch-pounds due to the SNS installation. This increase is unexplained (para 19).

c. A comparison of the Phase II loads data obtained at 7520 pounds and the data obtained during the BHC flight loads survey tests at 6500 pounds indicated no significant difference, with the exception of the lateral boost tube loads. The lateral boost tube load data obtained by BHC indicated 170 pounds less oscillatory load and 200 pounds less mean load throughout the operational airspeed range than the data obtained during these tests. The Phase I lateral boost tube loads data with the standard AH-1G nose installed agreed with the Phase II data, but the oscillatory loads with the SNS installed were approximately 100 pounds higher for the Phase I data than for the Phase II data (para 19 and ref 2, app I).

d. A comparison was made of the loads data obtained at 9240 pounds with the data obtained by BHC at 9500 pounds. BHC data showed mean beamwise bending moments at blade station 46 which were 2000 inch-pounds lower at 70 KCAS and 6500 inch-pounds lower at 130 KCAS. The oscillatory bending moments were the same. The BHC lateral boost tube loads data were lower than Phase II data at airspeeds greater than 80 KCAS. The BHC data showed oscillatory loads 240 pounds lower and mean loads 200 pounds lower than the Phase II data at 130 KCAS. The Phase I lateral boost tube loads data with the standard AH-1G nose installed agreed with the Phase II data, but the Phase I oscillatory loads with the mock-up SNS installed were about 300 pounds higher than Phase II loads for airspeeds greater than 100 KCAS (para 19 and ref 2, app I).

e. Loads data were obtained at 155 KCAS with five different engine power/collective settings at 7520 pounds with the standard AH-1G nose installed. The magnitudes of rotor and control loads are less for reduced engine power/collective settings (figs. 1 through 6, app III).

17. The symmetrical pullout data were obtained either using the engine power required for level flight at the trim airspeed or the maximum power permitted for those trim airspeeds above the maximum airspeed in level flight (V_H). The pullout was accomplished from a dive with longitudinal cyclic so that each normal acceleration value was achieved at the desired airspeed and altitude. The data obtained in symmetrical pullouts are presented in figures 13 through 48, appendix III, and indicate the following:

a. At 7520 pounds, oscillatory and mean chordwise bending moments at blade station 135 and the lateral boost tube loads are increased slightly by the SNS installation (para 19).

b. At 9240 pounds, the data obtained at a trim airspeed of approximately 125 KCAS showed that the SNS installation increased the lateral boost tube loads (200 pounds, oscillatory; 100 pounds, mean) and increased the beamwise bending moments at blade station 110 (1000 inch-pounds oscillatory; 2200 inch-pounds mean) (para 19).

c. Comparison of Phase II loads data with BHC data (ref 6, app I) indicates similar loads. A detailed comparison was not made since the BHC data for symmetrical pullouts did not include the normal acceleration values achieved.

18. Loads data were obtained during various types of maneuvering flight. These data are tabulated in tables A through C, appendix III. During most of the maneuvers, the maximum loads were maintained for only a few seconds. These data are presented to indicate the level of loads which occur during maneuvering flight.

19. During Phase I testing, the loads recorded for the three control boost tubes were higher (both with and without the mock-up SNS installed) than the loads recorded by BHC during their flight loads survey. There was also an increase in these loads (particularly the lateral boost tube loads) due to the mock-up SNS installation. This indicated that excessive loads might be occurring in the rotating components which would significantly reduce the fatigue life of these components. The results of the Phase II tests did not confirm the suspected high loads in the rotating components. In fact, during the Phase II tests, the loads in the longitudinal and collective boost tubes (both with and without the SNS installed) were lower than those recorded during Phase I tests and agreed with BHC data. The Phase II lateral boost tube loads showed no difference due to the SNS installation and agreed with the Phase I standard AH-1G nose data. However, they were consistently higher than published BHC data. The loads in some of the rotating components were increased by the SNS installation, and some of the loads with the standard AH-1G nose were higher than the loads recorded by BHC. Concurrent analysis of the increased loads in the lateral boost tubes and the rotating components by USAASTA, USAAVSCOM and BHC engineers produced no explanation of these increases or of the discrepancy between Phase I and Phase II data. It was concluded that none of the loads data recorded during Phase II testing in either the standard AH-1G nose or the SNS nose configuration indicated any significant reduction of component fatigue life. Therefore, no limitations are recommended to the AH-1G flight envelope with the SNS installed due to structural loads.

STABILITY AND CONTROL TESTS

20. The handling qualities of the AH-1G with the SNS installed were evaluated at each of the configurations described in paragraph 14. The qualitative and quantitative results revealed no significant change in the handling qualities due to the modification of the standard AH-1G nose shape with the SNS installed. The static longitudinal trim stability, static directional stability and dihedral effects are presented in figures 49 through 53, appendix III.

AIRCRAFT REACTIONS TO SUDDEN ENGINE FAILURE

21. The reactions of the SNS modified AH-1G to sudden engine failure were evaluated in the heavy scout configuration at a 9240-pound grwt, mid cg and 5000-foot H_D. Tests were conducted at airspeeds between 80 and 166 KCAS, the limit airspeed (V_L). The engine power was set at the power required for level flight at airspeeds less than V_H and at the maximum power permitted at all dive airspeeds. Additional tests were made at V_L using reduced engine power and collective settings. The aircraft's reactions and the control delay times at airspeeds greater than V_H (using the maximum permitted power and collective settings) were unacceptable. The left roll rates and accelerations induced by the left yaw following sudden power loss were very high, and maximum delay possible before recovery action was approximately 1 second at 140 KCAS. This decreased to 0.5 second at V_L for the maximum power condition. Recoveries required a large (approximately 2 inches) aft and right movement of the cyclic to arrest the left roll rate and establish a nose-up pitch rate. Heavy control feedback was experienced during the high-speed recoveries and limited the recovery capability. Control delay times were acceptable (greater than one second) at all airspeeds when the maximum torque used was 35 psi.

22. The limitations to high-speed, high-power dive conditions for the AH-1G with the SNS installed should be: all dives to airspeeds greater than 150 KCAS should be made at medium torque settings with 35 psi as the maximum permitted for any dive, and cockpit torquemeters should be marked with a yellow line at 35 psi. This mark should be explained in the pilot's handbook as the maximum permitted torque at dive airspeeds greater than 150 KCAS.

WEAPONS FIRING TESTS

23. Firing tests of the 7.62 millimeter (mm) machine gun were conducted in daylight conditions to evaluate turret and sight-tracking firing effects on the SNS and turret envelope for firing. The SNS

installed on the aircraft was in an operating mode for daylight conditions with a lens cover installed to prevent damage to the sight. The turret and SNS movement followed the movement of the gunner's sighting station, and the firing cutout circuits stopped the machine gun firing at the upper elevation limit. The turret positions and aircraft maneuvers for the tests are shown in table 1. The 40mm grenade launcher could not be fired since the drive motor could not pull the 20 rounds of ammunition through the chute without the ammunition can boost. Instrumentation located in the ammunition bay prevented installation of the ammunition can.

Table 1. Firing Conditions with the SNS Installed and Operating.

Gross weight: 8500 pounds
Rotor speed: 324 rpm
Density altitude: 5000 feet
Center of gravity: mid

Maneuver	Turret Position Azimuth (deg)	Turret Position Elevation (deg)	Calibrated Airspeed (kts)
Level flight	0	30 down	105
20-degree bank, left turn	30 right	10 down	105
20-degree bank, right turn	60 left	10 down	105
20-degree bank, left turn	60 right	10 down	105
Dive	0	0	162
Right rolling pullout	Traverse On target	Traverse On target	170
Left rolling pullout	Traverse On target	Traverse On target	170
Dive	0	30 down to full up	170
Dive	0	0	175

24. Further firing tests of the turret minigun and 2.75-inch rockets were conducted at night. The SNS installed on the test aircraft was not fully functional due to the following: the laser was inoperable because of low helium charge and low vacuum pressure; the image stabilization and focus functions were inoperable due to damaged wiring; the sight was not bore-sighted with the weapons; and the sight reticle was not functioning. The firing tests were conducted using the SNS in the passive mode (no laser illumination or ranging). The conditions were very dark with no moon or ground lighting. The test range was desert terrain with few contrasting features. The muzzle flash and vibration while firing the minigun had no significant effect on the sight picture, but the tracers produced large bright tracks in the sight. The sight target picture was blanked for a brief period during rocket firing due to the amount of light produced by the rocket motors. This "blooming" of the sight lasted until burnout or impact when two or more rockets were fired. The rockets were fired from the outboard wing station from the XM159 pods. No flight path anomalies of the rockets were noted due to the airflow around the SNS nose.

25. The major problems experienced during the night firing tests were: excessive reflection of cockpit lights on the canopy, unreliable aircraft attitude information due to excessive precession of the indicators during maneuvers and the lack of a visual display in the aft cockpit to show the relative location of targets being tracked by the gunner with the SNS and turret weapons. The test aircraft, S/N 66-15293, did not have NWO-1420-221-30/19 incorporated and was not equipped with the M55 (Lear Siegler) attitude indicating system. The M1 indicator installed precessed in both pitch and roll during firing maneuvers as much as 20 degrees in bank and 10 degrees in pitch. This is unacceptable for use in any condition and limits this aircraft to flight in conditions where a clear external horizon is always available. The excessive reflections of cockpit lights in the canopy were very distracting and resulted in pilot orientation problems when transitioning to contact (reference to an external horizon) from instrument (reference to cockpit instruments) flying and vice versa. The degree of distraction and pilot disorientation produced by these reflections make gunnery maneuvers in other-than-complete contact flight conditions extremely hazardous. Correction of these major deficiencies is mandatory for the aircraft modified for SNS operations in night and instrument conditions.

26. Additionally, it was determined essential that the pilot be provided with a visual display on the instrument panel that would indicate the relative azimuth and elevation of the gunner's line of sight. Since this system is designed to be operated in conditions where visual target engagement cannot be made, it is essential that

the pilot have a visual indication of the relative position of the target or area being tracked by the gunner with the SNS and turret. With this information, the aircraft can be maneuvered on instruments and sustain an engagement by the gunner with the turret weapons. This information is absolutely essential for engaging a target not clearly visible to the pilot when firing wing-mounted weapons such as rockets or XM18 guns.

LEVEL FLIGHT PERFORMANCE

27. Six level-flight performance tests were conducted to determine the performance change with the SNS installed. Three tests were made with the SNS installed and three with the standard AH-1G nose. These tests were conducted with the aircraft at a forward cg and in the heavy scout configuration at: 8100 pounds, 5000 feet; 8100 pounds, 10,000 feet; and 9200 pounds, 10,000 feet. The results are presented in figures 54 through 60, appendix III.

28. The results of these tests show that the SNS installation caused an increase in equivalent flat plate area of approximately 0.7 square feet. It was anticipated that the change in equivalent flat plate area caused by the SNS installation would be greater; however, the data did not show this. A probable cause for this difference is the position-error calibration of the airspeed system. The position error of the test system established with the SNS installed was approximately 3 knots different than the position error established with the standard AH-1G nose. A discrepancy of approximately 2.5 knots occurred between the two methods used to determine the position error of the test system with the standard AH-1G nose. Sufficient time was not available to resolve this position error discrepancy. A 2.5-knot change in airspeed would result in a change in equivalent flat plate area of approximately 1.7 square feet at 125 knots true airspeed (KTAS) which would be more consistent with the antiticpated increase in flat plate area.

VIBRATION

29. Vertical and lateral vibration data at the copilot's seat were recorded during the Phase II testing. The data were extremely difficult to reduce due to the large number of active parameters recorded on the oscillograph. Only a limited amount of vibration data was reduced in order to reduce the time and cost of publishing this report. A comparison of this data with Phase I data revealed no changes in the vibration characteristics for those conditions. Qualitative results for all comparable conditions during Phase I and

Phase II testing showed no differences. Therefore, the four-per-revolution and six-per-revolution (11.6 and 32.4 Hertz) vibrations were excessive and should be reduced (ref 2, app I).

COCKPIT EVALUATION

Pilot's Position, Aft Cockpit

30. The only change in the aft cockpit with the SNS modification was the addition of a five-switch control panel on the right console forward of the light control panel. The five switches control the power to the SNS system, preamp, sight azimuth and elevation units, line of sight stabilization and the laser. The switches were positioned forward for ON and were positive-position type switches (lift and move). The switches were clearly labeled and well lighted by surface lighting. An inoperative circuit was indicated by lighting the appropriate switch label. Some reduction in forward visibility was noted with the SNS installed but was not significant for the pilot in the aft seat.

Gunner's Position, Forward Cockpit

31. The SNS function switch, laser ON/OFF switch and light intensity rheostats were located in a single control unit which was positioned in the upper part of the radio section on the instrument panel. Lighting and function of the switches were satisfactory.

32. Entry and exit from the gunner's position with the SNS installed were difficult since the XM28 sighting station had to be lifted up near the top of the canopy. Removal and replacement of the sighting station from the stowage bracket were very difficult tasks and necessitated that the copilot/gunner assume an unnatural and very uncomfortable position in the seat in order to clear the sighting station over the right leg. Placing the sighting station on the stowage bracket was difficult due to interference between the sight grip and canopy and also due to binding at the support structure elbow. Moving the stowage bracket approximately ½ inch inboard would allow clearance between the canopy and the sight grip and would eliminate binding at the support structure elbow.

33. Movement of the sight head to the limit azimuth and elevation angles required more force with this installation than with the standard XM28 sighting station due to stiffness of the fiber optic rope. The sight head could be moved to the extremes in elevation

and azimuth, however, the force required was not considered objectionable. Holding the sight head up near the eye required considerable force and was tiring for a tall gunner due to the additional weight and stiffness of the fiber optic rope. Stronger counterbalancing springs and a longer optic rope should be incorporated to alleviate this problem.

34. The structural modification of the nose included the addition of a 1-inch square brace along both sides of the forward cockpit under the instrument panel. With the directional pedals adjusted full aft, it is possible to restrict the travel of the pedal by pinching the gunner's feet between the pedals and the braces. In the full aft pedal position, the clearance between either pedal at full travel and the brace is less than 1 inch. The adjustment range of the front directional pedals should be modified to limit the aft travel on all SNS modified aircraft to maintain a minimum clearance of at least 2 inches between the pedal and the structural brace.

CONCLUSIONS

35. The airworthiness and flight characteristics of the AH-1G helicopter with the stabilized night sight system installed are acceptable for further tests of the system's performance and operational capability (paras 19 and 20).

36. The operating stress loads in the main rotor and controls are not significantly increased by the SNS modification of the nose shape or mass distribution of the AH-1G (para 19).

37. The level flight performance of the AH-1G is not significantly reduced by the installation of the SNS system (para 28).

38. The published AH-1G flight envelope is satisfactory for SNS modified aircraft with one exception: the aircraft reactions to a sudden, total power loss (in both the SNS and standard nose configurations) are unacceptable in high-speed dives with an engine-torque setting greater than 35 PSI (paras 20 through 22).

39. Correction of the following deficiencies is mandatory:

a. Unreliable aircraft attitude instruments (para 25).

b. Excessive canopy reflections of cockpit and instrument lights (para 25).

c. Lack of a visual display to the pilot indicating the azimuth and elevation (relative to the aircraft) of the SNS line of sight (para 26).

d. Insufficient clearance between the directional control pedals and the SNS structural brace in the forward cockpit (para 34).

40. The following shortcomings were found which limit mission effectiveness:

a. Excessive force required to hold the sighting station at eye level (para 33).

b. Lack of adequate clearance between the sighting station and the canopy with the sighting station on the stowage bracket (para 32).

c. The excessive vertical six-per-revolution and lateral four-per-revolution vibrations (para 29).

RECOMMENDATIONS

41. Based on the information and data contained in this report, it is recommended that:

a. The permitted engine torque be limited to 35 PSI during dives at airspeeds greater than 150 KCAS (paras 21 and 22).

b. The cockpit torquemeters be marked with a yellow cautionary mark at 35 PSI (paras 21 and 22).

c. The operating envelope of the standard AH-1G, as contained in the operator's manual (TM55-1520-221-10) be applied to the SNS modified aircraft with the additional limitation of paragraph 41a (paras 35, 36 and 38).

42. It is further recommended that the following corrective actions be taken prior to operational tests of the system performance and capability in instrument flight conditions or in a combat zone:

a. Install reliable aircraft attitude instruments (para 25).

b. Reduce canopy reflections of cockpit and instrument lights (para 25).

c. Provide a visual display in the aft cockpit to indicate the azimuth and elevation (relative to the aircraft) of the SNS line of sight (para 26).

d. Modify the adjustment range of the directional pedals in the forward cockpit to limit the aft travel so a minimum clearance between the pedal and the SNS structural brace is at least 2 inches (para 34).

43. It is recommended that the following corrective actions be taken to improve mission effectiveness:

a. Install stiffer counter-balancing springs on the XM28/SNS sighting station (para 33).

b. Move the XM28/SNS sighting station stowage bracket ½ inch inboard (para 32).

c. Reduce the vertical six-per-revolution vibration (para 29).

APPENDIX I. REFERENCES

1. Test Plan, USAASTA, Project No. 69-01, *Airworthiness and Flight Characteristics, AH-1G Helicopter, Stabilized Night Sight (SNS)*, November 1969.

2. Final Report, USAASTA, Project No. 69-01, *Airworthiness and Flight Characteristics, AH-1G Helicopter with Stabilized Night Sight (SNS), Phase I*, November 1969.

3. Final Report, USAASTA, Project No. 66-06C, *Stability and Control Tests of the AH-1G, Phase D*, to be published.

4. Report, Bell Helicopter Company, 209-099-041, *Model AH-1G, Non-firing Load Level Survey*, June 1967.

5. Letter, USAASTA, SAVTE-C(TEA), AMSAV-R-F, subject: Airworthiness and Flight Characteristics of AH-1G with Stabilized Night Sight Installed, 14 November 1969.

6. Final Report, USAASTA, Project No. 66-06C, *Performance Test of the AH-1G Helicopter, Phase D*, to be published.

APPENDIX II.
TEST INSTRUMENTATION

1. All instrumentation was installed and maintained by USAASTA personnel with the exception of the strain gages on the rotor blade, drag brace and pitch link. These gages were installed by BHC personnel.

2. A high-speed, fixed-type pitot-static probe and an angle-of-attack and angle-of-sideslip head were installed on a test boom mounted on the right side of the aircraft extending forward of the nose.

3. Instrumentation was installed to monitor the following parameters:

a. <u>Pilot's Panel</u>

Longitudinal cyclic control position
Lateral cyclic control position
Collective pitch control position
Directional control position
Airspeed (boom system)
Altitude (boom system)
Rotor speed
Angle of attack
Angle of sideslip
Gas producer speed (N_1)
Engine rpm (N_2)
Exhaust gas temperature
CG normal acceleration
Rate of climb

b. <u>Engineer's Panel</u>

Torque
Rotor speed
Airspeed (modified standard system)
Altitude (modified standard system)
Gas producer speed (N_1)
Outside air temperature
Exhaust gas temperature
Fuel used
Oscillograph record number

c. <u>Oscillograph</u>

Longitudinal cyclic control position
SCAS longitudinal position
Pitch angle
Pitch rate
Lateral cyclic control position
SCAS lateral position
Roll angle
Roll rate
Directional control position
SCAS pedal position
Yaw angle
Yaw rate
Angle of sideslip
Angle of attack
Collective pitch control position
Throttle position
CG normal acceleration
Rotor speed (linear)
Rotor blip
Pilot's event
Engineer's event
Tail rotor torque
Tail rotor blade angle
Horizontal stabilizer position
Lateral vibration at copilot's station
(FS 79, water line (WL) 52, butt line (BL) 10 right)
Vertical vibration at copilot's station
(FS 79, WL 52, BL 10 right)

d. <u>Oscillograph Strain Parameters on Structural Members</u>

Control link/tube, BHC P/N 209-030-124-1
Control link/tube, BHC P/N 209-030-124-3
Control link/tube, BHC P/N 209-030-124-5
Horizontal stabilizer (chordwise bending)
Horizontal stabilizer (beamwise bending)
Horizontal stabilizer (torsional bending)
Main rotor drag brace
Main rotor pitch link
Main rotor blade (beamwise bending at blade stations
46, 60, 85, 110 and 135)
Main rotor blade (chordwise bending at blade stations
60, 85, 110, and 135)

APPENDIX III. TEST DATA

Subject	Figure Number
Loads in 1.0g flight	1 through 12
Loads in symmetrical pullouts	13 through 48
Static stability	49 through 53
Level flight performance	54 through 60
Airspeed calibration	61 through 62

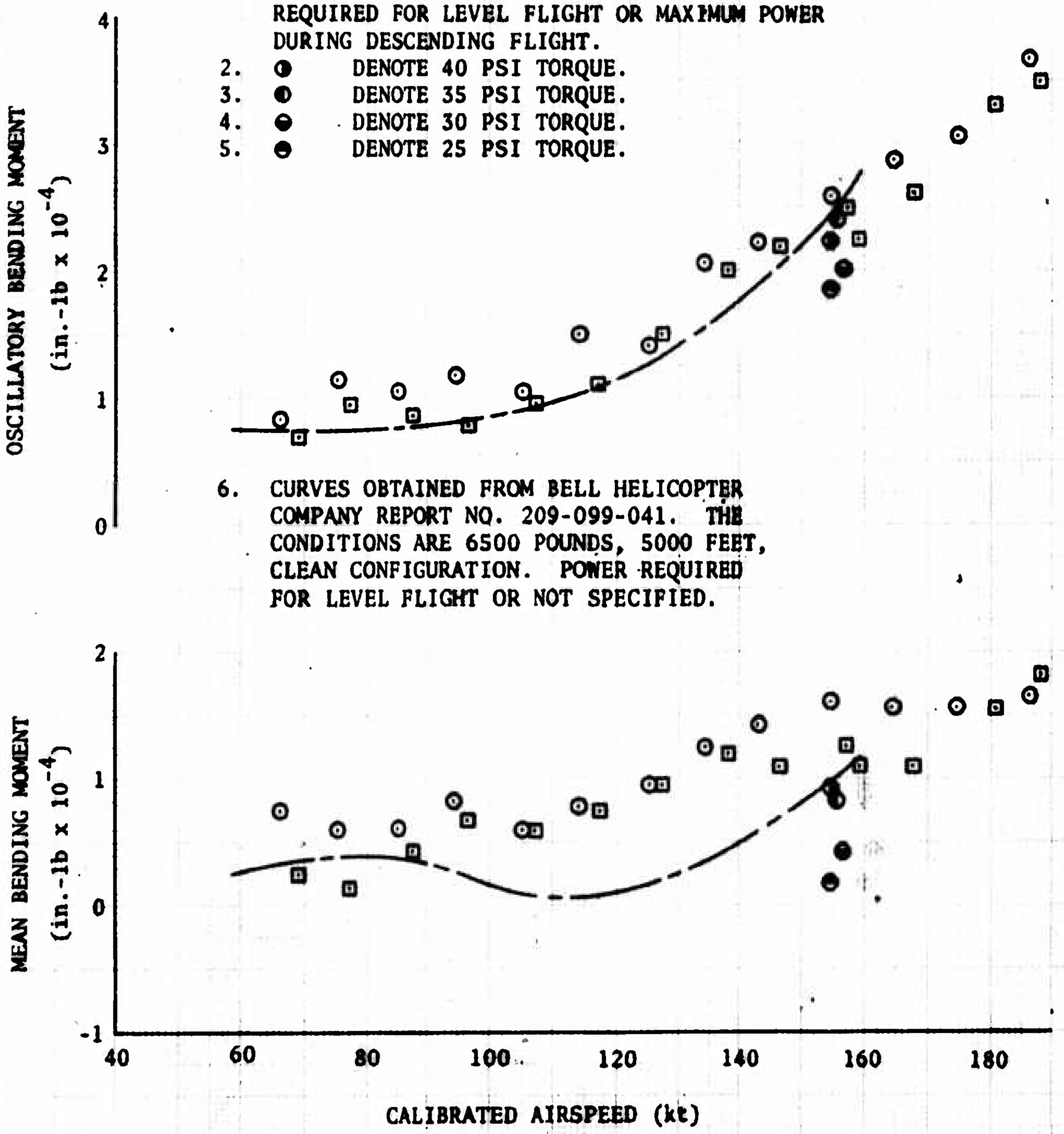
Subject	Table Number
Loads in maneuvering flight	A through C

FIGURE 1
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 46 FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	7520	195.6	324	CLEAN, STD NOSE
□	5000	7520	195.6	324	CLEAN, SNS

NOTES:

1. OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.
2. ◑ DENOTE 40 PSI TORQUE.
3. ◐ DENOTE 35 PSI TORQUE.
4. ⊖ DENOTE 30 PSI TORQUE.
5. ● DENOTE 25 PSI TORQUE.

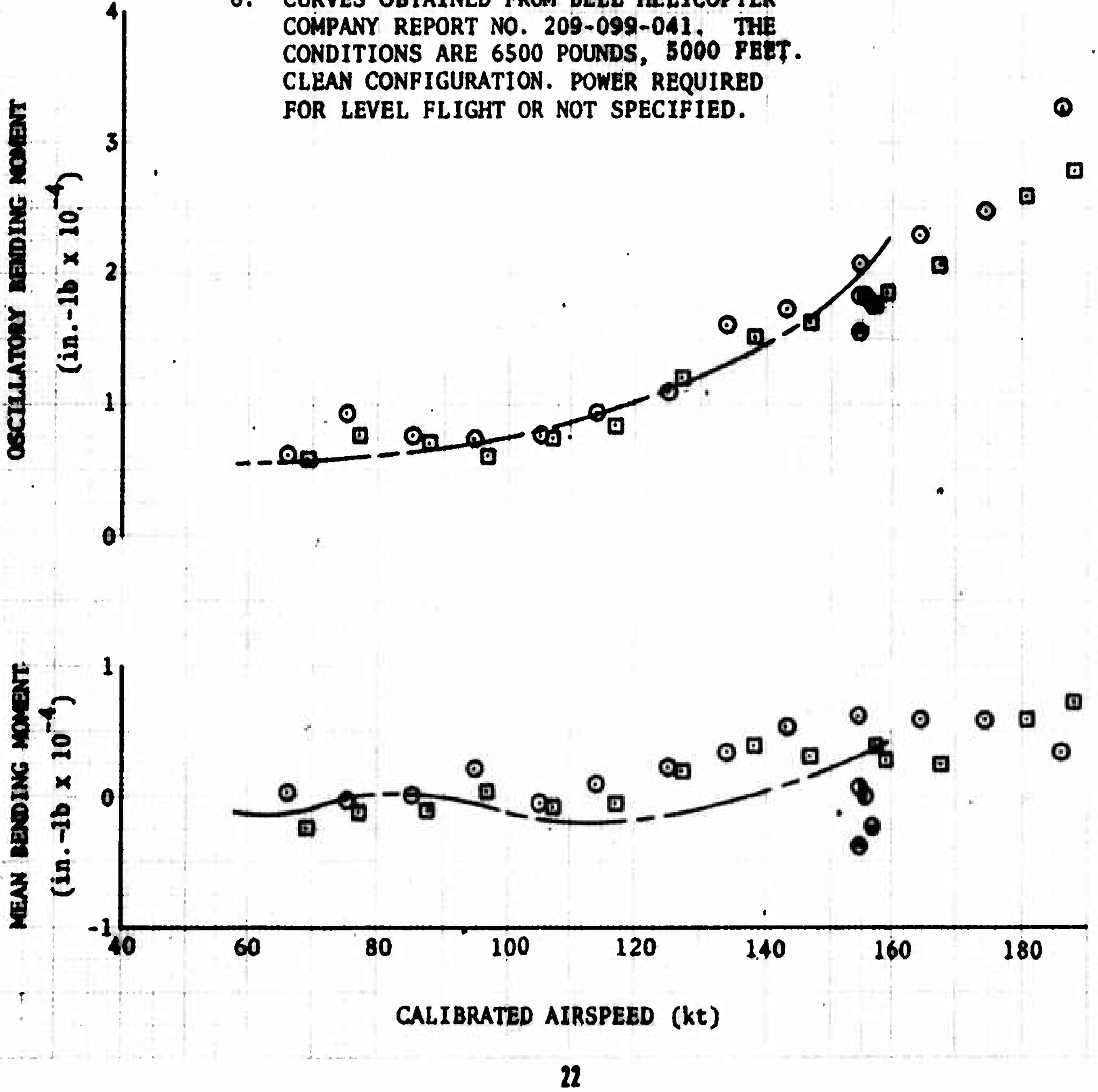


6. CURVES OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041. THE CONDITIONS ARE 6500 POUNDS, 5000 FEET, CLEAN CONFIGURATION. POWER REQUIRED FOR LEVEL FLIGHT OR NOT SPECIFIED.

FIGURE 2
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 60 FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	7520	195.6	324	CLEAN, STD NOSE
□	5000	7520	195.6	324	CLEAN, SNS

NOTES:
1. OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.
2. ◑ DENOTE 40 PSI TORQUE.
3. ◐ DENOTE 35 PSI TORQUE.
4. ◒ DENOTE 30 PSI TORQUE.
5. ● DENOTE 25 PSI TORQUE.
6. CURVES OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041. THE CONDITIONS ARE 6500 POUNDS, 5000 FEET. CLEAN CONFIGURATION. POWER REQUIRED FOR LEVEL FLIGHT OR NOT SPECIFIED.



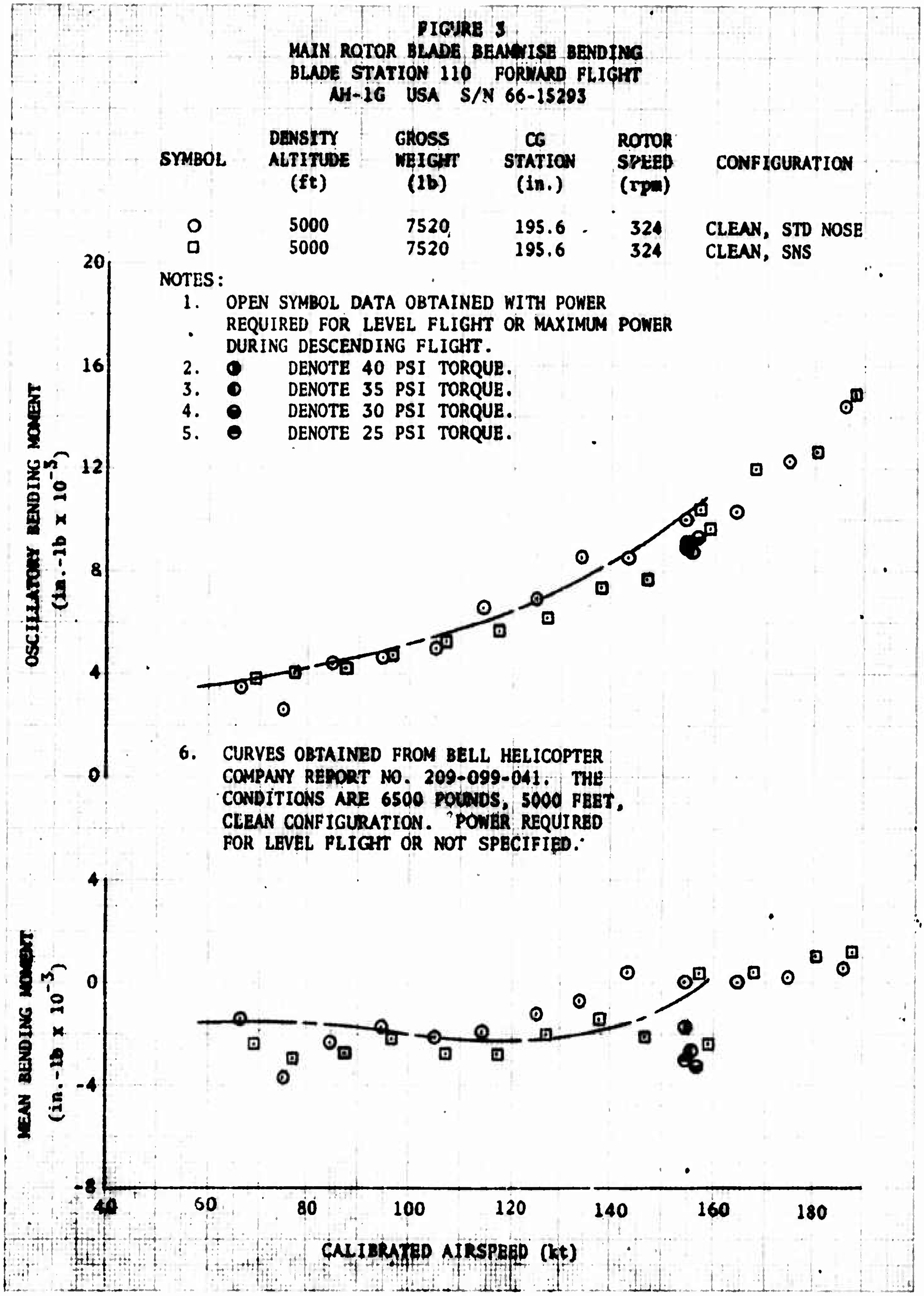
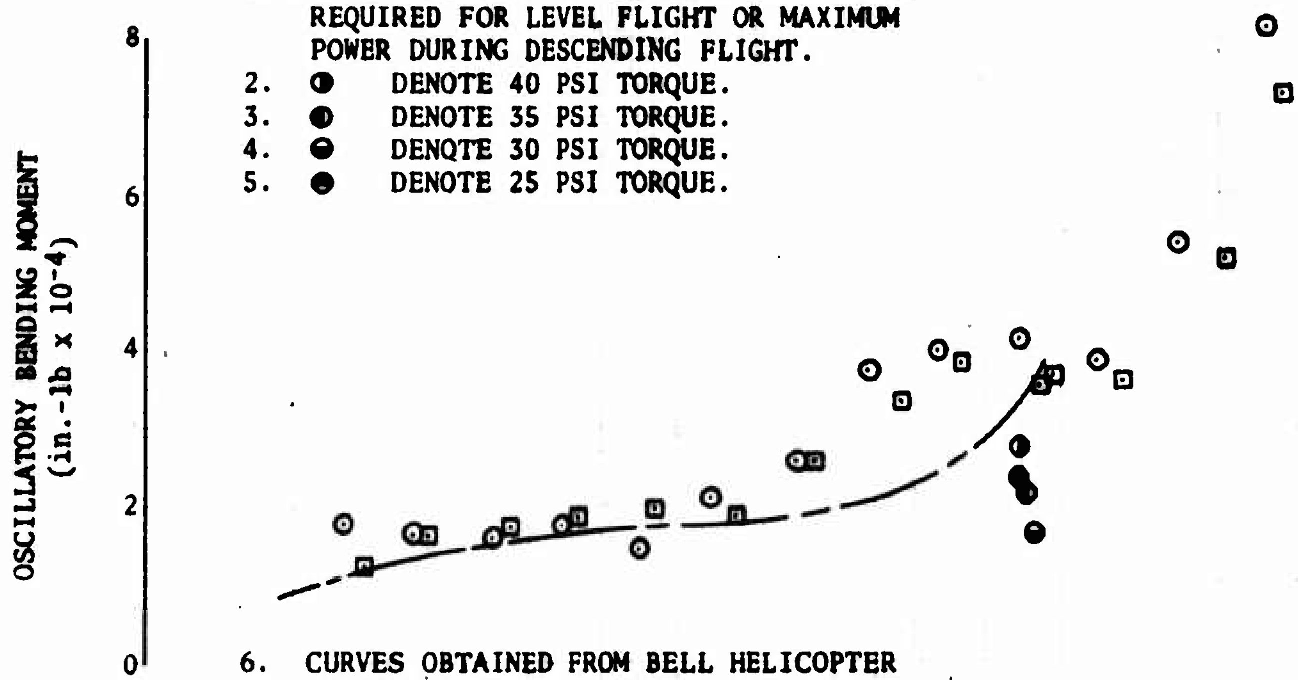


FIGURE 3
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 110 FORWARD FLIGHT
AH-1G USA S/N 66-15293

FIGURE 4
MAIN ROTOR BLADE CHORDWISE BENDING
BLADE STATION 135 FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
O	5000	7520	195.6	324	CLEAN, STD NOSE
□	5000	7520	195.6	324	CLEAN, SNS

NOTES:
1. OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.
2. ◑ DENOTE 40 PSI TORQUE.
3. ◐ DENOTE 35 PSI TORQUE.
4. ◒ DENOTE 30 PSI TORQUE.
5. ● DENOTE 25 PSI TORQUE.



6. CURVES OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041. THE CONDITIONS ARE 6500 POUNDS, 5000 FEET, CLEAN CONFIGURATION. POWER REQUIRED FOR LEVEL FLIGHT OR NOT SPECIFIED.

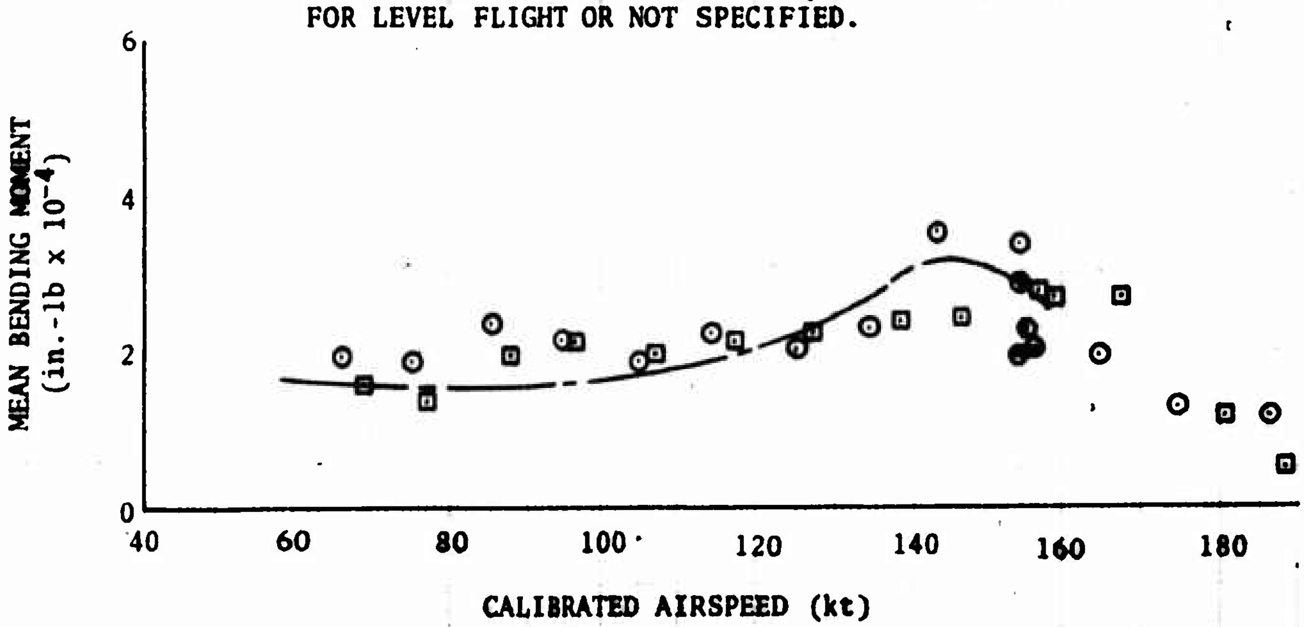


FIGURE 5
DRAG BRACE AXIAL LOAD
FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	7520	195.6	324	CLEAN, STD NOSE
□	5000	7520	195.6	324	CLEAN, SNS

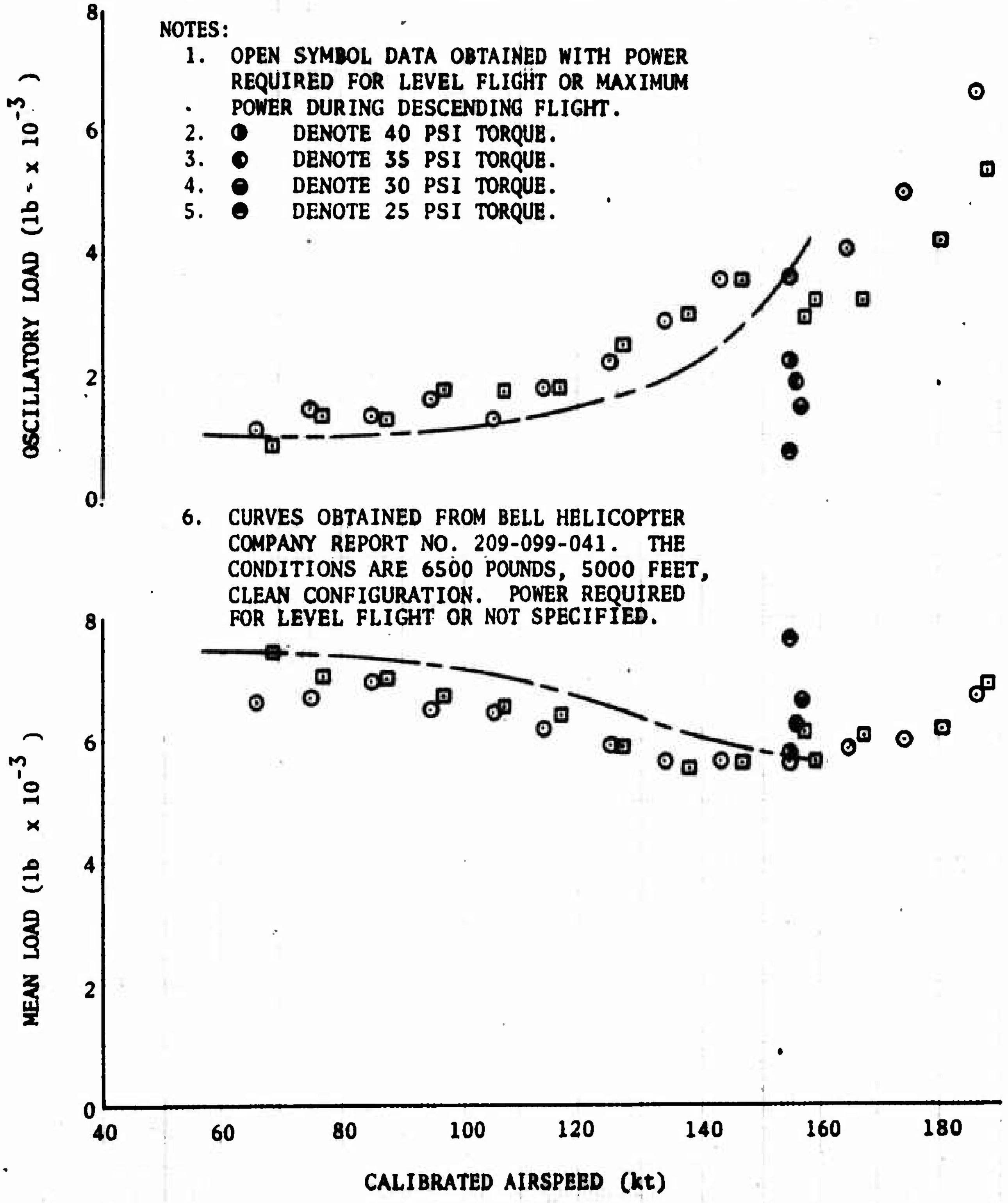


FIGURE 6
LATERAL BOOST TUBE AXIAL LOADS
FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	7520	195.6	324	CLEAN, STD NOSE
□	5000	7520	195.6	324	CLEAN, SNS

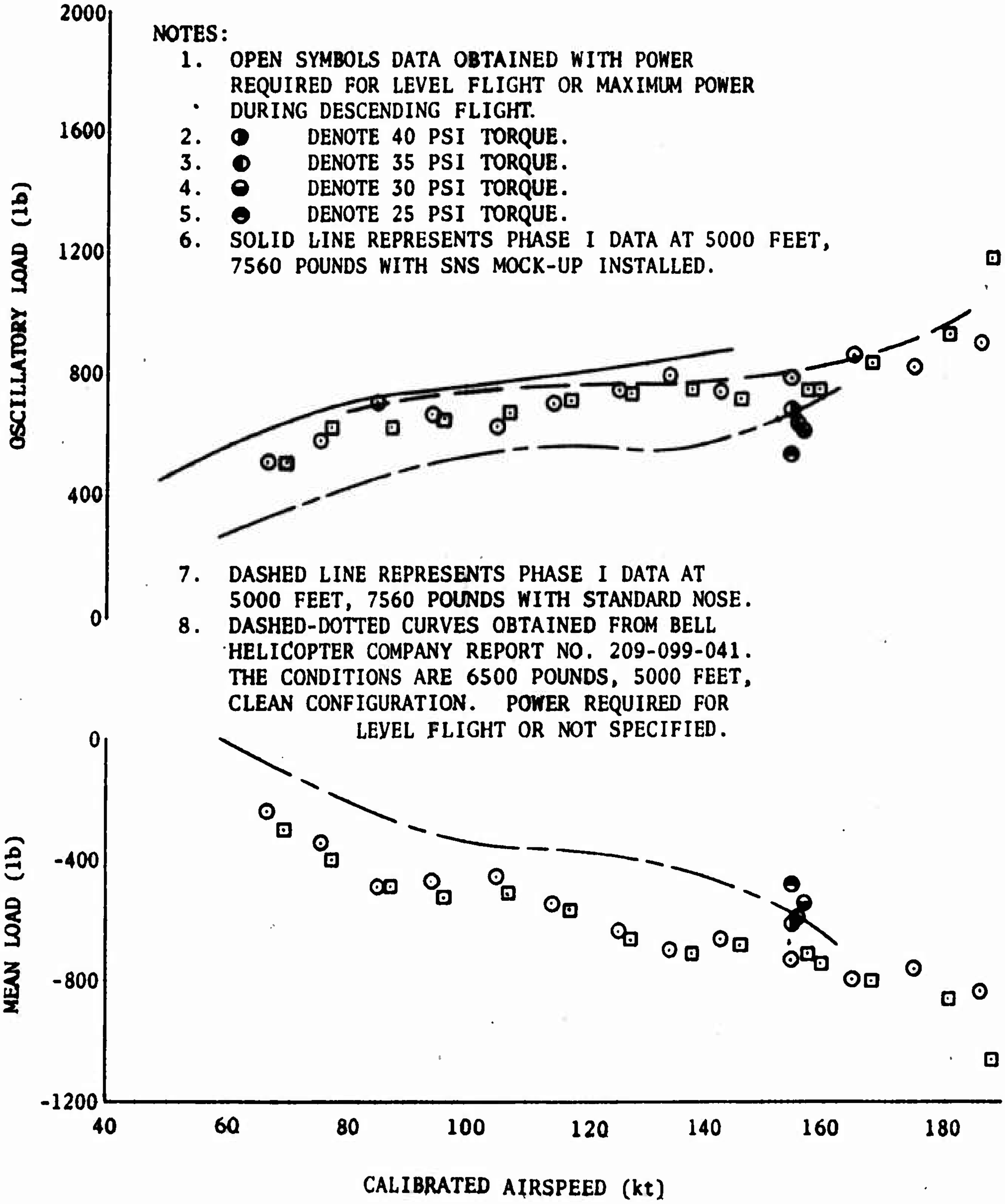


FIGURE 7
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 46 FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
O	5000	9240	195.4	324	HEAVY SCOUT, STD NOSE
□	5000	9240	195.4	324	HEAVY SCOUT, SNS

NOTES:

1. OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.
2. CURVES OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041. THE CONDITIONS ARE 5000 FEET, 9500 POUNDS, HOG CONFIGURATION. POWER REQUIRED FOR LEVEL FLIGHT OR NOT SPECIFIED.

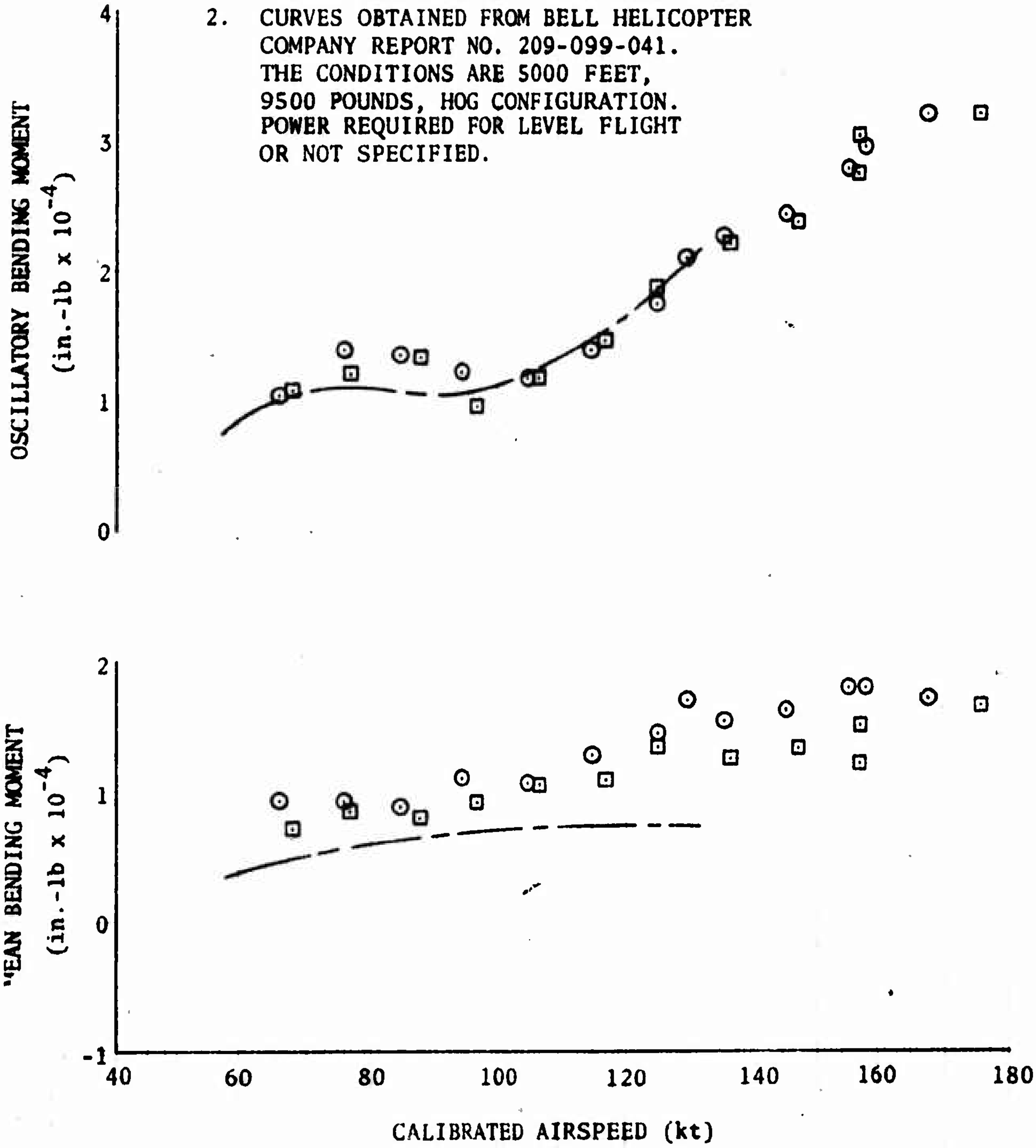


FIGURE 8
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 60 FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	9240	195.4	324	HEAVY SCOUT, STD NOSE
□	5000	9240	195.4	324	HEAVY SCOUT, SNS

NOTES:
1. OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.
2. CURVES OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041. THE CONDITIONS ARE 5000 FEET, 9500 POUNDS, HOG CONFIGURATION. POWER REQUIRED FOR LEVEL FLIGHT OR NOT SPECIFIED.

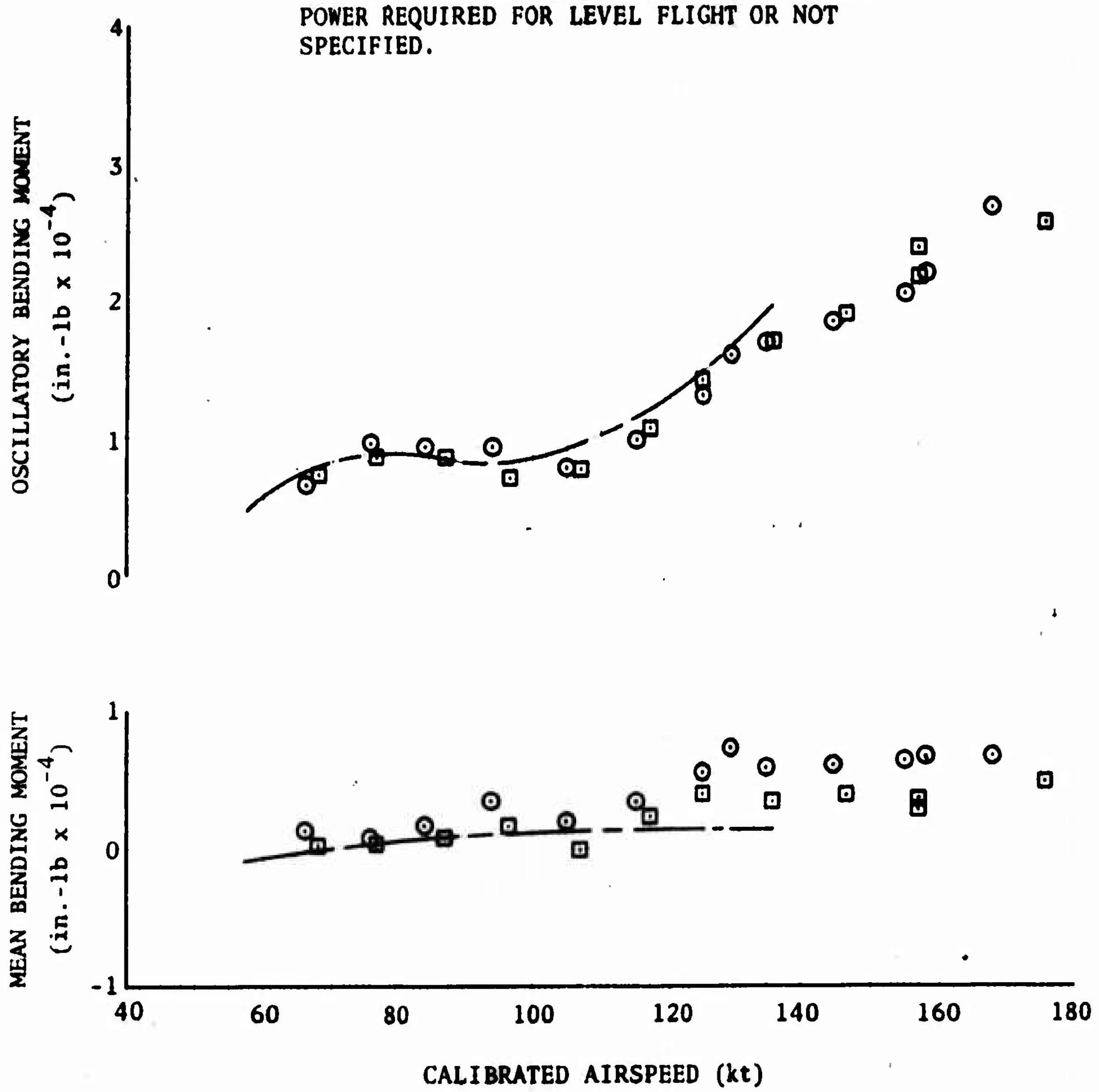


FIGURE 9
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 110 FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	9240	195.4	324	HVY SCOUT, STD NOSE
□	5000	9240	195.4	324	HVY SCOUT, SNS

NOTE: OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.

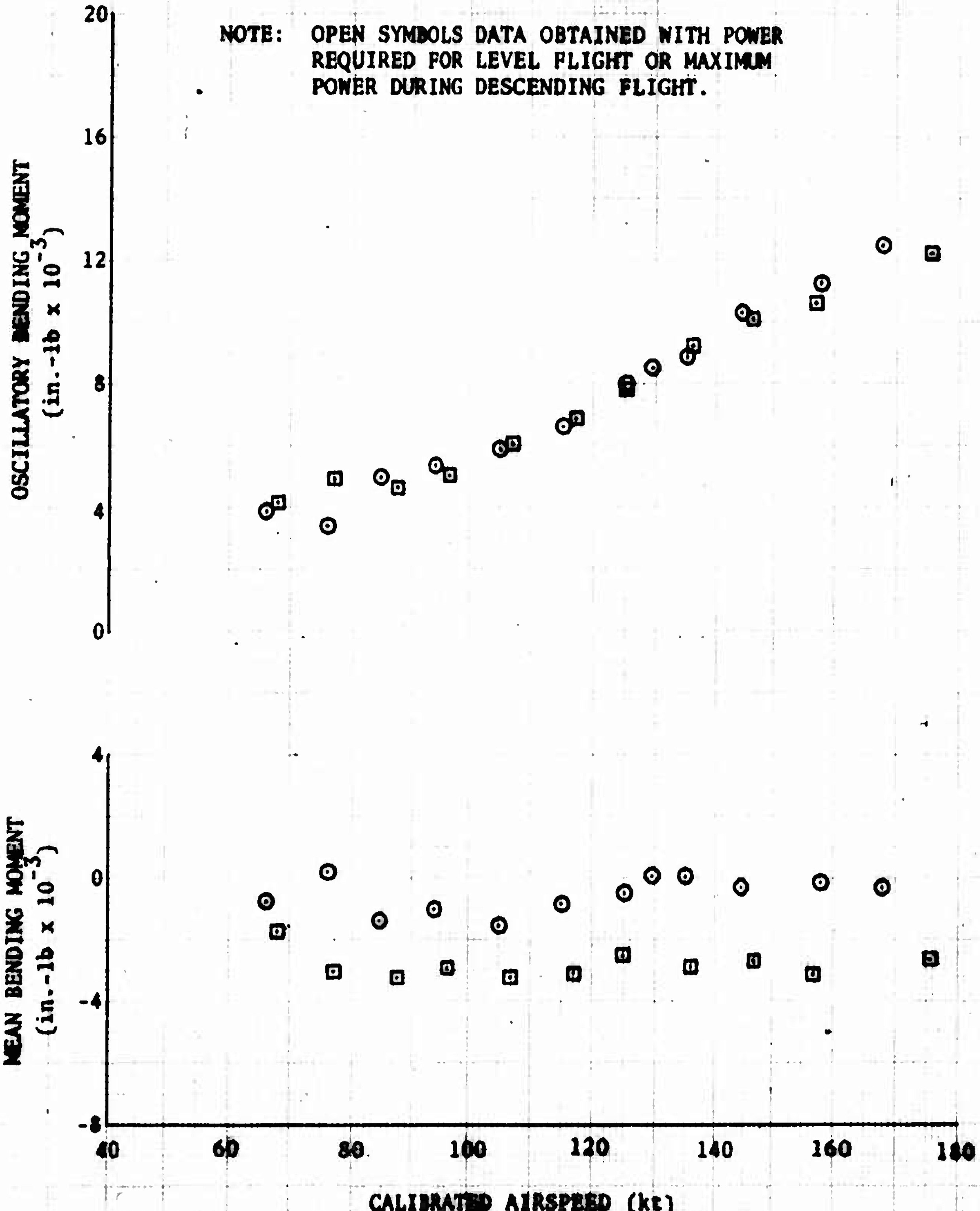


FIGURE 10
MAIN ROTOR BLADE CHORDWISE BENDING
BLADE STATION 135 FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	9240	195.4	324	HEAVY SCOUT, STD NOSE
□	5000	9240	195.4	324	HEAVY SCOUT, SNS

NOTES:
1. OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.
2. CURVES OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041. THE CONDITIONS ARE 5000 FEET, 9500 POUNDS, HOG CONFIGURATION. POWER REQUIRED FOR LEVEL FLIGHT OR NOT SPECIFIED.

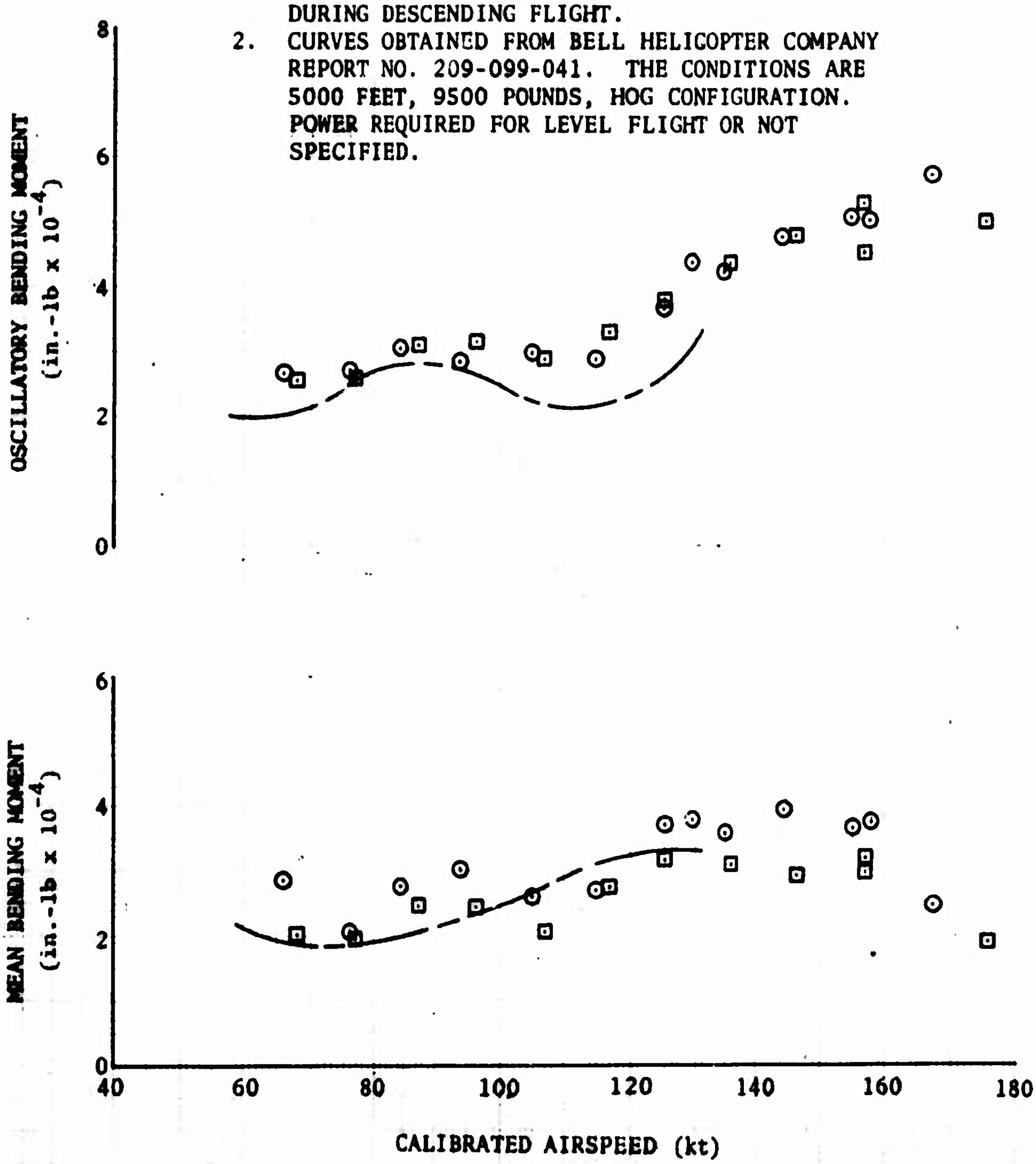


FIGURE 11
DRAG BRACE AXIAL LOAD
FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	9240	195.4	324	HEAVY SCOUT, STD NOSE
□	5000	9240	195.4	324	HEAVY SCOUT, SNS

NOTES:
1. OPEN SYMBOLS DATA OBTAINED WITH POWER REQUIRED FOR LEVEL FLIGHT OR MAXIMUM POWER DURING DESCENDING FLIGHT.
2. CURVES OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041. THE CONDITIONS ARE 5000 FEET, 9500 POUNDS, HOG CONFIGURATION. POWER REQUIRED FOR LEVEL FLIGHT OR NOT SPECIFIED.

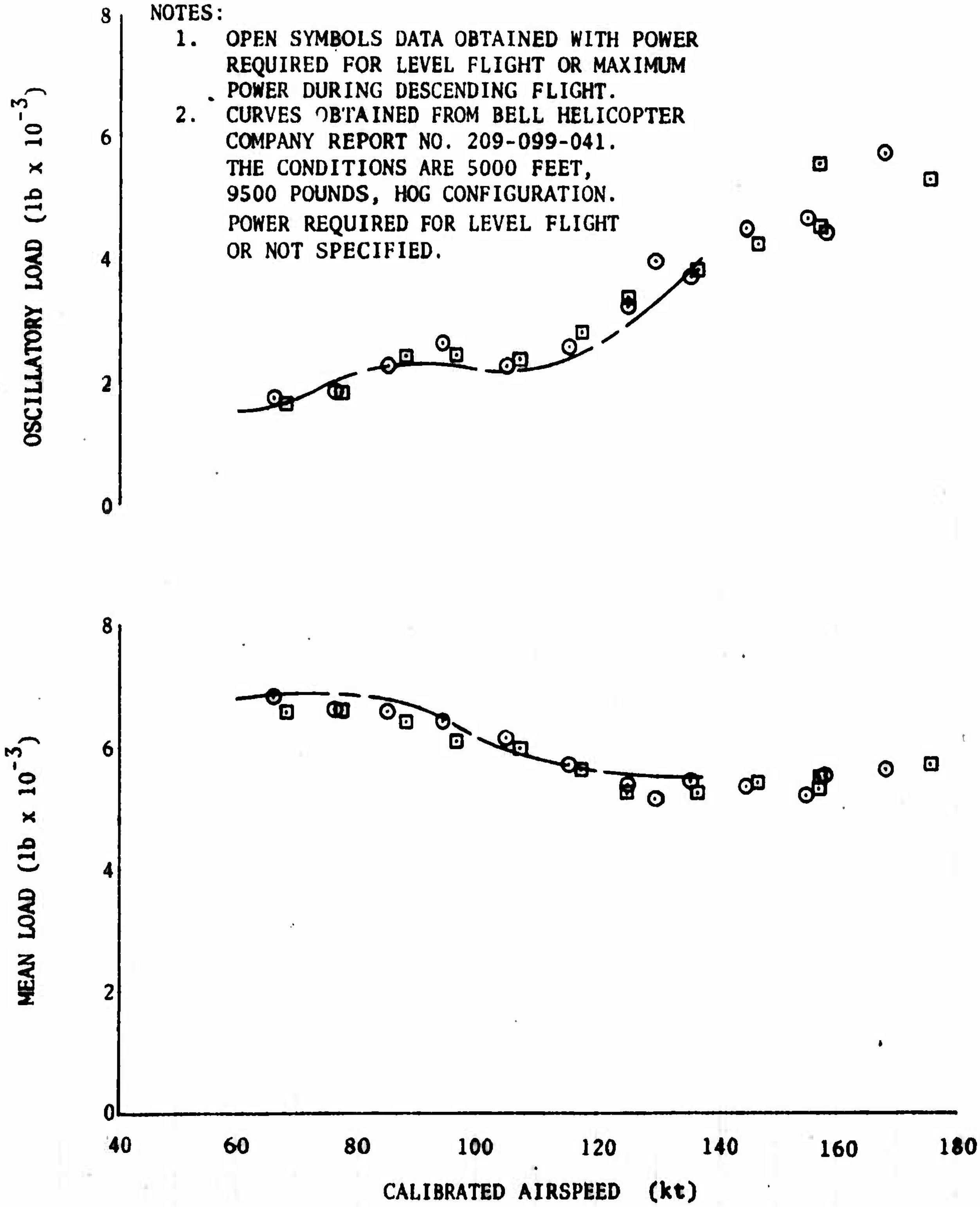


FIGURE 12
LATERAL BOOST TUBE AXIAL LOADS
FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	9240	195.4	324	HEAVY SCOUT, STD NOSE
□	5000	9240	195.4	324	HEAVY SCOUT, SNS

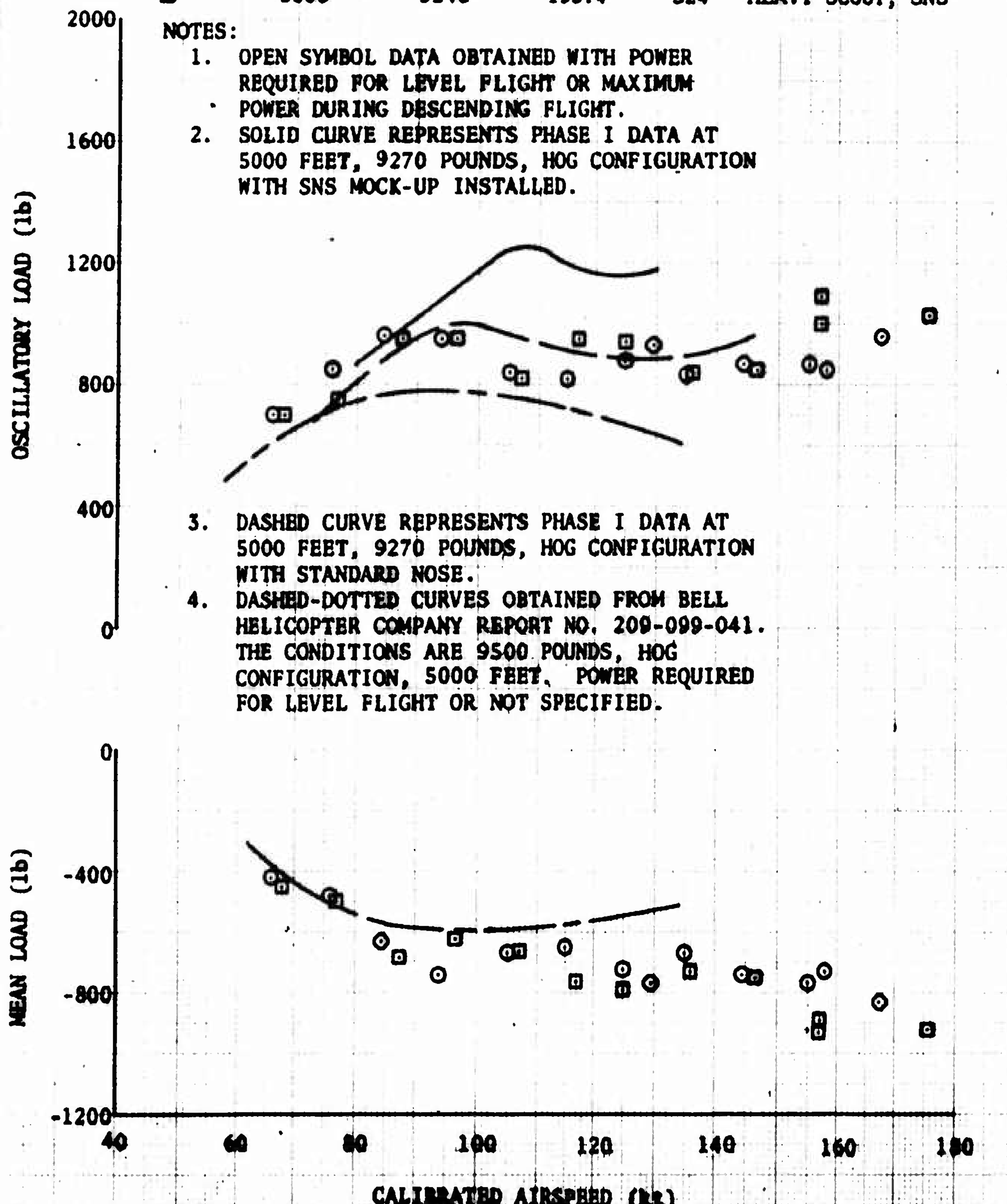


FIGURE 13
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 46 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
O	5000	7520	195.6	324	126	CLEAN, STD NOSE
□	5000	7520	195.6	324	127	CLEAN, SNS

NOTES:

1. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 1 AT 126.5 KCAS.

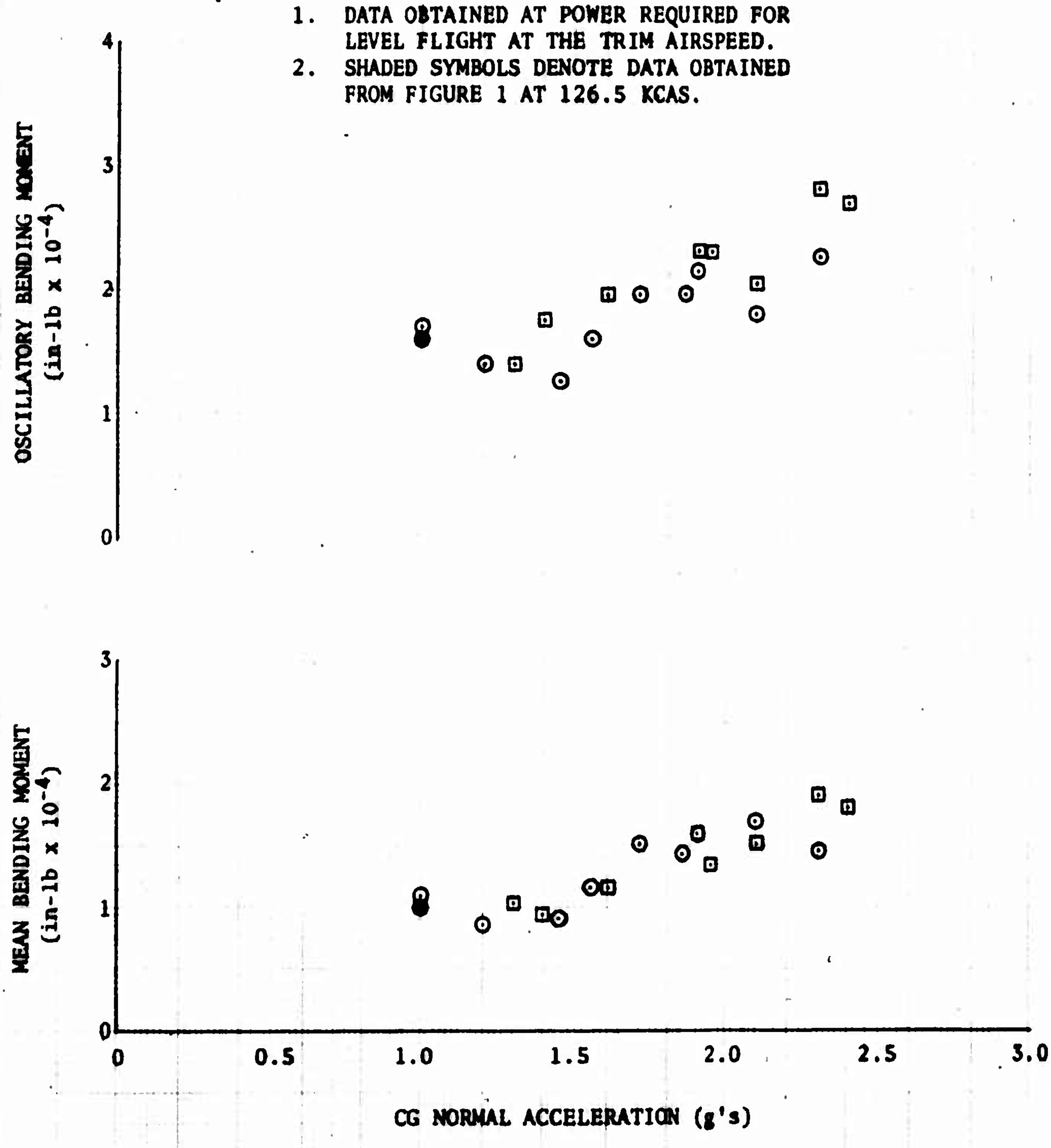


FIGURE 14
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 60 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	7520	195.6	324	126	CLEAN, STD NOSE
□	5000	7520	195.6	324	127	CLEAN, SNS

NOTES:

1. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 2 AT 126.5 KCAS.

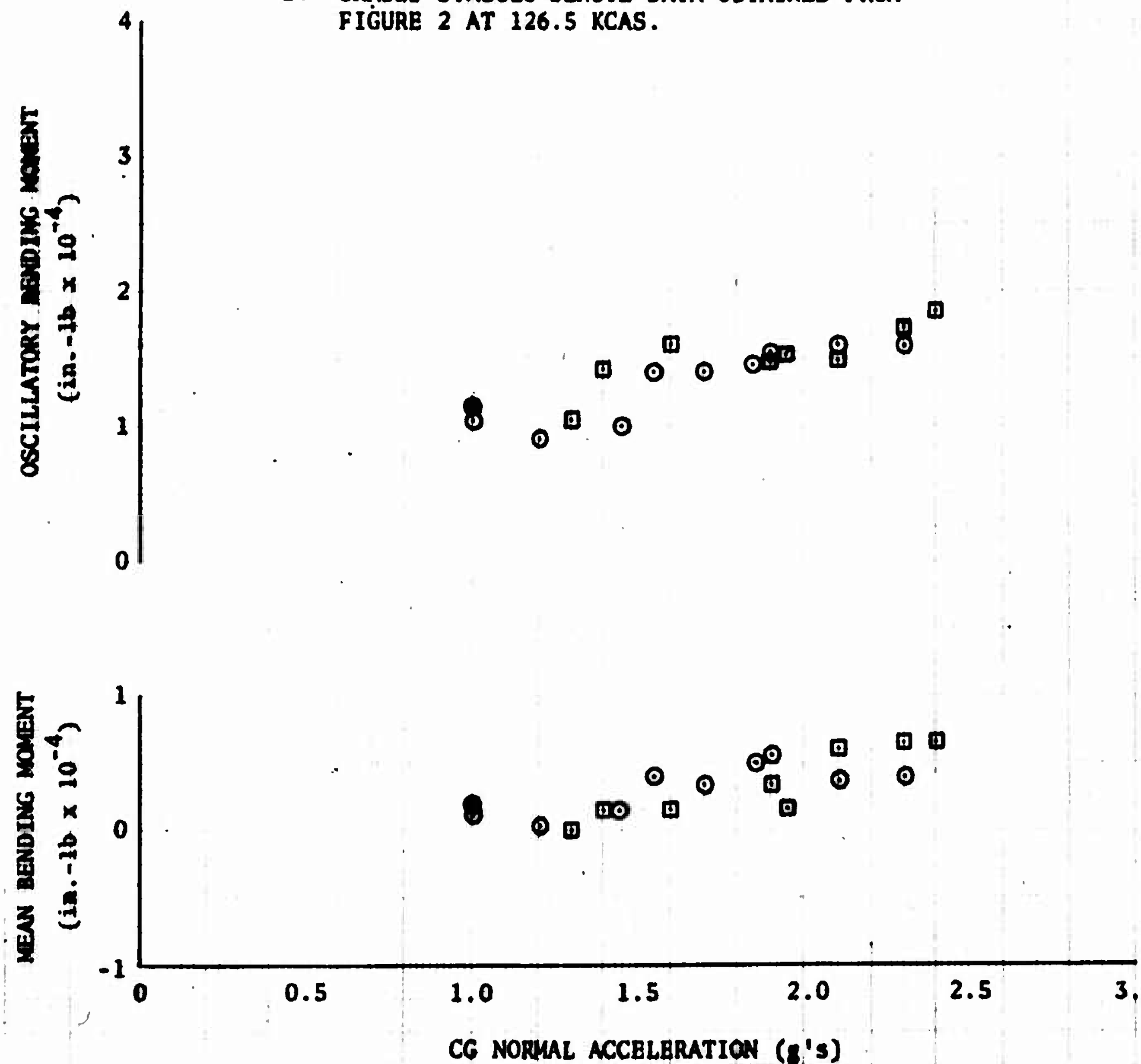


FIGURE 15
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 110 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	7520	195.6	324	126	CLEAN, STD NOSE
□	5000	7520	195.6	324	127	CLEAN, SNS

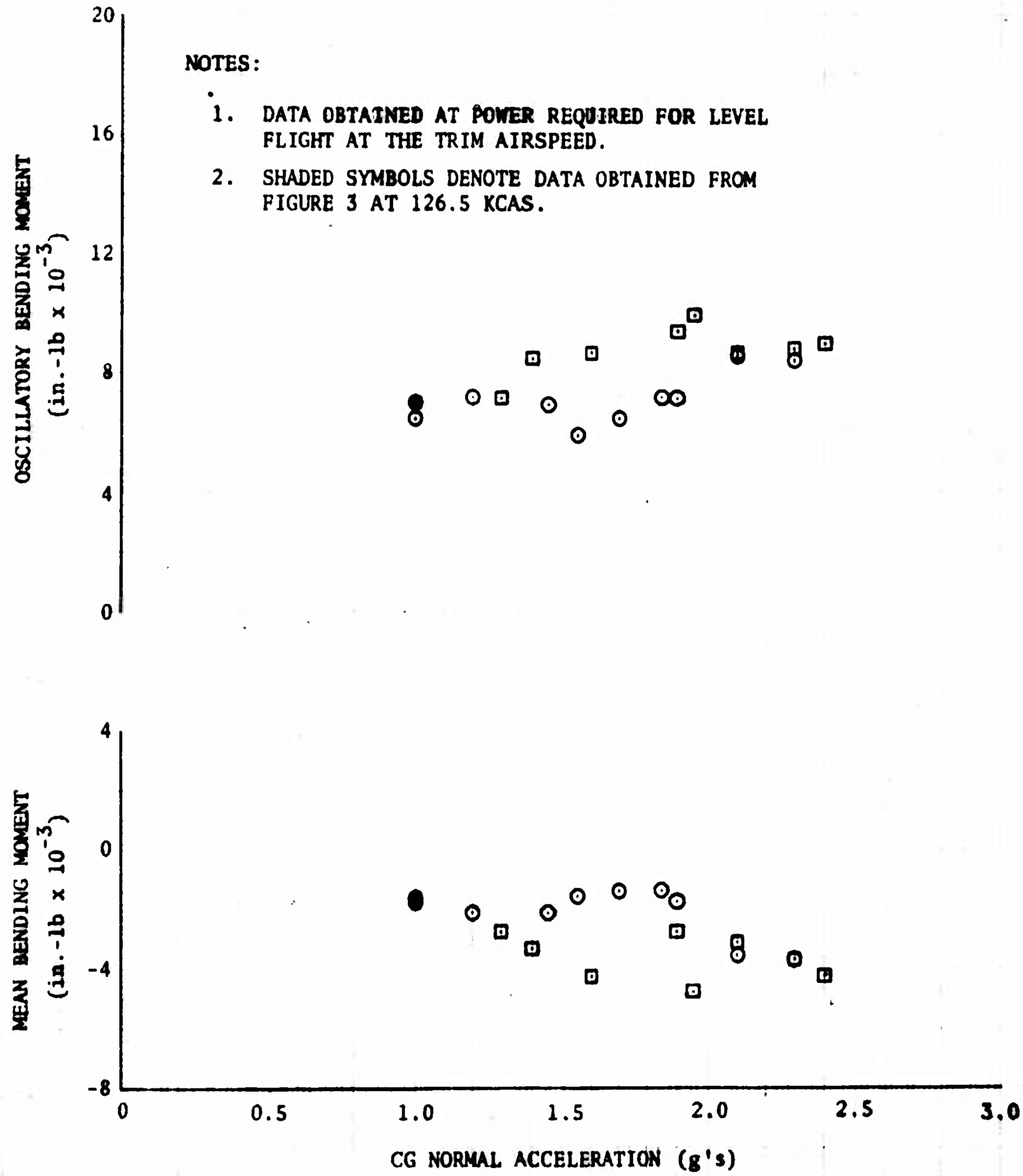


FIGURE 16

MAIN ROTOR BLADE CHORDWISE BENDING
BLADE STATION 135 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
O	5000	7520	195.6	324	126	CLEAN, STD NOSE
□	5000	7520	195.6	324	127	CLEAN, SNS

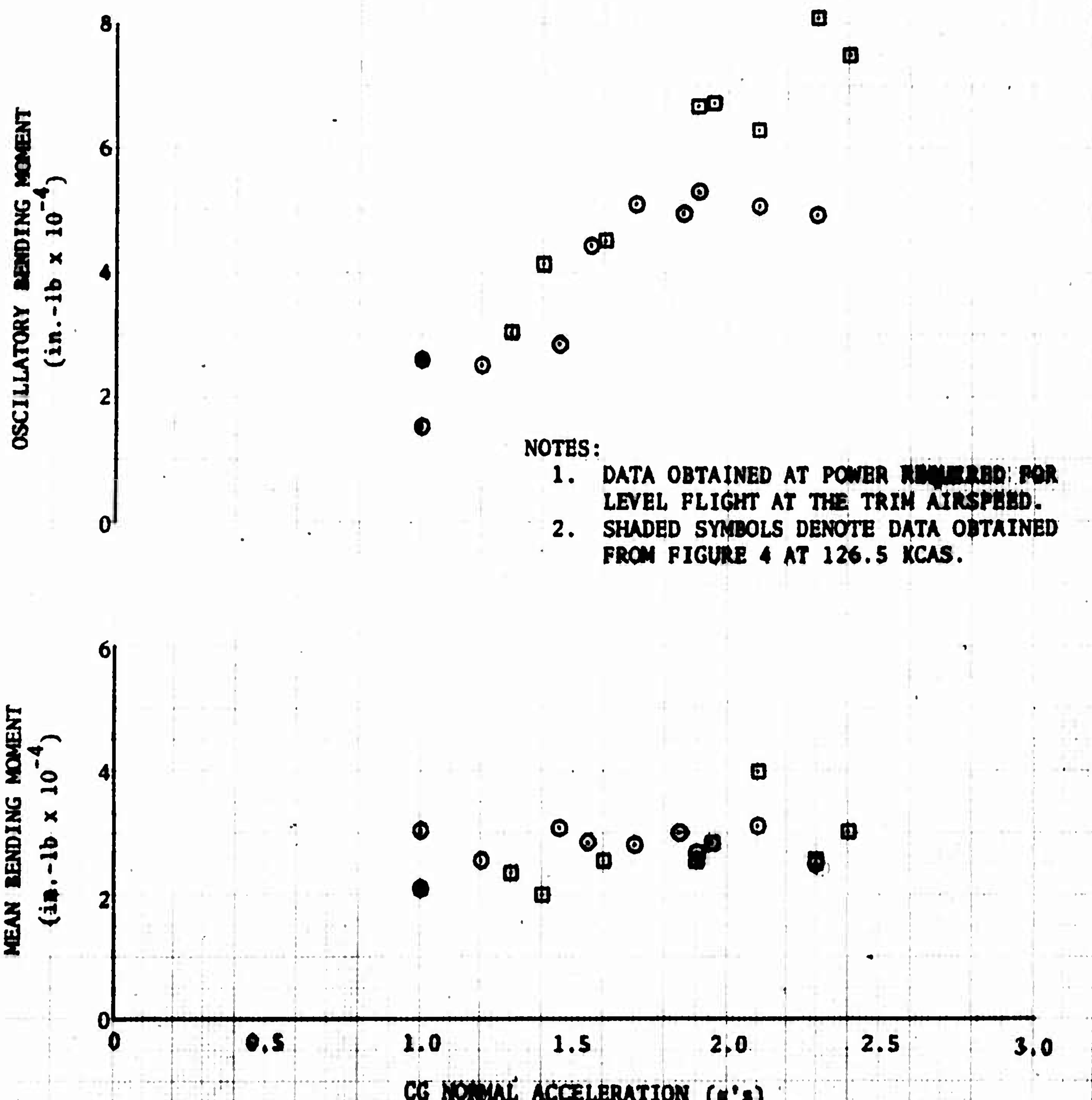


FIGURE 17
DRAG BRACE AXIAL LOAD
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	7520	195.6	324	126	CLEAN, STD NOSE
□	5000	7520	195.6	324	127	CLEAN, SNS

NOTES:

1. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 5 AT 126.5 KCAS.

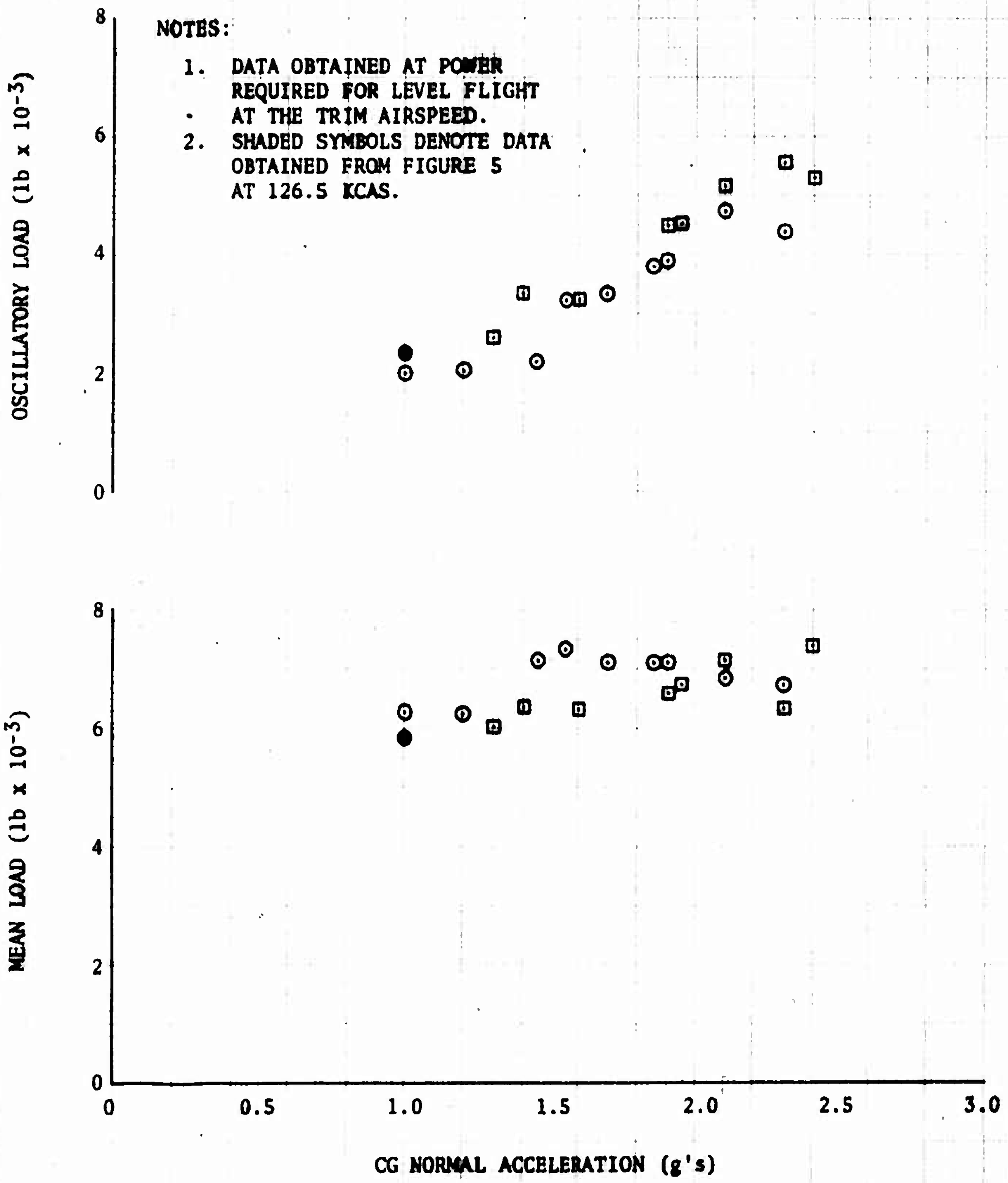


FIGURE 18
LATERAL BOOST TUBE AXIAL LOADS
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	7520	195.6	324	126	CLEAN, STD NOSE
◻	5000	7520	195.6	324	127	CLEAN, SNS

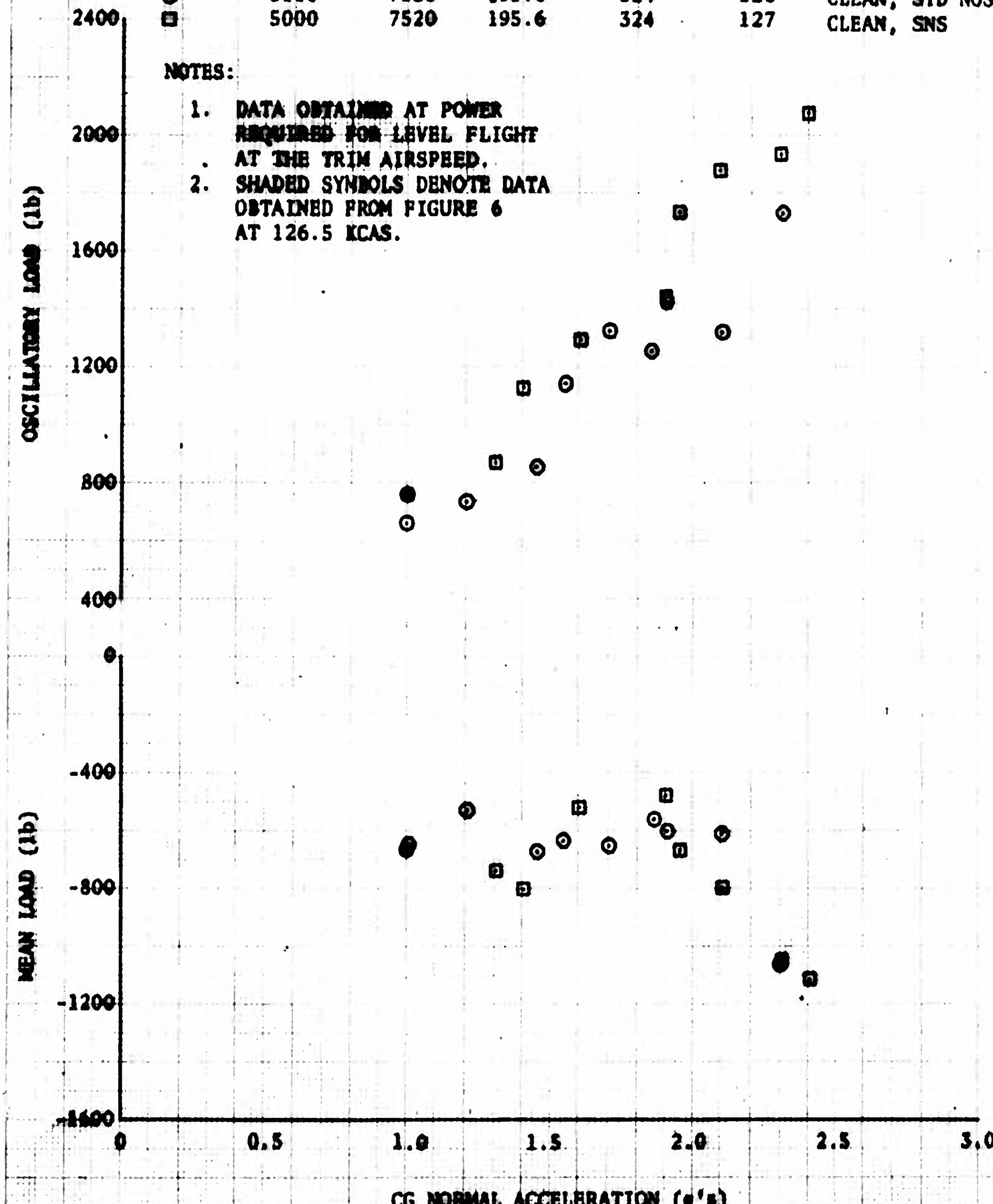


FIGURE 19
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 46 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	9240	195.4	324	125	HVY SCOUT,STD NOSE
□	5000	9240	195.4	324	127	HVY SCOUT, SNS

NOTES: 1. SOLID LINE REPRESENTS DATUM OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 5000 FEET, 9500 POUNDS, HOG CONFIGURATION, AND AIRSPEED DURING PULL-OUT OF 122.5 KCAS. NORMAL ACCELERATION VALUE UNKNOWN. POWER UNKNOWN.

2. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.

3. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 7 AT 126.5 KCAS.

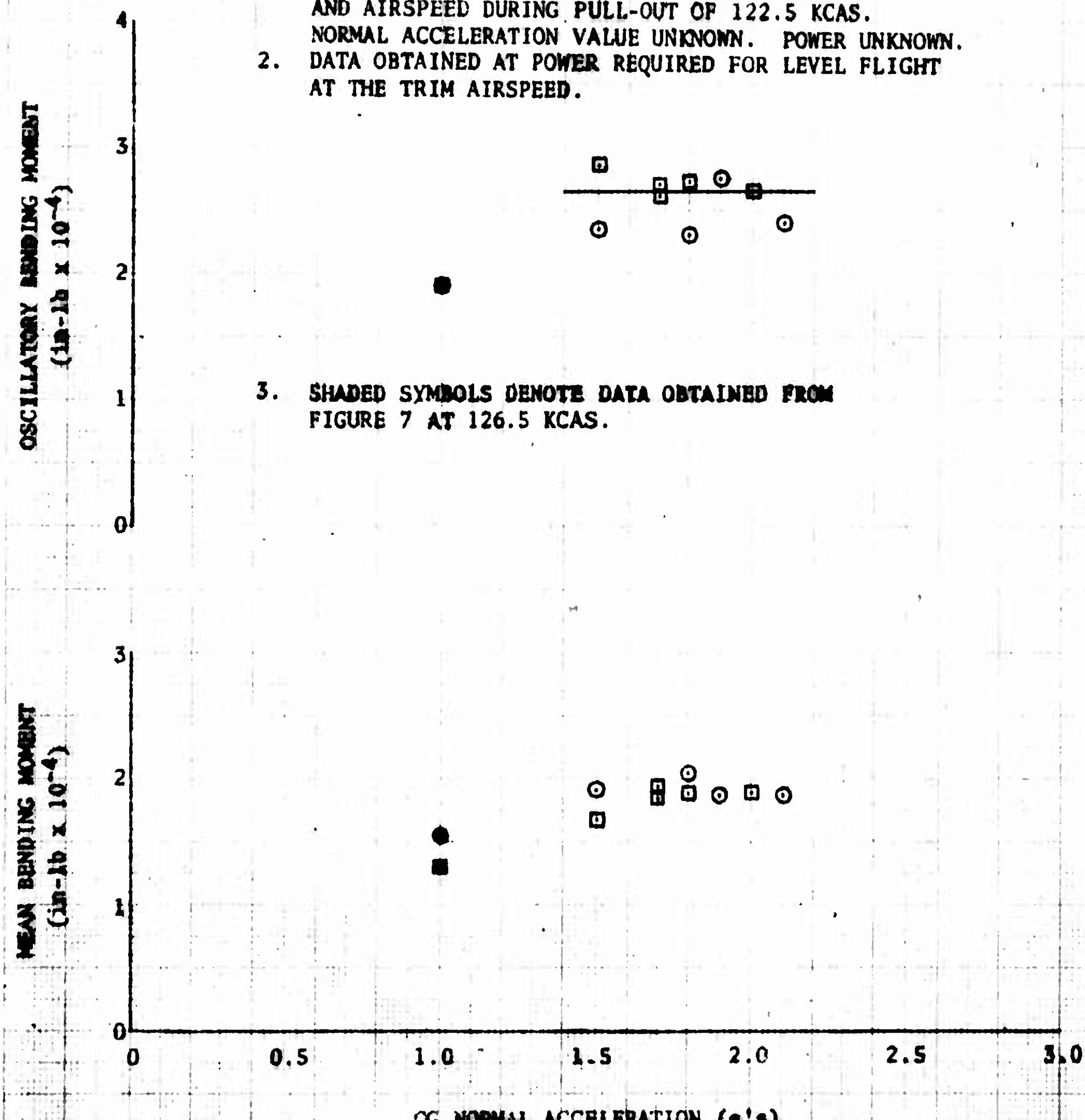


FIGURE 20
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 60 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	9240	195.4	324	125	HVY SCOUT, STD NOSE
□	5000	9240	195.4	324	127	HVY SCOUT, SNS

NOTES: 1. SOLID LINE REPRESENTS DATUM OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 5000 FEET, 9500 POUNDS, HOG CONFIGURATION, AND AIRSPEED DURING PULL-OUT OF 122.5 KCAS. NORMAL ACCELERATION VALUE UNKNOWN. POWER UNKNOWN.

2. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.

3. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 8 AT 126.5 KCAS.

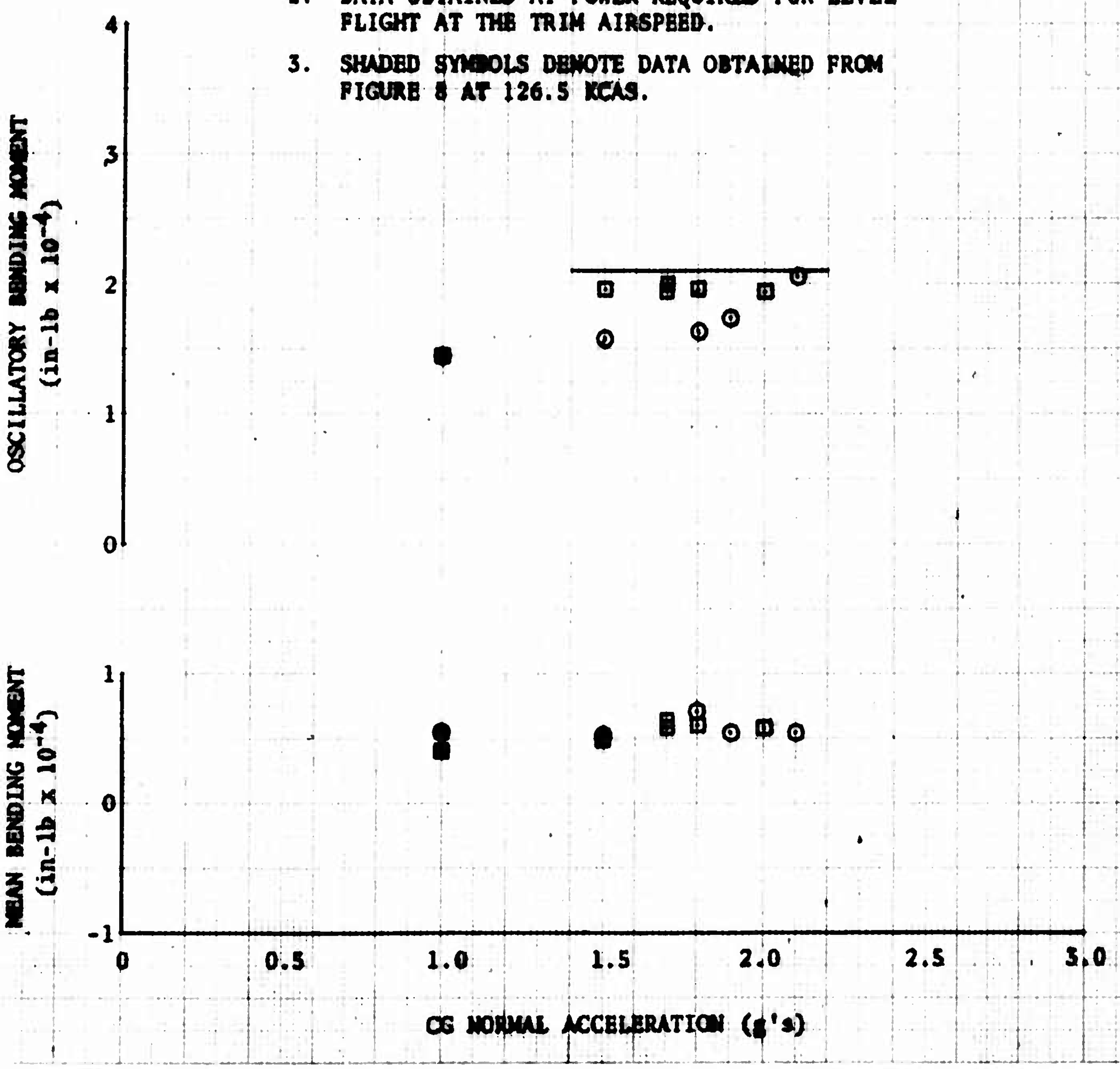


FIGURE 21
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 110 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	9240	195.4	324	125	HVY SCOUT, STD NOSE
□	5000	9240	195.4	324	127	HVY SCOUT, SNS

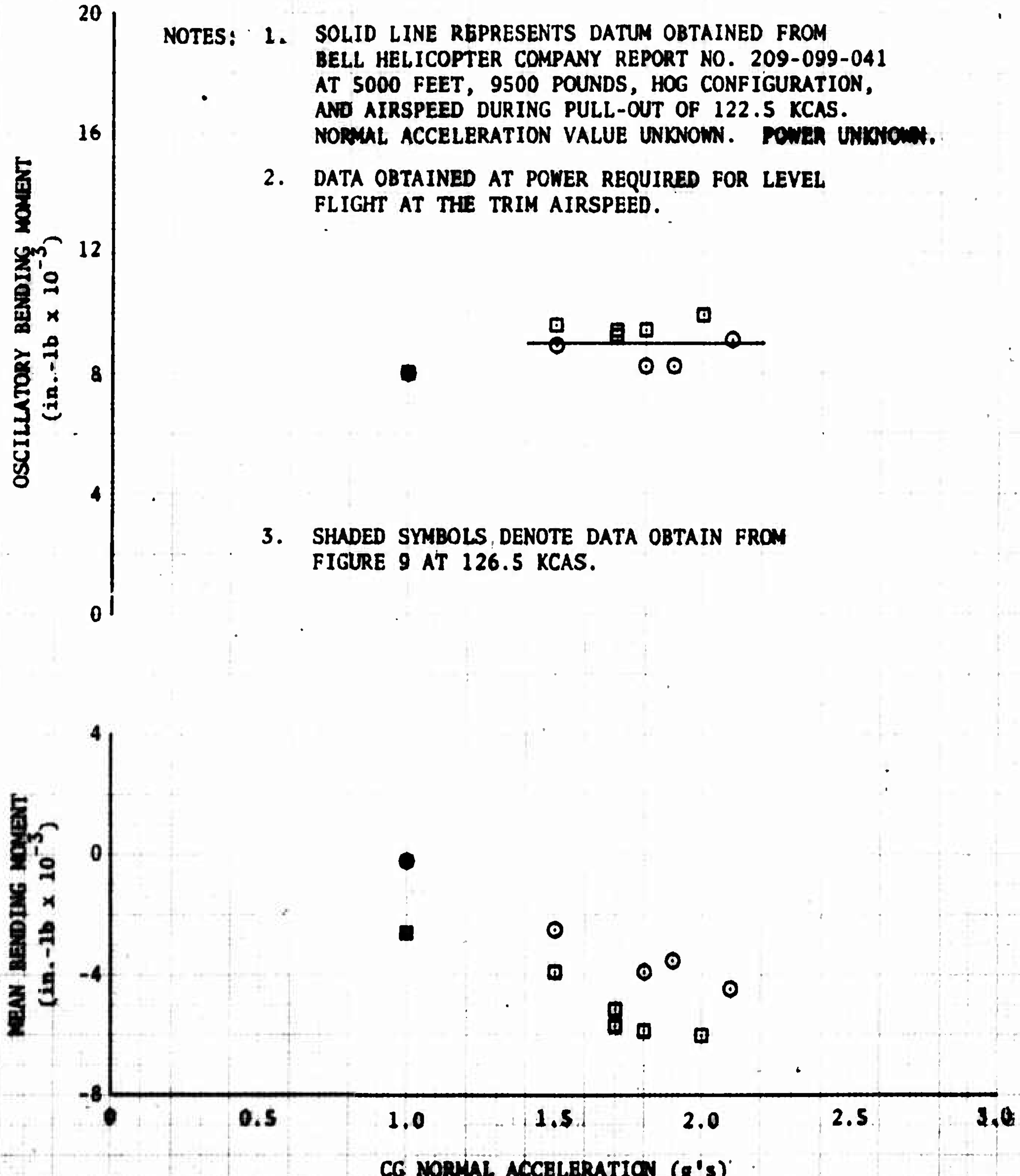
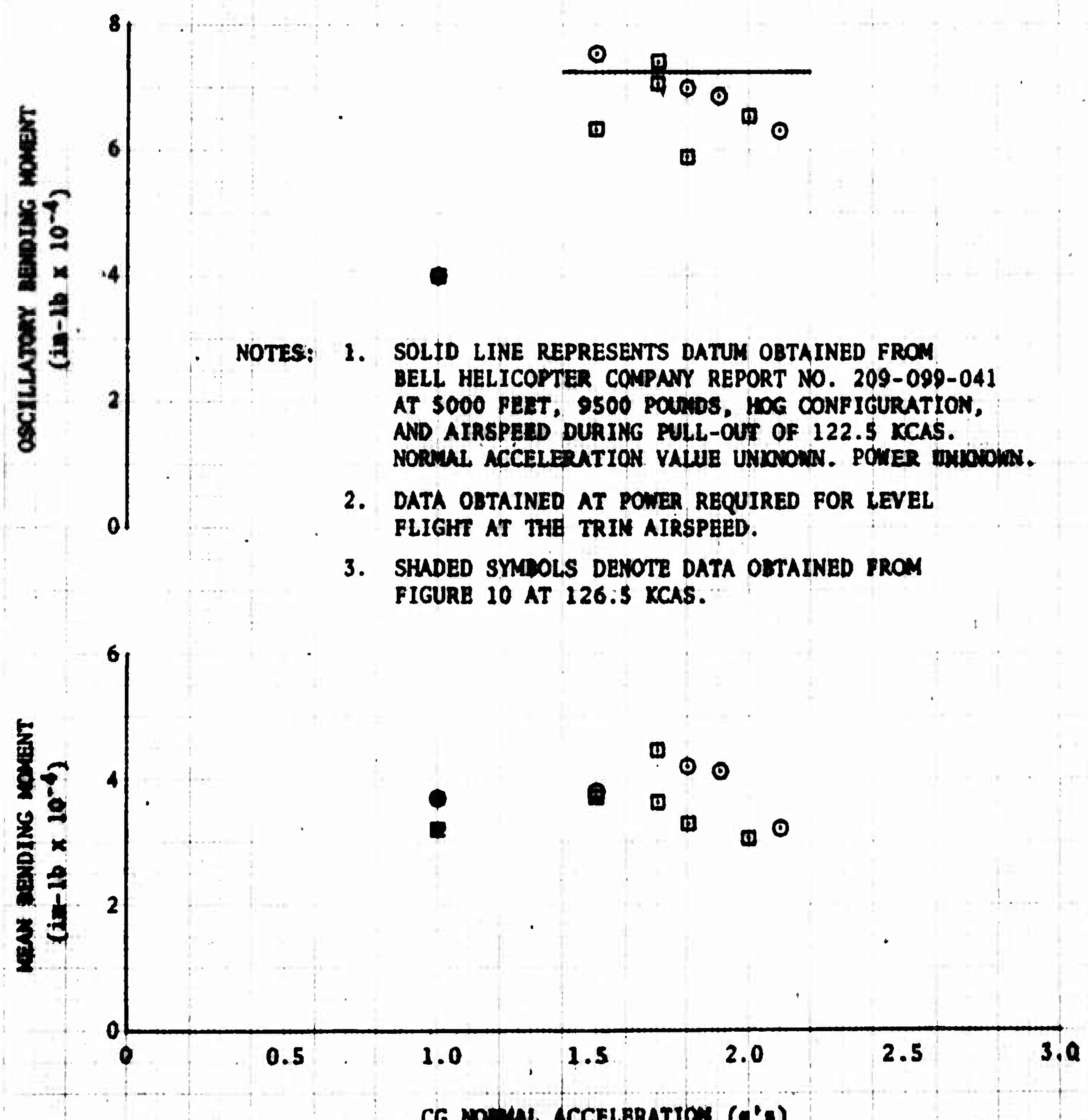


FIGURE 22
MAIN ROTOR BLADE CHORDWISE BENDING
BLADE STATION 135 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	9240	195.4	324	125	HVY SCOUT,STD NOSE
□	5000	9240	195.4	324	127	HVY SCOUT, SNS



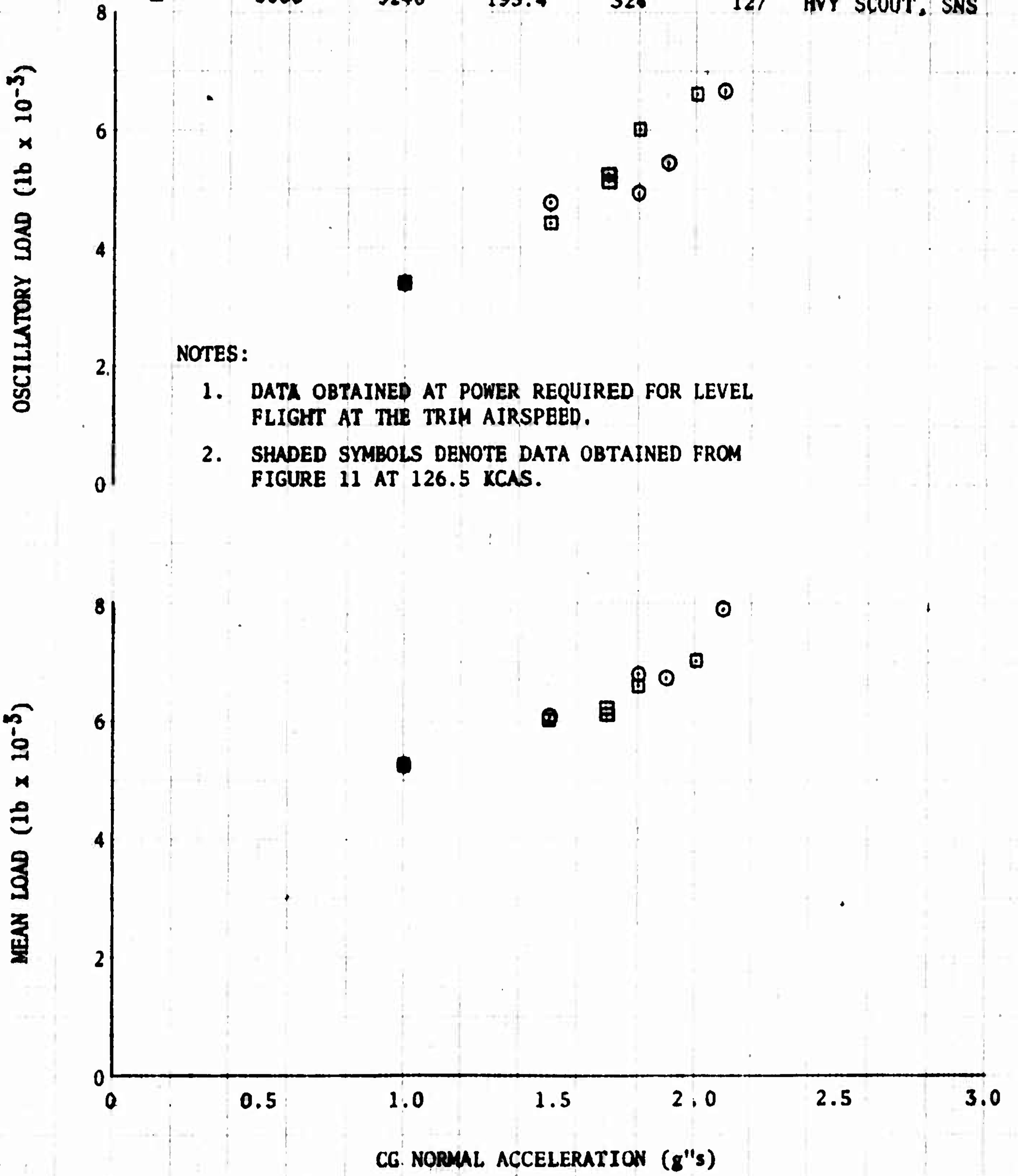
NOTES: 1. SOLID LINE REPRESENTS DATUM OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 5000 FEET, 9500 POUNDS, HOG CONFIGURATION, AND AIRSPEED DURING PULL-OUT OF 122.5 KCAS. NORMAL ACCELERATION VALUE UNKNOWN. POWER UNKNOWN.

2. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.

3. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 10 AT 126.5 KCAS.

FIGURE 23
DRAG BRACE AXIAL LOAD
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	9240	195.4	324	125	HVY SCOUT, STD NOSE
□	5000	9240	195.4	324	127	HVY SCOUT, SNS



NOTES:

1. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 11 AT 126.5 KCAS.

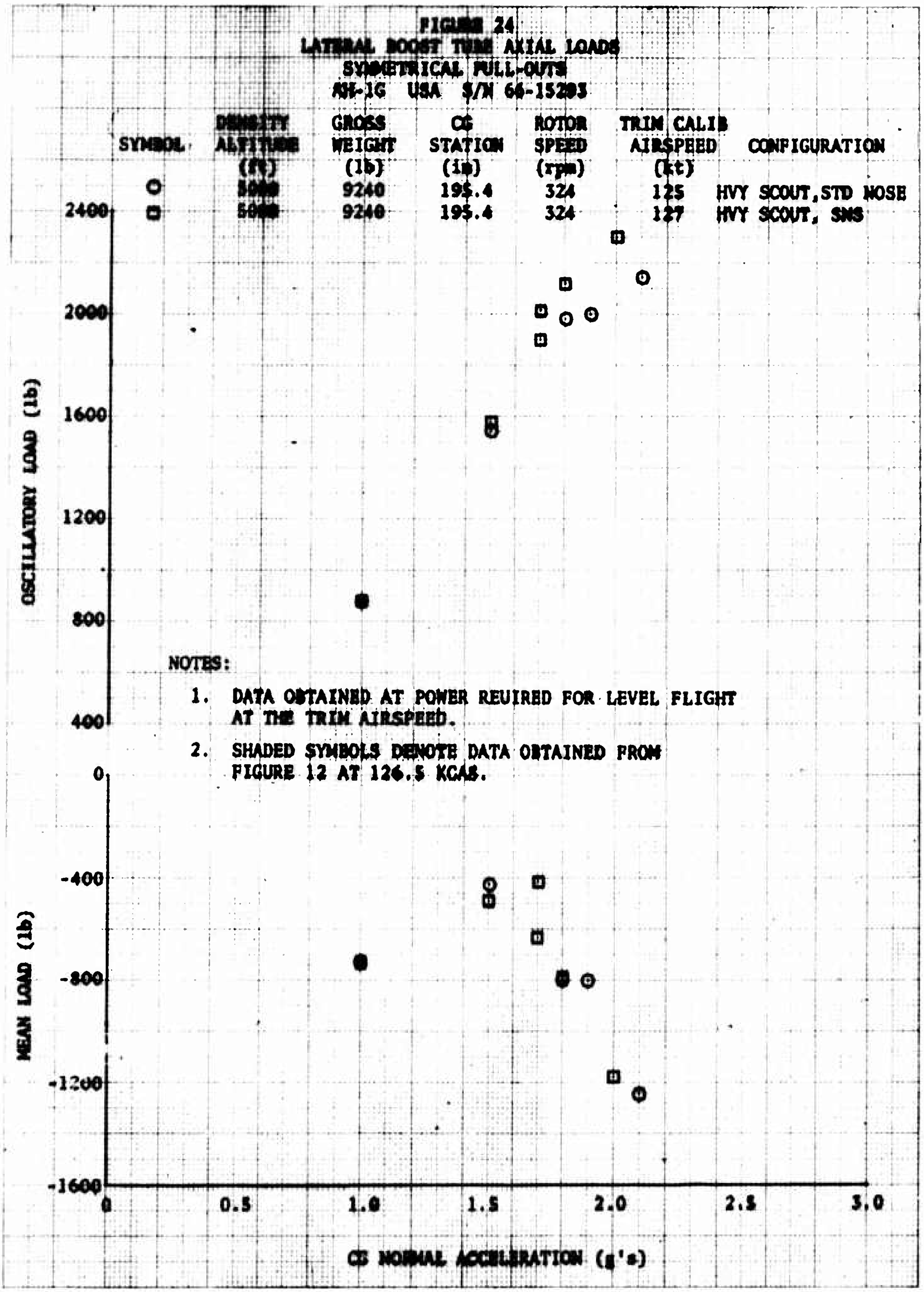


FIGURE 24
LATERAL BOOST TUBE AXIAL LOADS
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15283

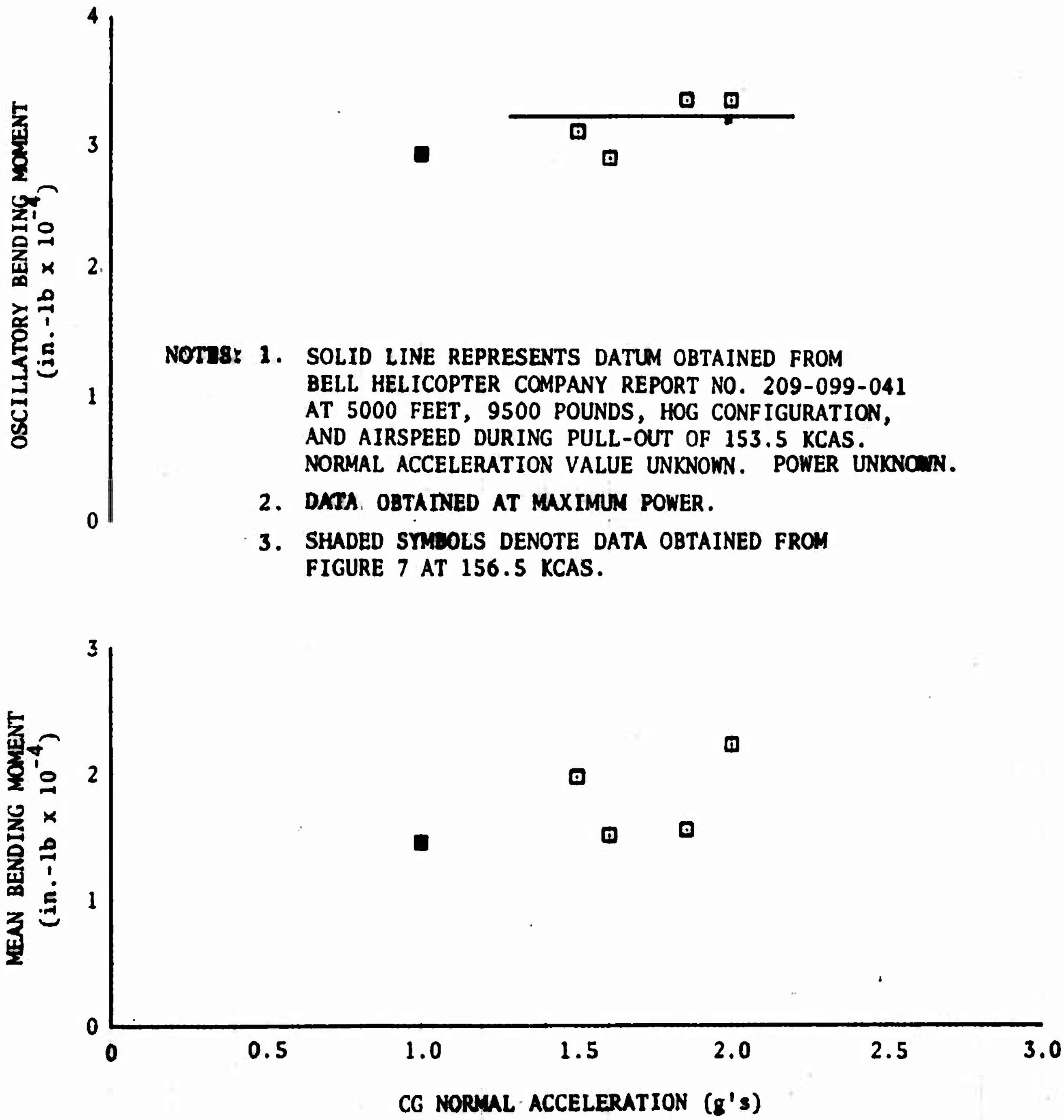
SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	9240	195.4	324	125	HVY SCOUT, STD NOSE
□	5000	9240	195.4	324	127	HVY SCOUT, SNS

NOTES:

1. DATA OBTAINED AT POWER REUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 12 AT 126.5 KCAS.

FIGURE 25
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 46 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
◻	5000	9240	195.4	324	156.5	HEAVY SCOUT, SNS



NOTES: 1. SOLID LINE REPRESENTS DATUM OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 5000 FEET, 9500 POUNDS, HOG CONFIGURATION, AND AIRSPEED DURING PULL-OUT OF 153.5 KCAS. NORMAL ACCELERATION VALUE UNKNOWN. POWER UNKNOWN.

2. DATA OBTAINED AT MAXIMUM POWER.

3. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 7 AT 156.5 KCAS.

FIGURE 26
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 60 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	9240	195.4	324	156.5	HEAVY SCOUT, SNS

NOTES: 1. SOLID LINE REPRESENTS DATUM OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 5000 FEET, 9500 POUNDS, HOG CONFIGURATION, AND AIRSPEED DURING PULL-OUT OF 153.5 KCAS. NORMAL ACCELERATION VALUE UNKNOWN. POWER UNKNOWN.

2. DATA OBTAINED AT MAXIMUM POWER.

3. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 8 AT 156.5 KCAS.

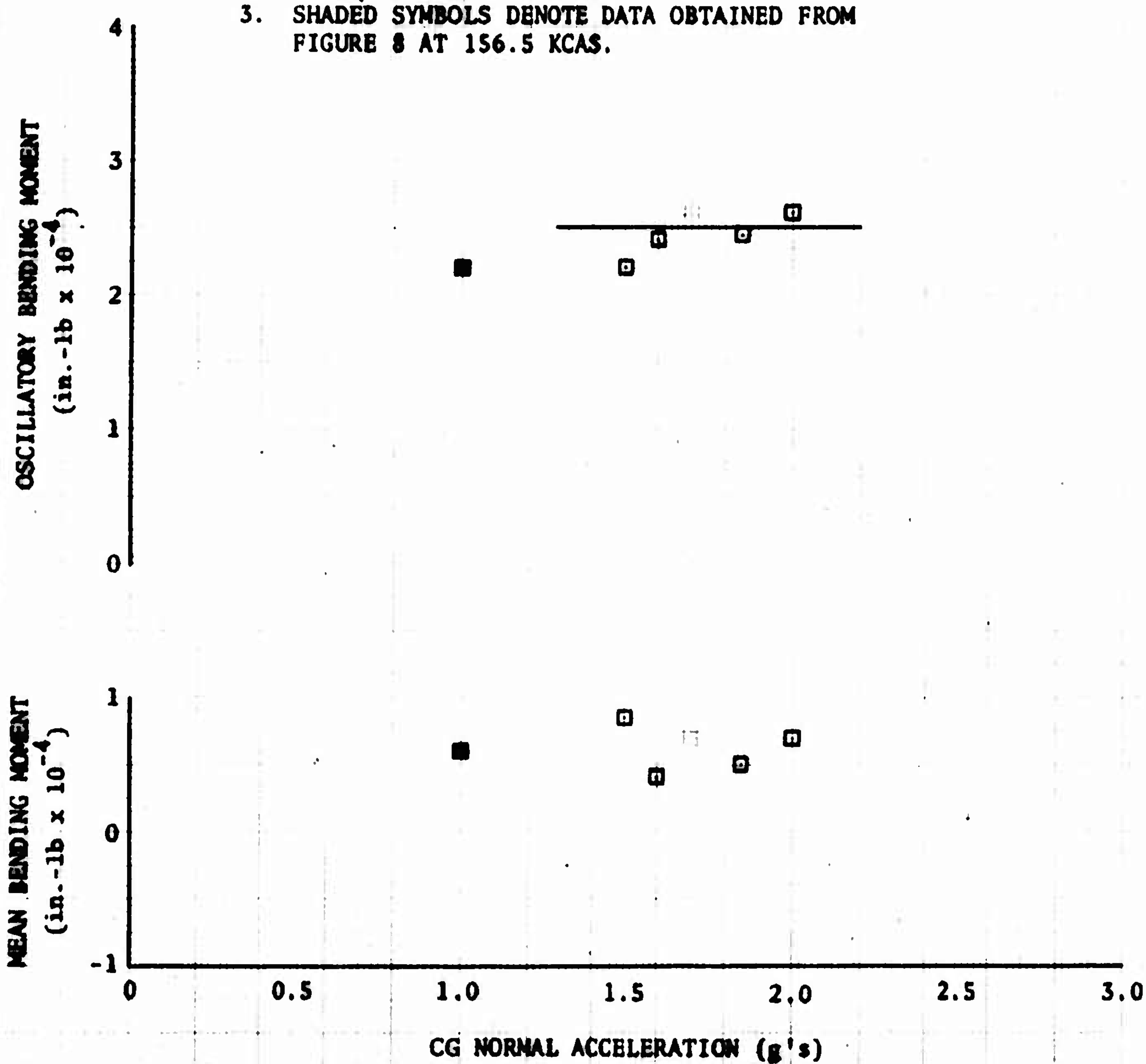


FIGURE 27
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 110 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	9240	195.4	324	156.5	HEAVY SCOUT, SNS

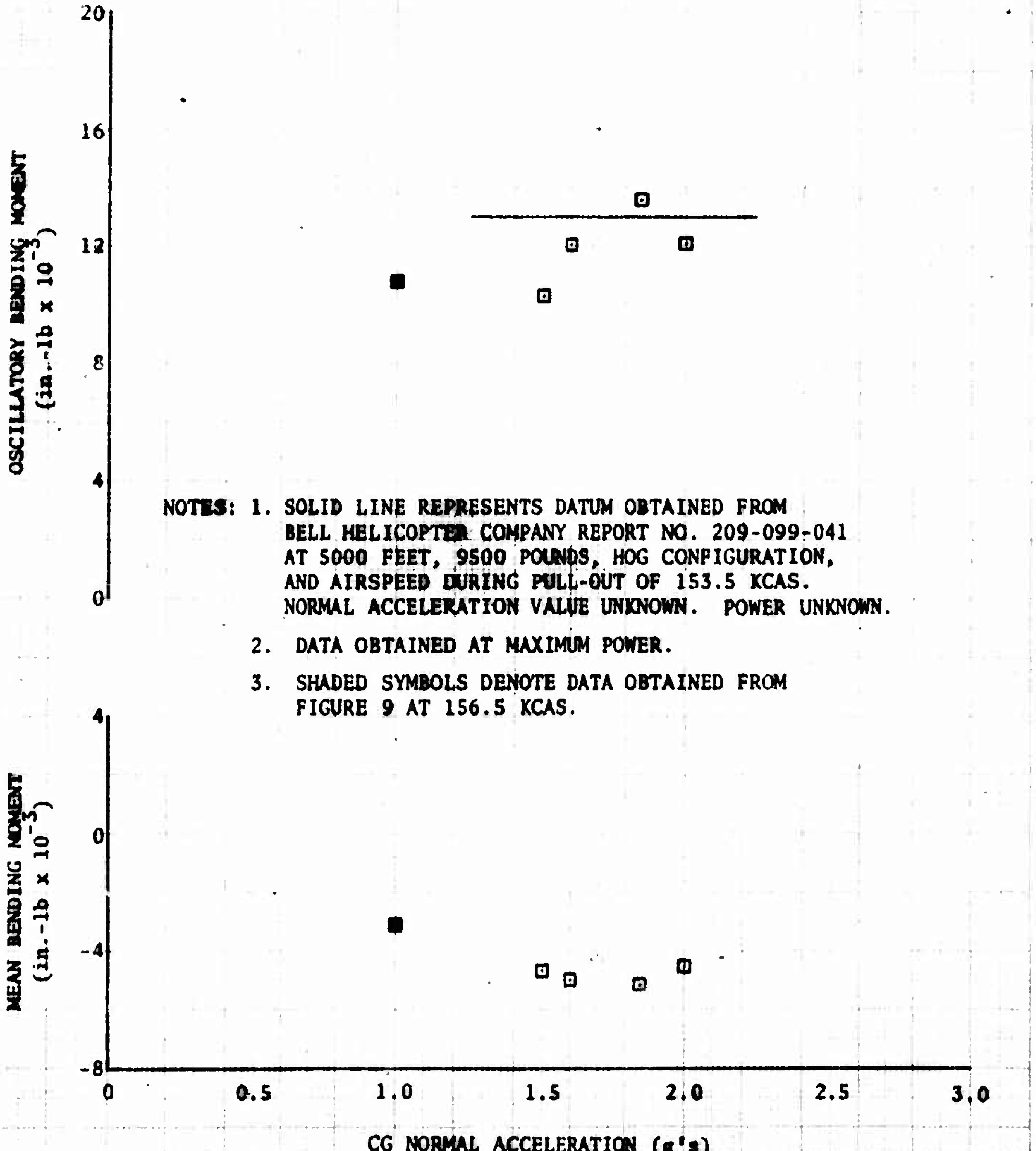
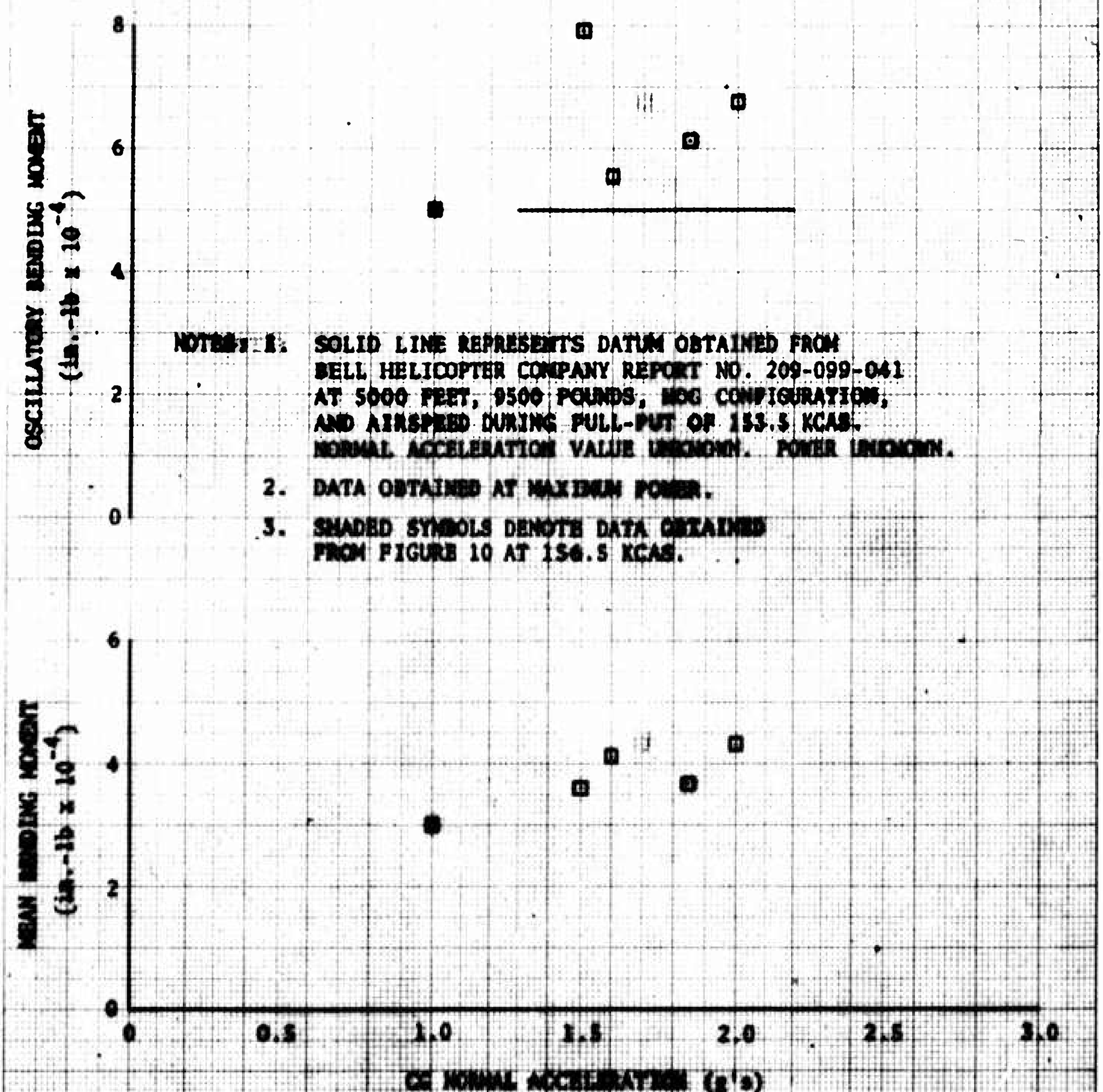


FIGURE 28
MAIN ROTOR BLADE CHORDWISE BENDING
BLADE STATION 155 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15298

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	9240	195.4	324	156.5	HEAVY SCOUT, SNS



NOTES: 1. SOLID LINE REPRESENTS DATUM OBTAINED FROM BELL HELICOPTER COMPANY REPORT NO. 209-099-041 AT 5000 FEET, 9500 POUNDS, HOG CONFIGURATION, AND AIRSPEED DURING PULL-OUT OF 153.5 KCAS. NORMAL ACCELERATION VALUE UNKNOWN. POWER UNKNOWN.

2. DATA OBTAINED AT MAXIMUM POWER.

3. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 10 AT 156.5 KCAS.

FIGURE 29
DRAG BRACE AXIAL LOAD
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
◘	5000	9240	195.4	324	156.5	HEAVY SCOUT, SNS

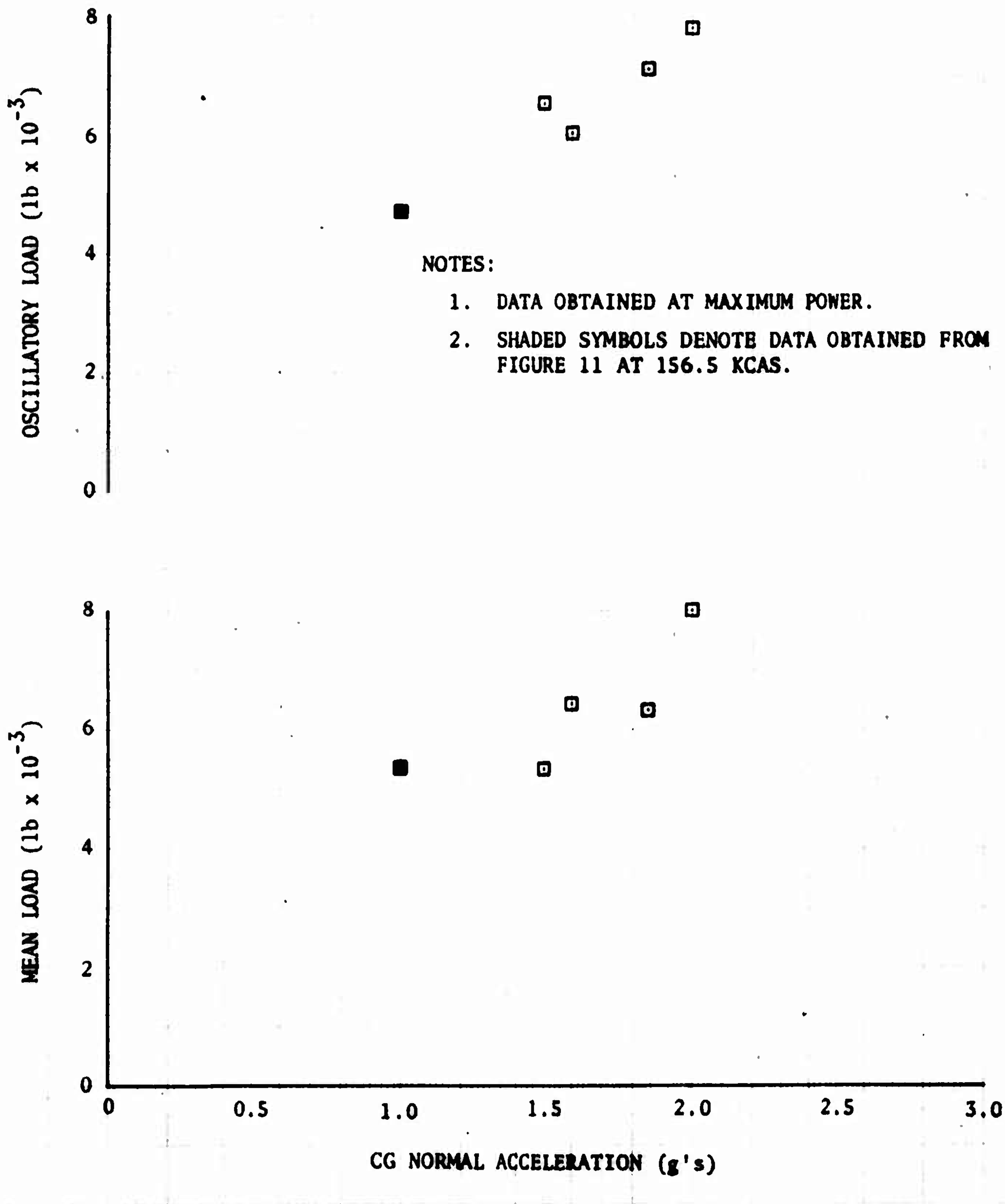


FIGURE 30
LATERAL BOOST TUBE AXIAL LOADS
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	9240	195.4	324	156.5	HEAVY SCOUT, SNS

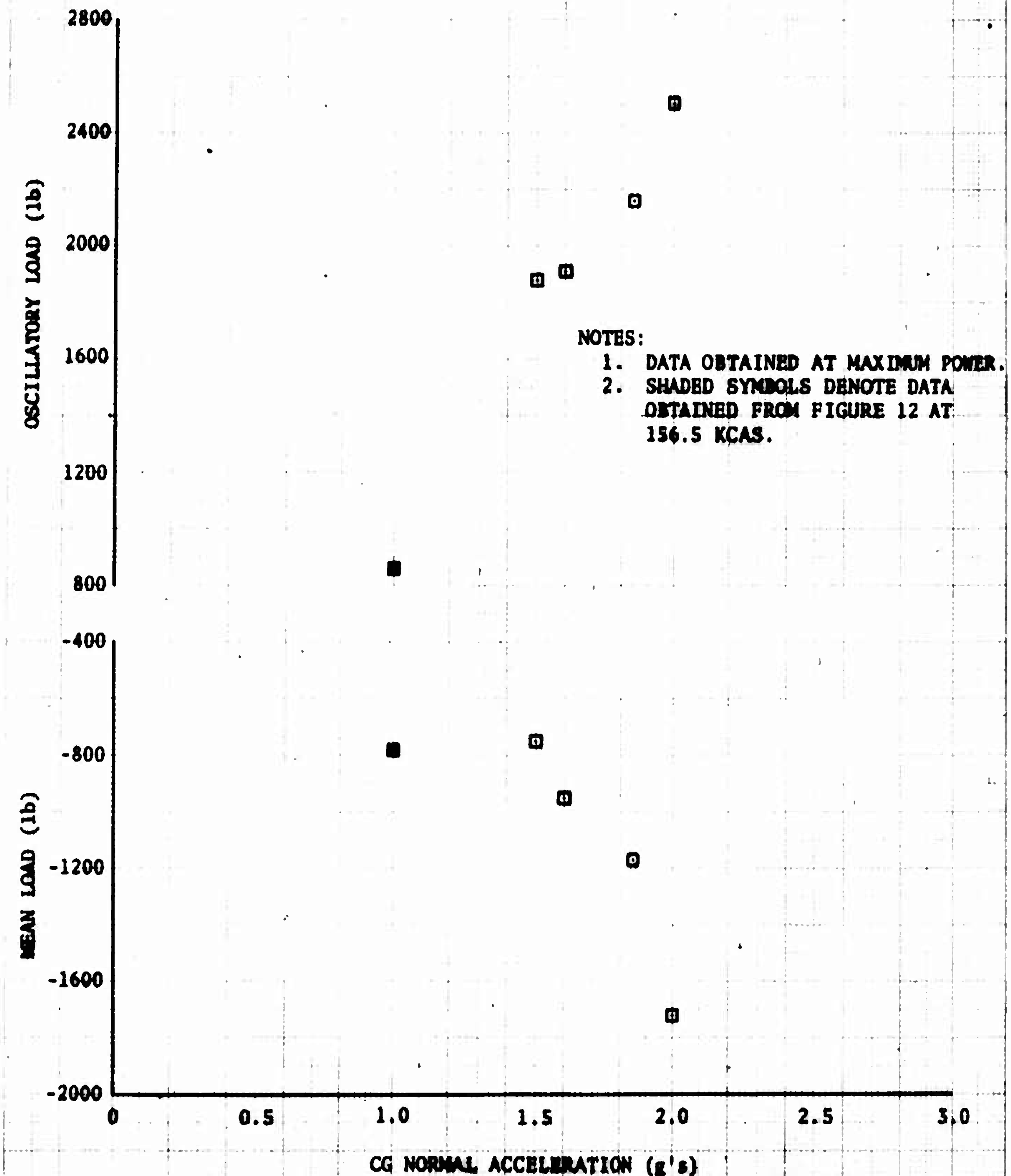


FIGURE 51
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 46 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15203

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	7520	195.6	324	156.5	CLEAN, SNS

NOTES:
1. DATA OBTAINED AT MAXIMUM POWER.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 1 AT 156.5 KCAS.

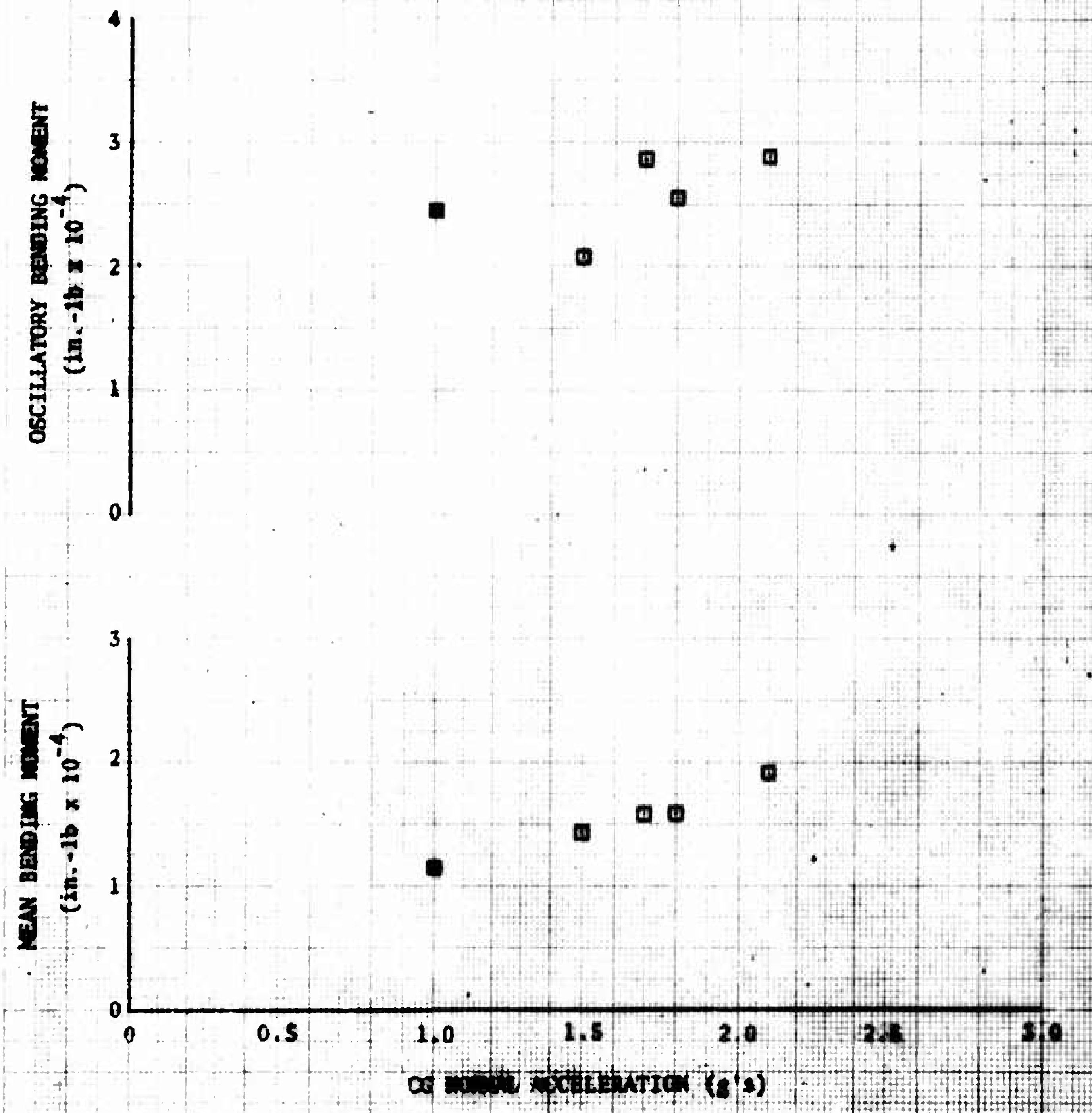


FIGURE 32
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 60 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	7520	195.6	324	156.5	CLEAN, SNS

NOTES: 1. DATA OBTAINED AT MAXIMUM POWER.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 2 AT 156.5 KCAS.

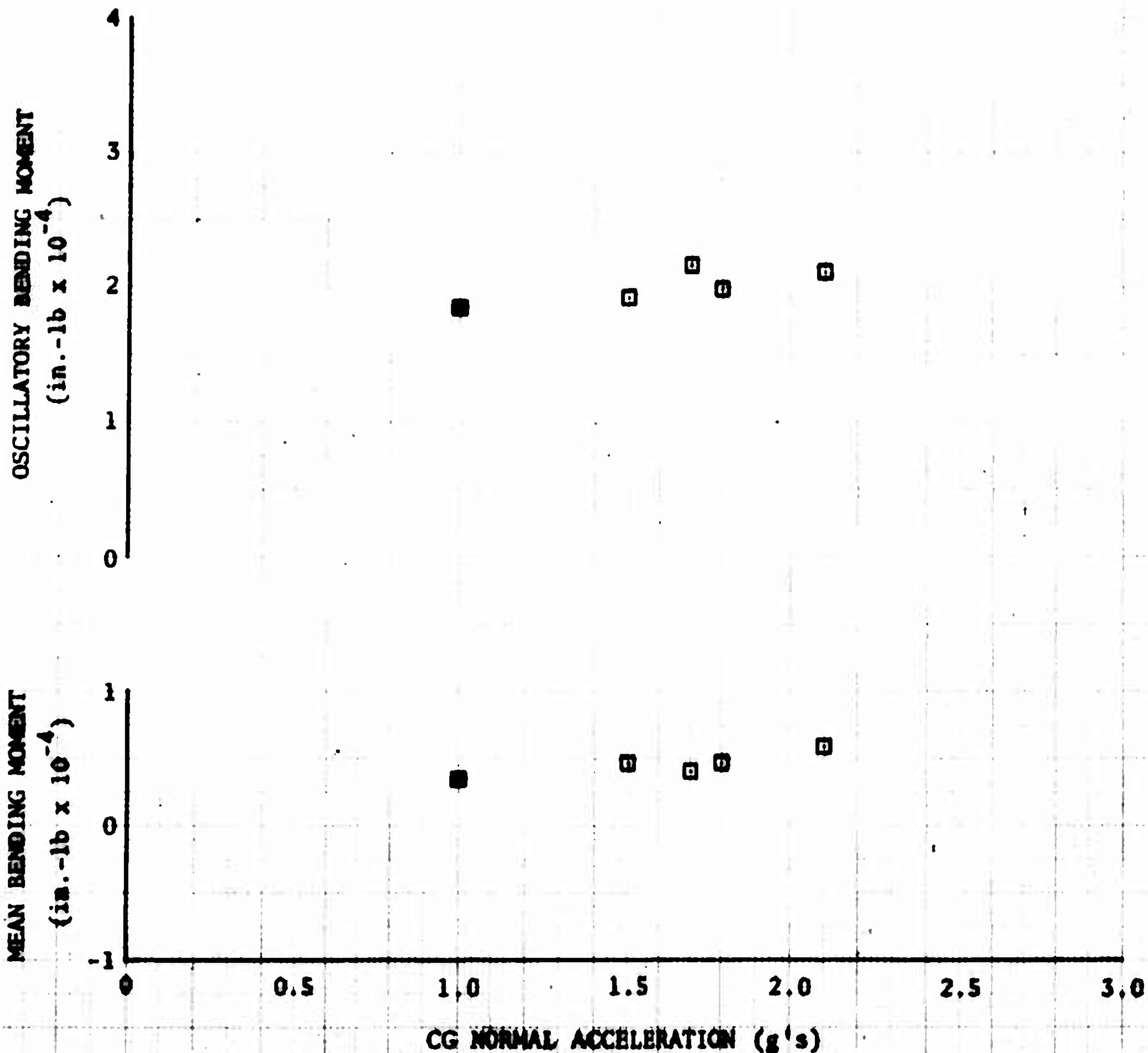


FIGURE 53
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 110 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	7520	195.6	324	156.5	CLEAN, SNS

NOTES:

1. DATA OBTAINED AT MAXIMUM POWER.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 3 AT 156.5 KCAS.

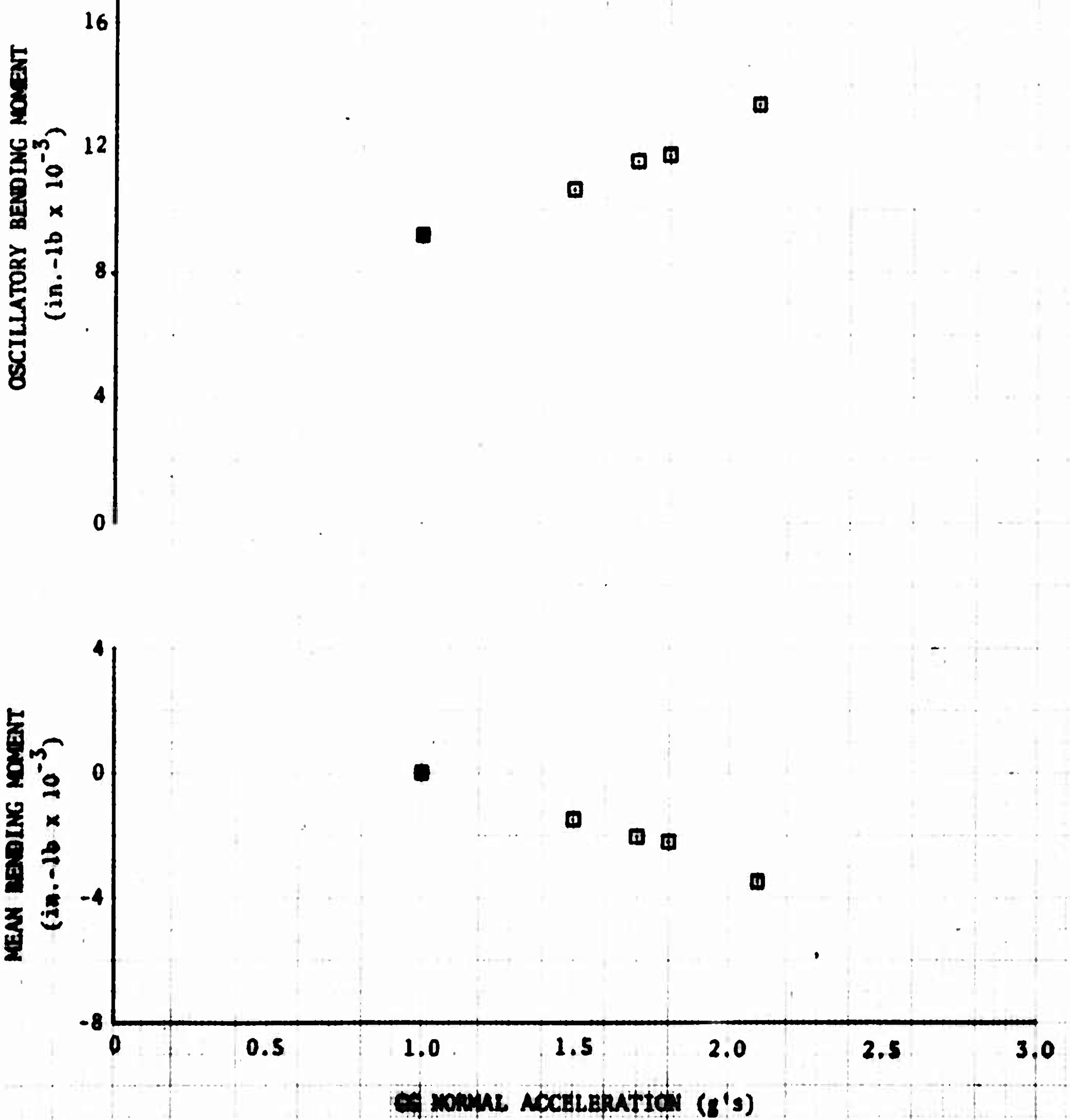


FIGURE 34
MAIN ROTOR BLADE CHORDWISE BENDING
BLADE STATION 135 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	7520	195.6	324	156.5	CLEAN, SNS

NOTES:

1. DATA OBTAINED AT MAXIMUM POWER.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 4 AT 156.5 KCAS.

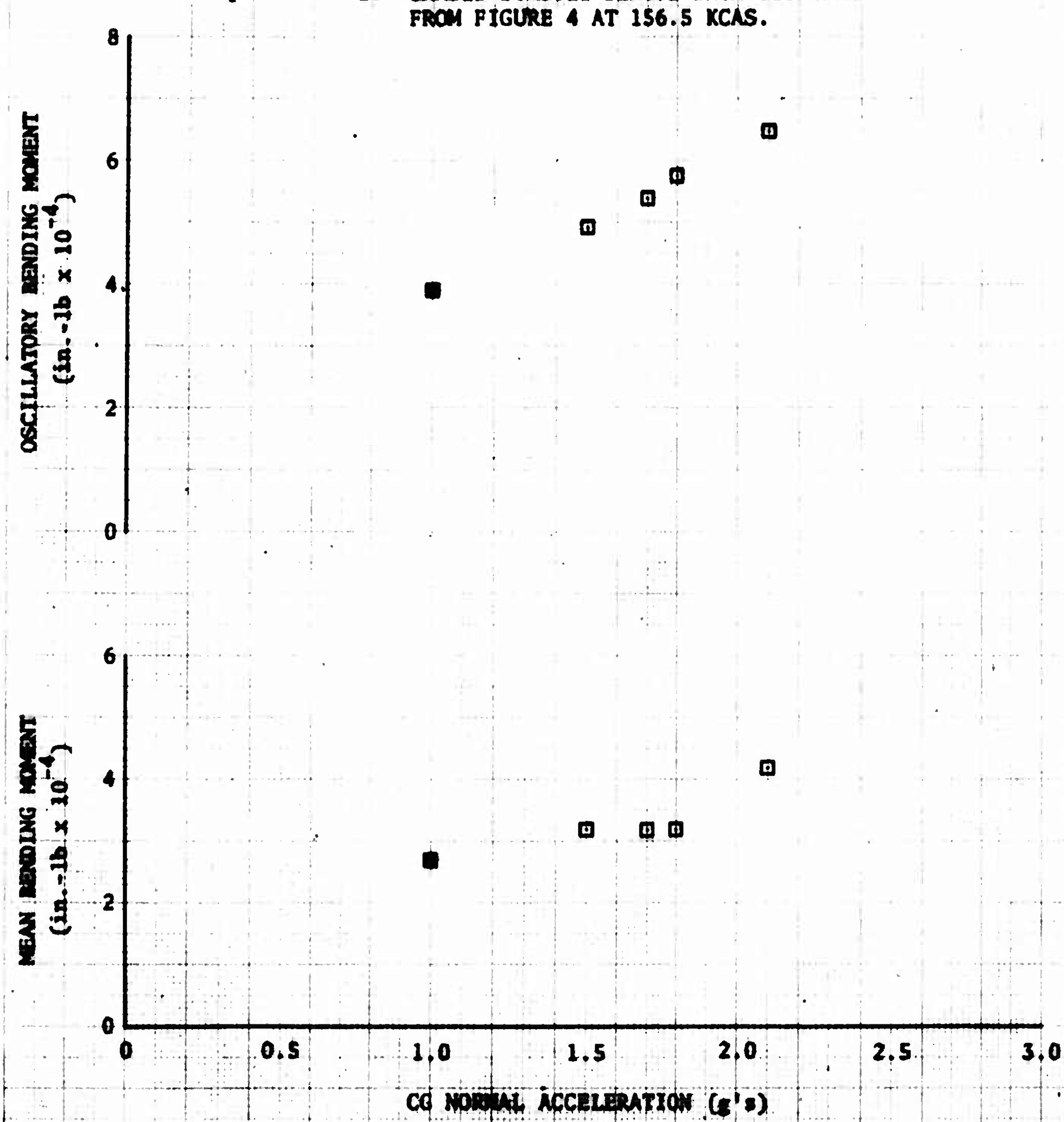


FIGURE 35
DRAG BRACE AXIAL LOAD
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	7520	195.6	324	156.5	CLEAN, SNS

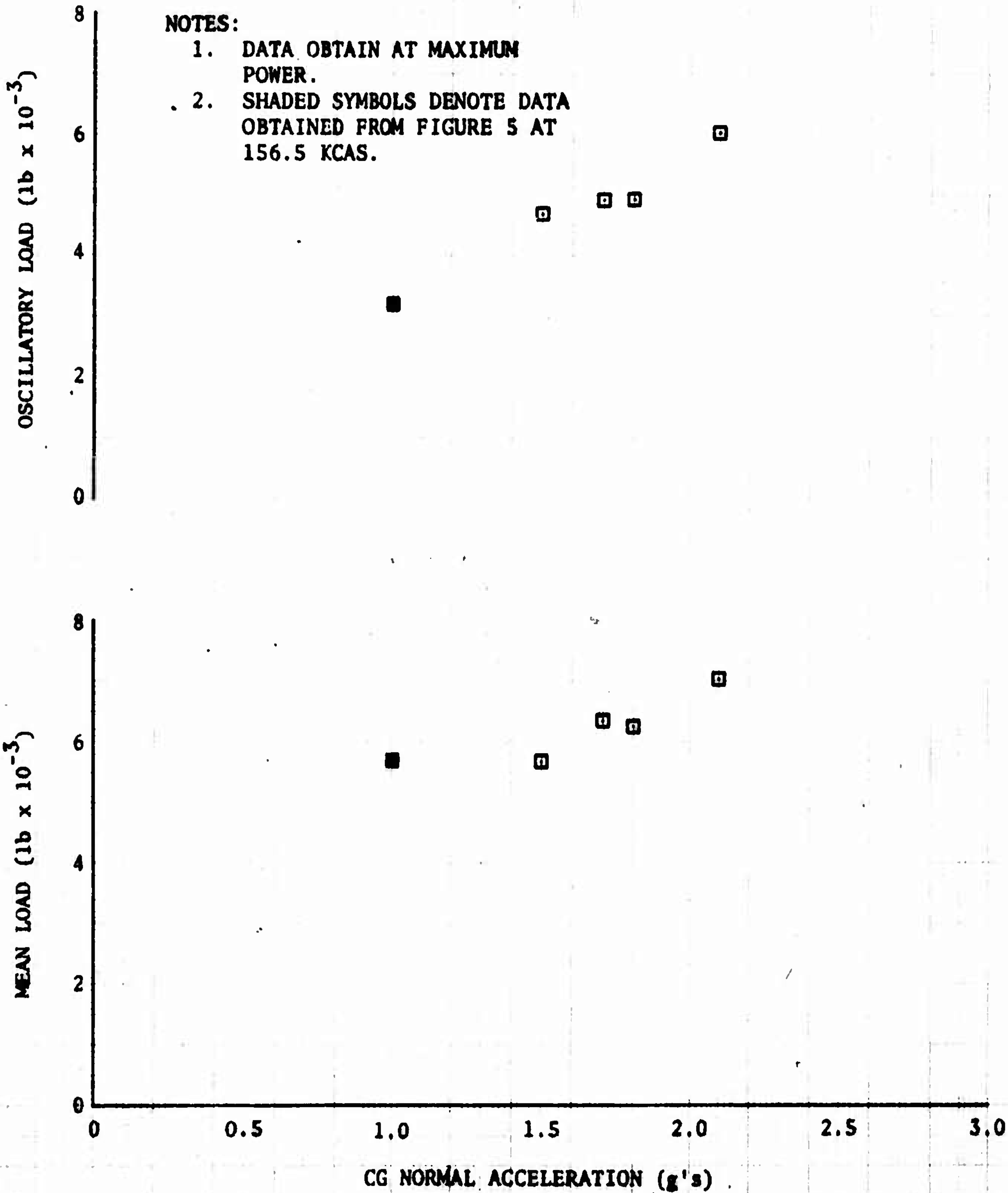


FIGURE 56
LATERAL ROCKET TUBE AXIAL LOADS
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15283

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	7520	195.6	324	156.5	CLEAN, SNS

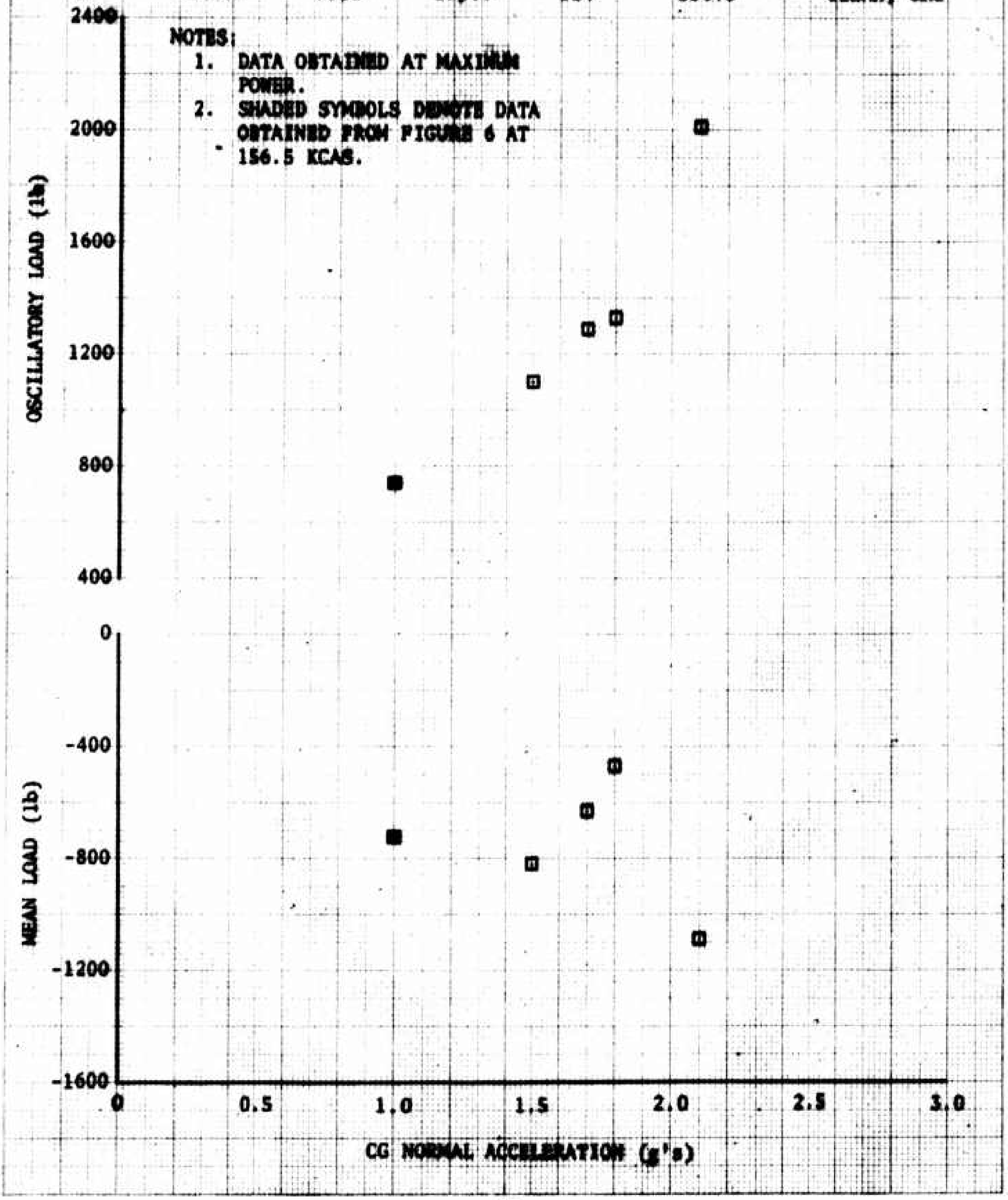


FIGURE 37
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION [illegible], SYMMETRICAL PULL-UPS
AH-1G USA S/N 66-15303

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	7520	195.6	324	173.5	CLEAN, SNS

NOTES: 1. DATA OBTAINED AT MAXIMUM POWER.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 1 AT 173.5 KCAS.

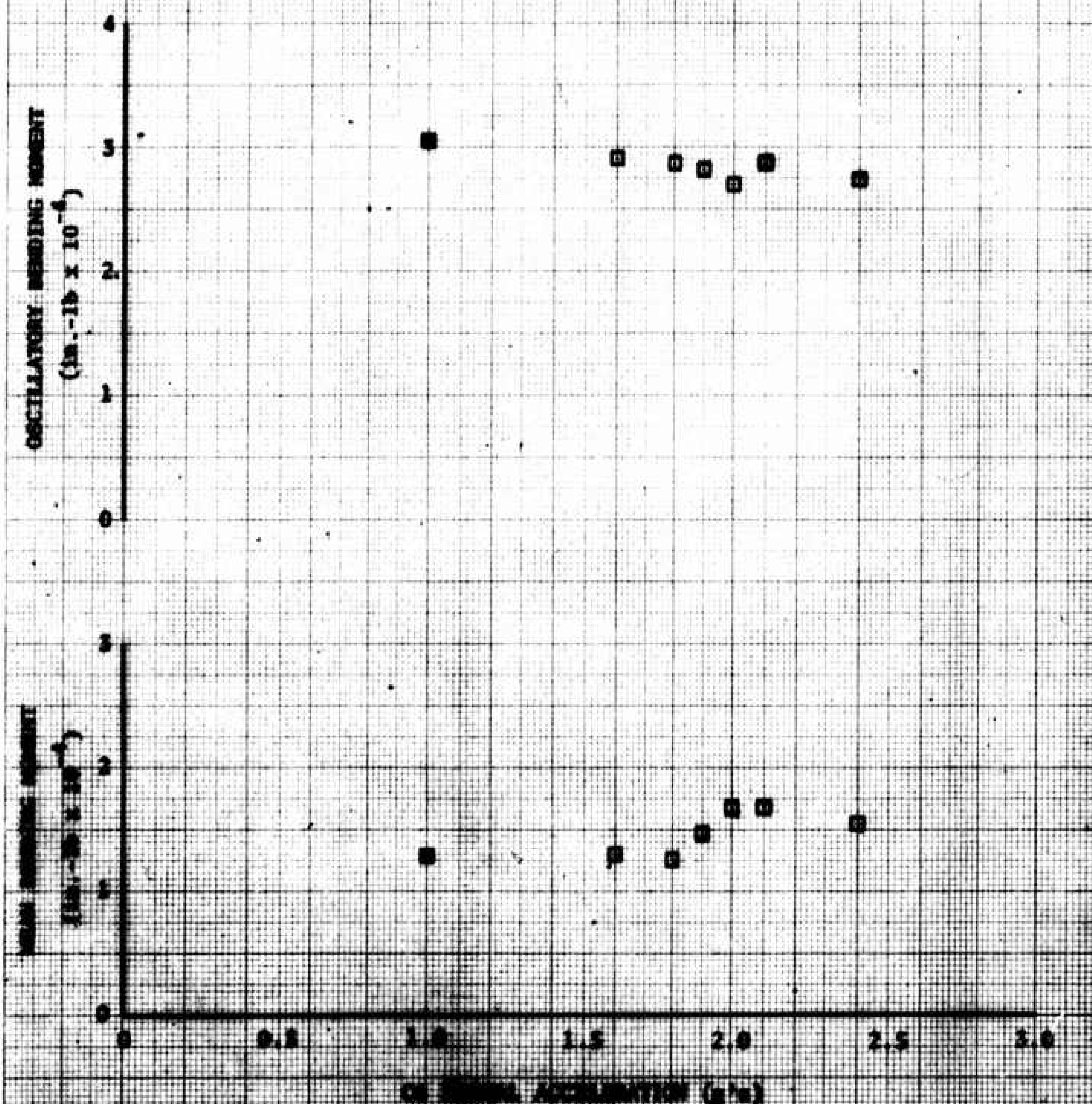


FIGURE [illegible]
MAIN ROTOR BLADE [illegible] BENDING
BLADE STATION [illegible] SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-152[illegible]

SYMBOL	DENSITY-ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
▢	5000	7520	198.6	324	173.5	CLEAN, SNS

NOTES:

1. DATA OBTAINED AT MAXIMUM POWER.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 2 AT 173.5 KCAS.

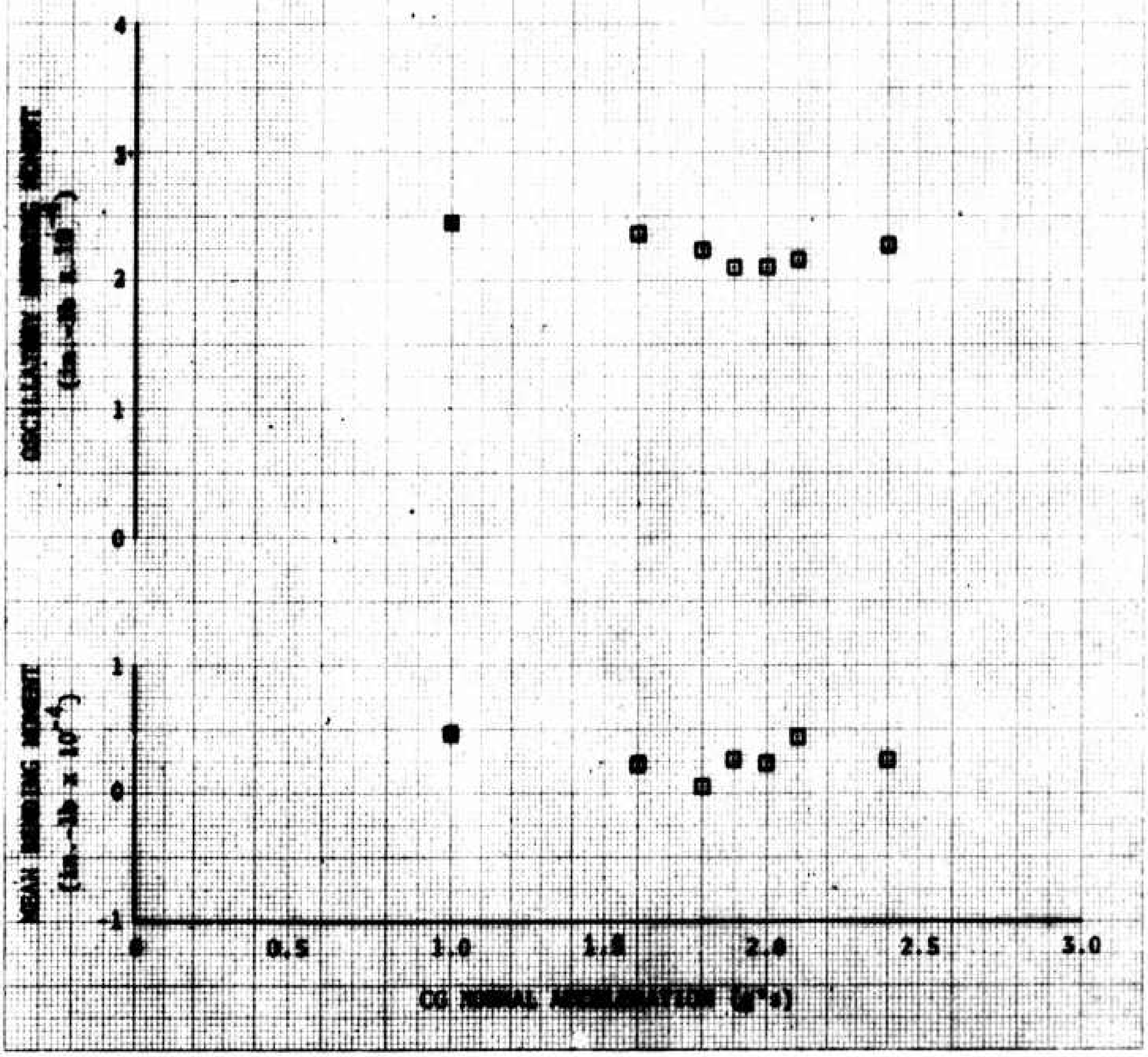


FIGURE 38
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 110 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15295

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
◻	5000	7520	195.6	324	173.5	CLEAN, SNS

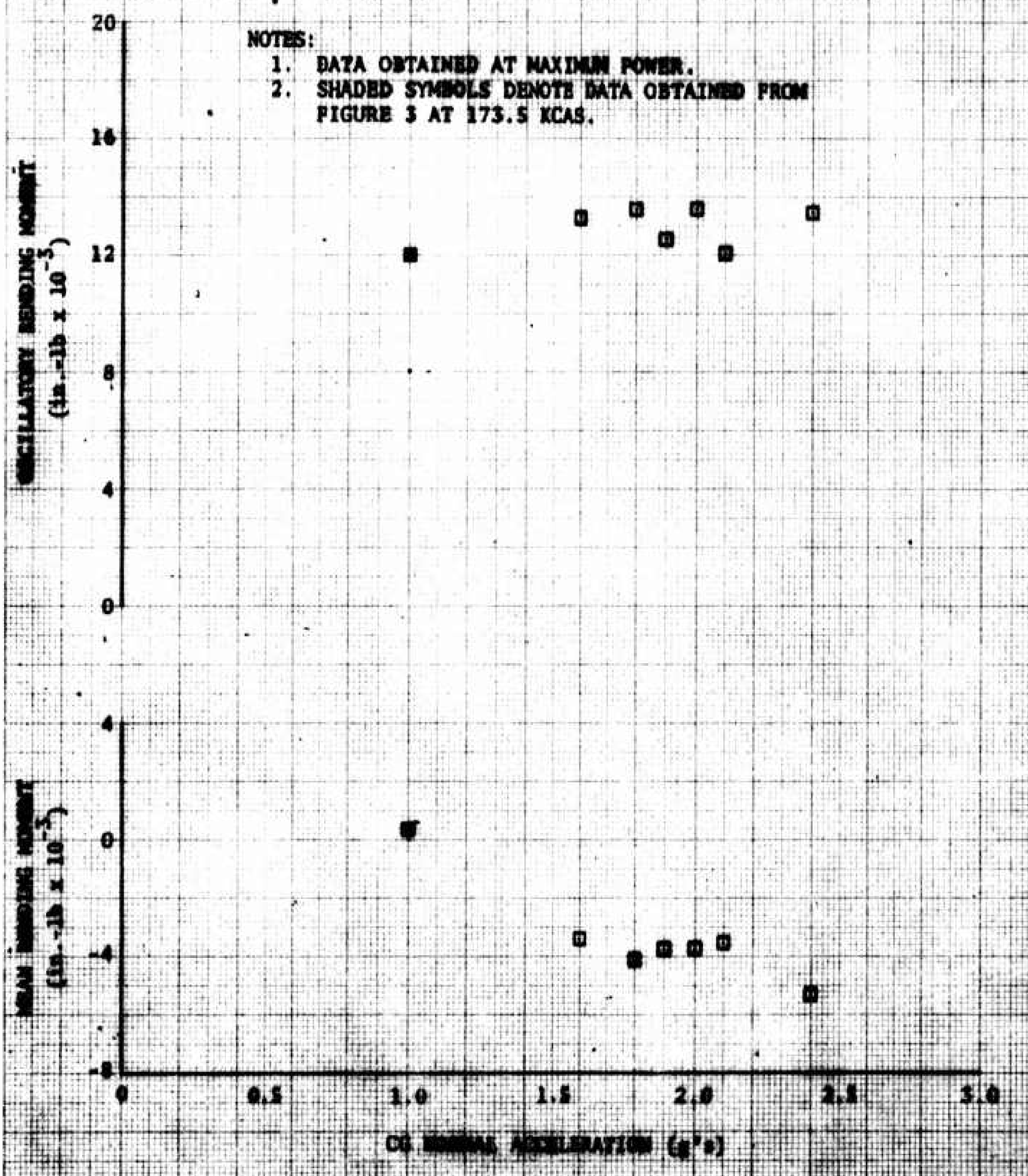
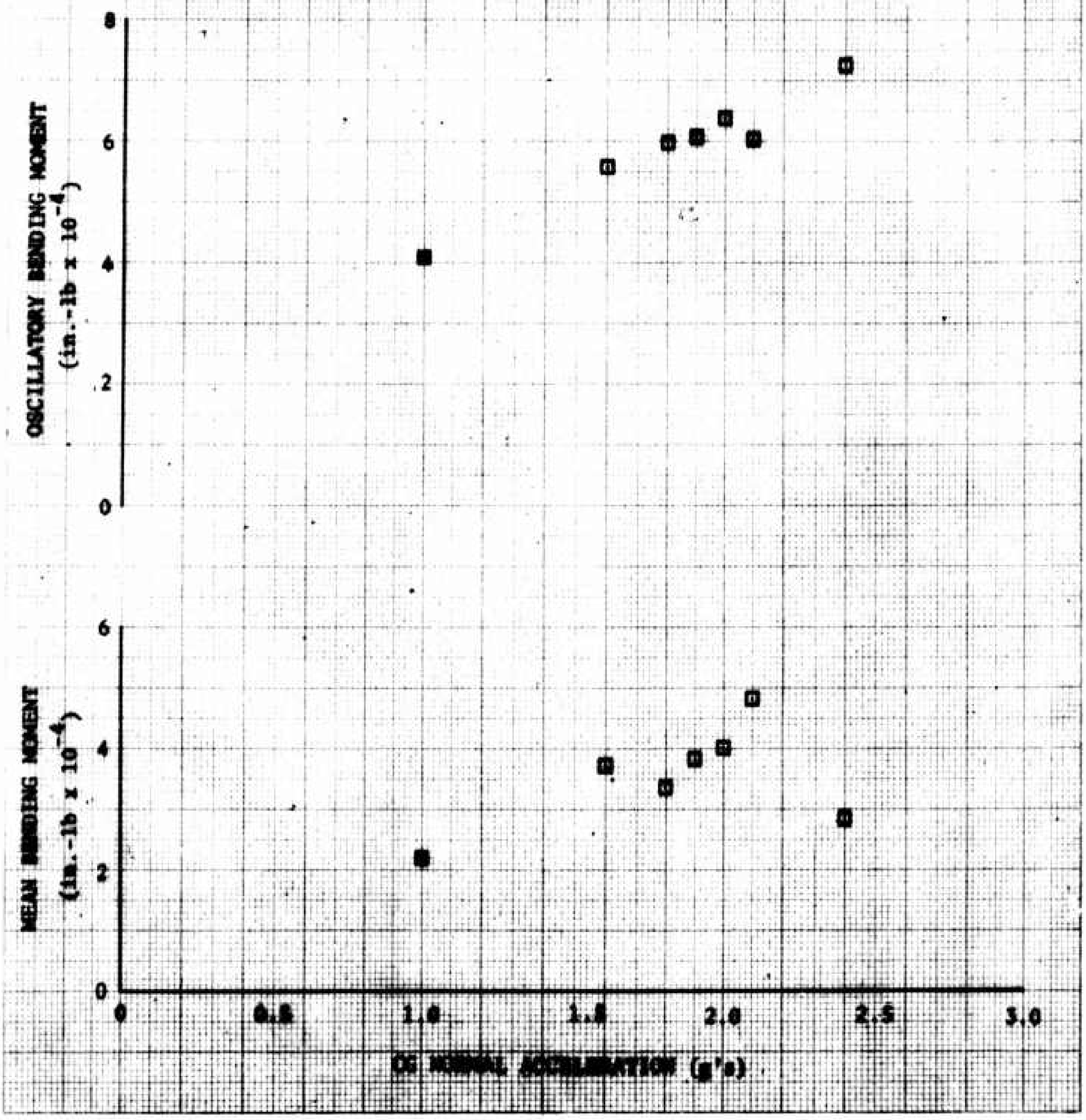


FIGURE 46
MAIN ROTOR BLADE CHORDWISE BENDING
BLADE STATION 135 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15283

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	7520	195.6	324	173.5	CLEAN, SNS

NOTES:
1. DATA OBTAINED AT MAXIMUM POWER.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 4 AT 173.5 KCAS.



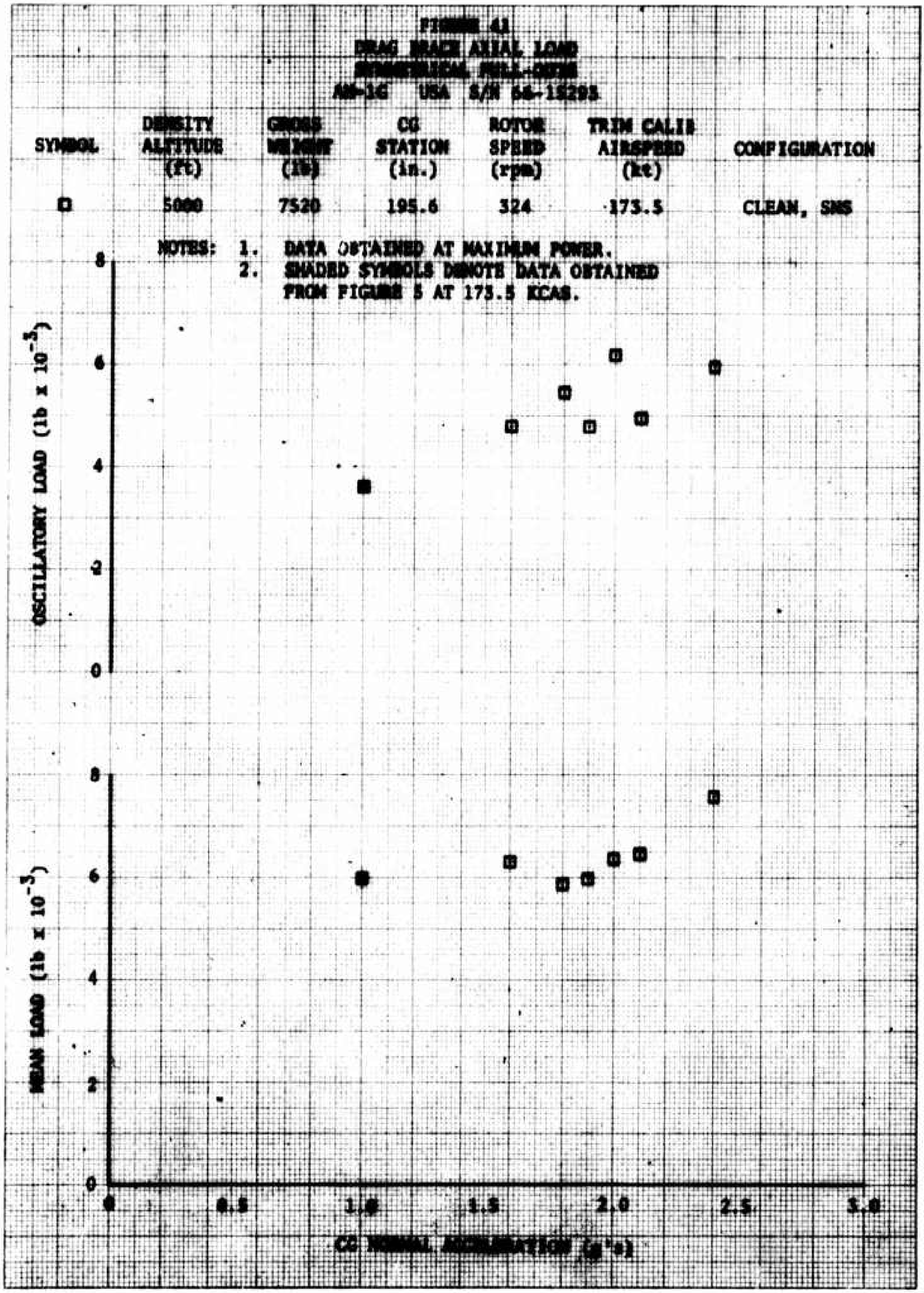


FIGURE 41
DRAG BRACE AXIAL LOAD
AH-1G USA S/N 66-15293
SYMBOL
DENSITY ALTITUDE (ft)
GROSS WEIGHT (lb)
CG STATION (in.)
ROTOR SPEED (rpm)
TRIM CALIB AIRSPEED (kt)
CONFIGURATION
5000
7520
195.6
324
173.5
CLEAN, SNS
NOTES: 1. DATA OBTAINED AT MAXIMUM POWER.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 5 AT 173.5 KCAS.
OSCILLATORY LOAD (lb x 10^-3)
MEAN LOAD (lb x 10^-3)
0
2
4
6
8
0.5
1.0
1.5
2.0
2.5
3.0
CG NORMAL ACCELERATION (g's)

FIGURE 42
LATERAL BOOST TUBE AXIAL LOADS
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15283

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
□	5000	7520	195.6	324	173.5	CLEAN, SNS

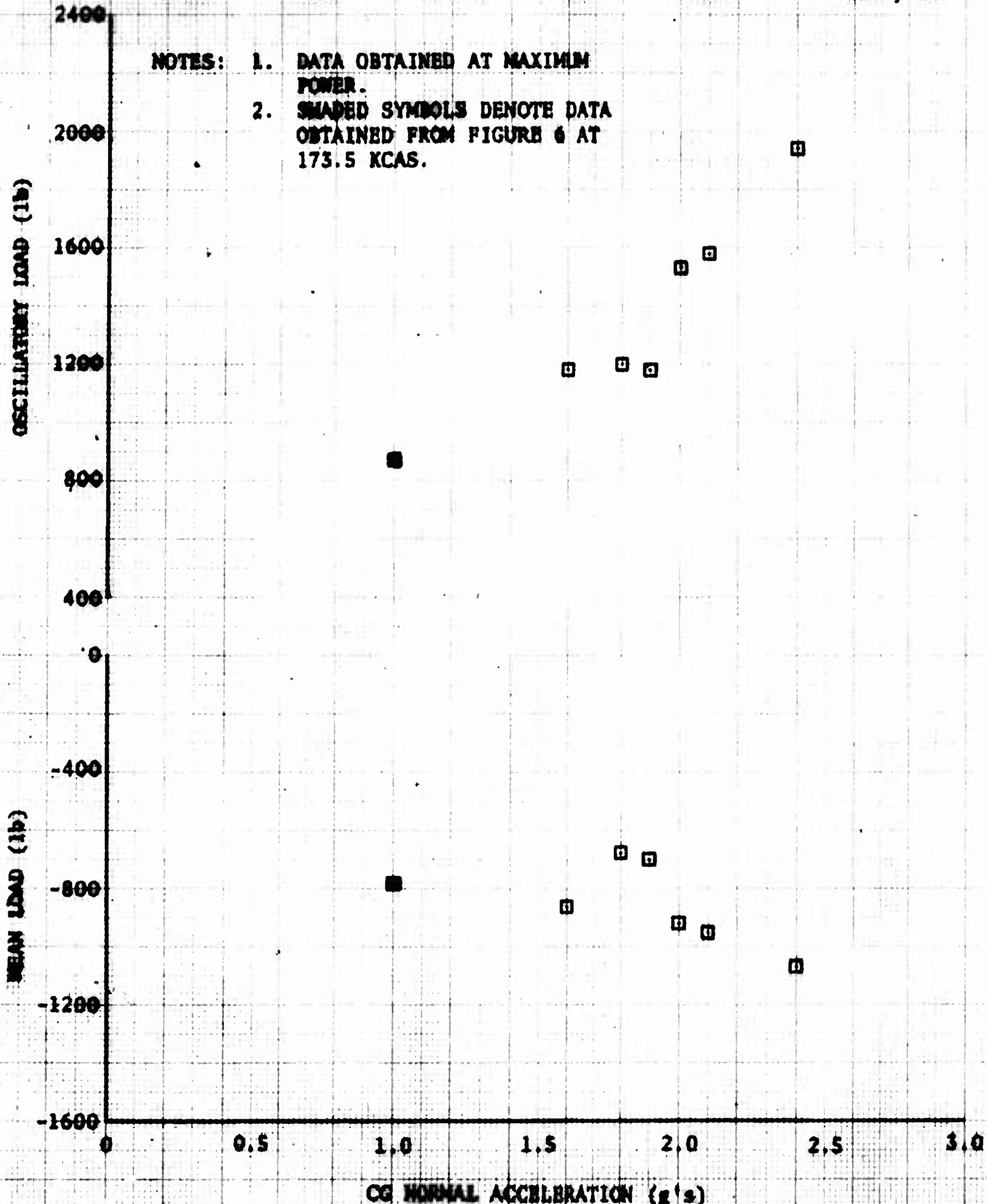


FIGURE 43
MAIN ROTOR BLADE CHORDWISE BENDING
BLADE STATION 46 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-18293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
○	5000	7520	195.6	324	144.5	CLEAN, STD NOSE

NOTES:
1. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 1 AT 144.5 KCAS.

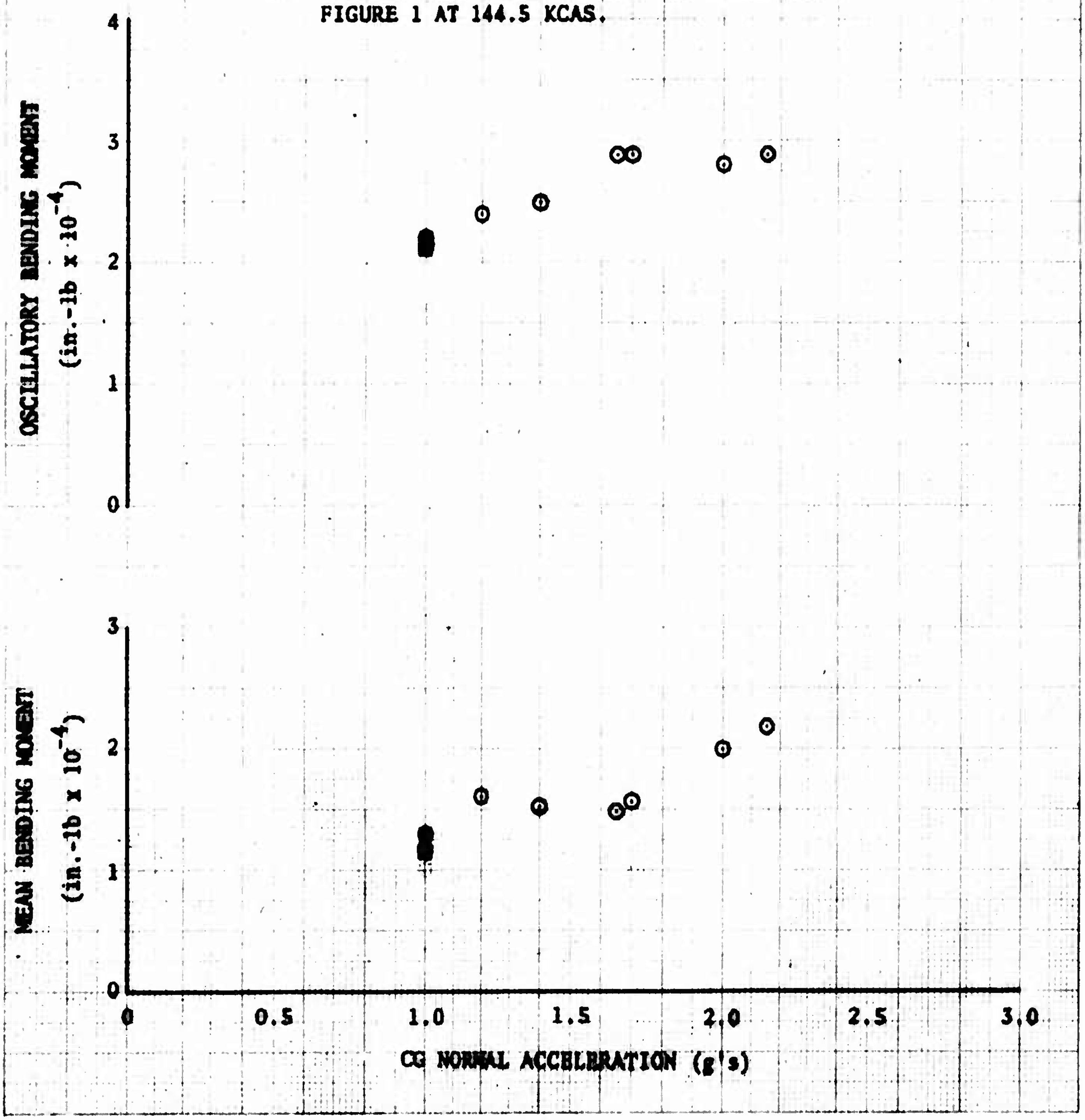


FIGURE 44
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 60 SYMMETRICAL PULL-OUTS
AH-1G S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
⊙	5000	7520	195.6	324	144.5	CLEAN, STD NOSE

NOTES:

1. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 2 AT 144.5 KCAS.

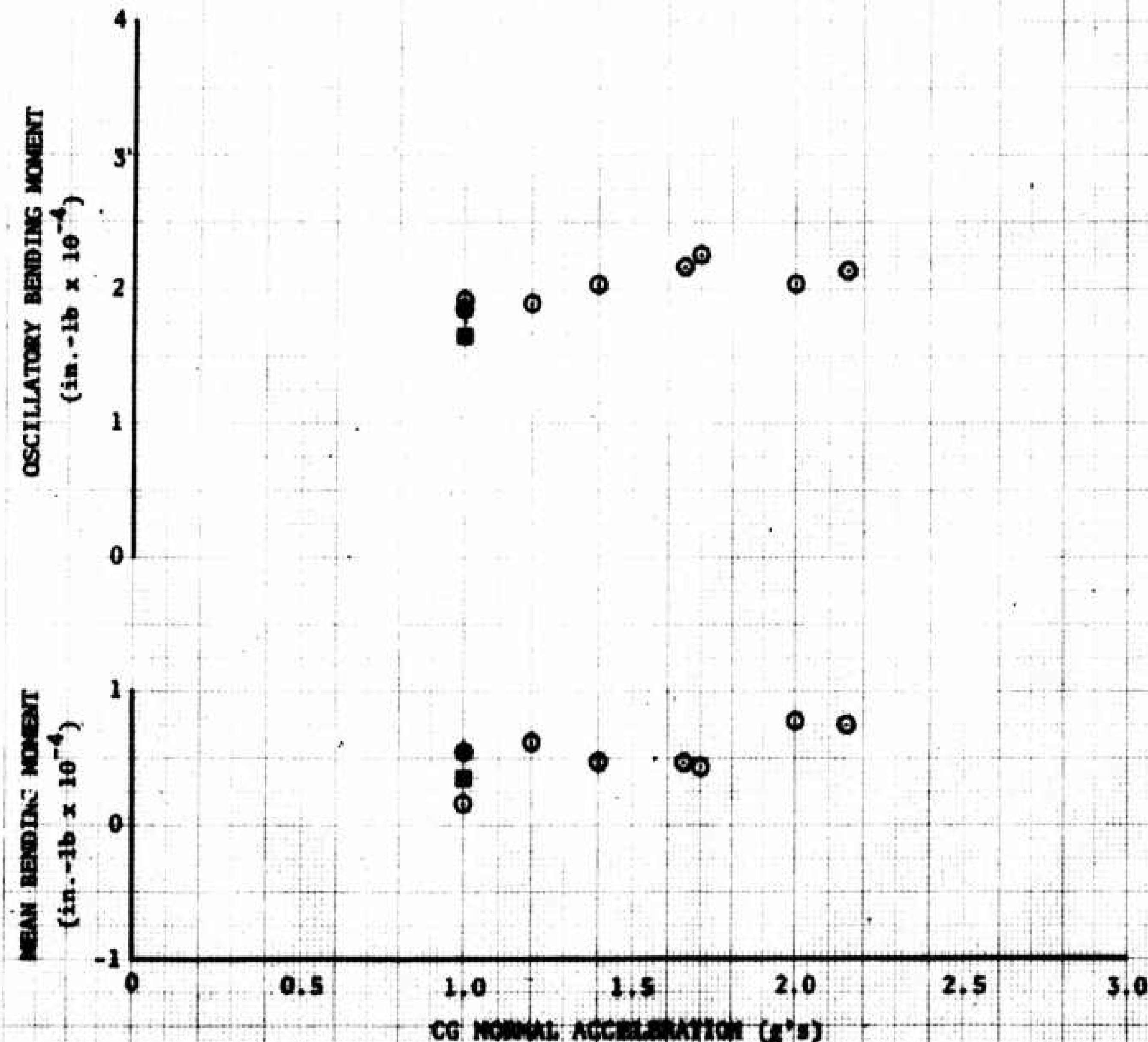


FIGURE 45
MAIN ROTOR BLADE BEAMWISE BENDING
BLADE STATION 110 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-1[illegible]

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
O	5000	7520	195.6	324	144.5	CLEAN, STD NOSE

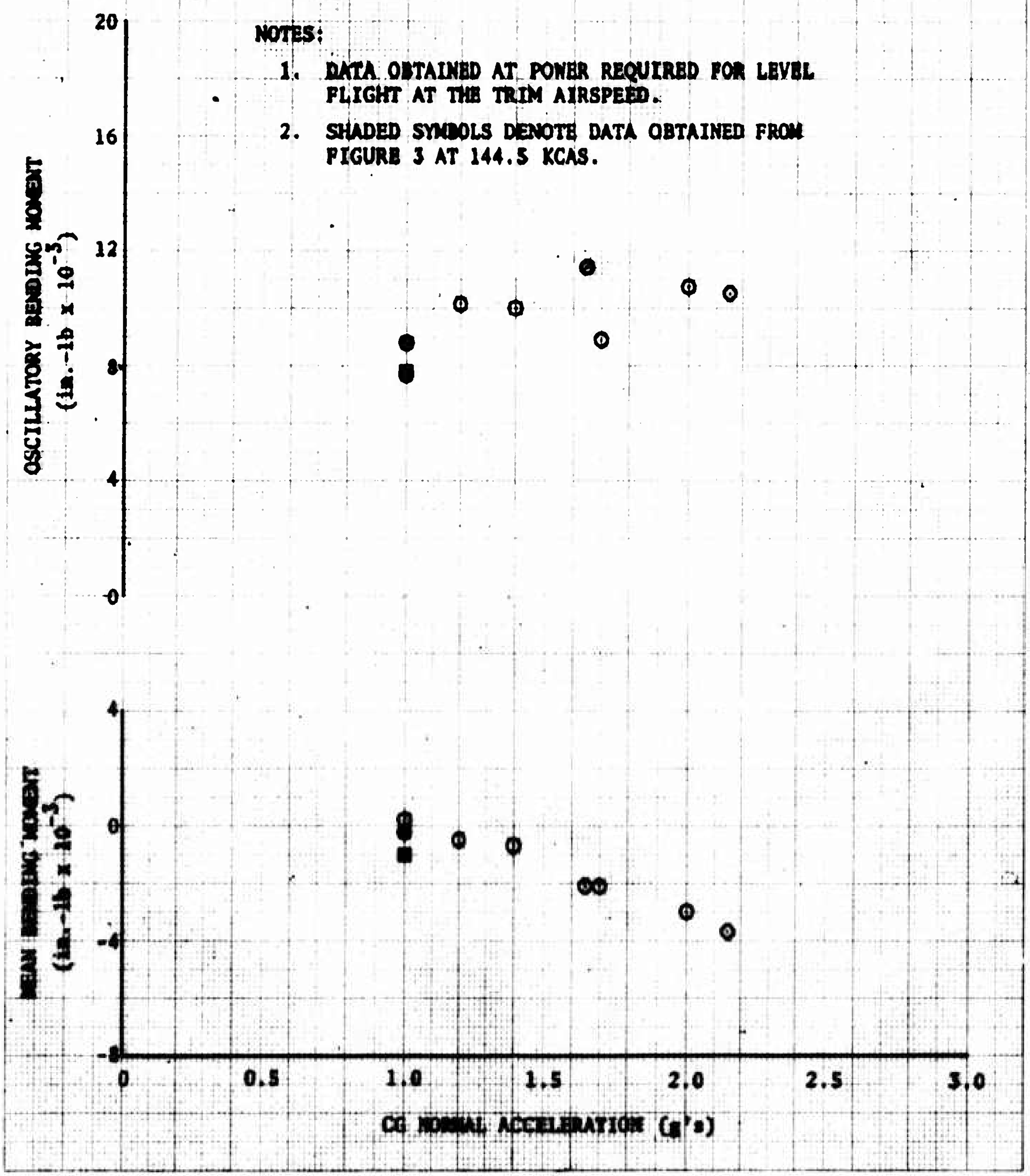


FIGURE 46
MAIN ROTOR BLADE CHORDWISE BENDING
BLADE STATION 135 SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
O	5000	7520	195.6	324	144.5	CLEAN, STD NOSE

NOTES: 1. DATA OBTAINED AT POWER REQUIRED FOR LEVEL FLIGHT AT THE TRIM AIRSPEED.
2. SHADED SYMBOLS DENOTE DATA OBTAINED FROM FIGURE 4 AT 144.5 KCAS.

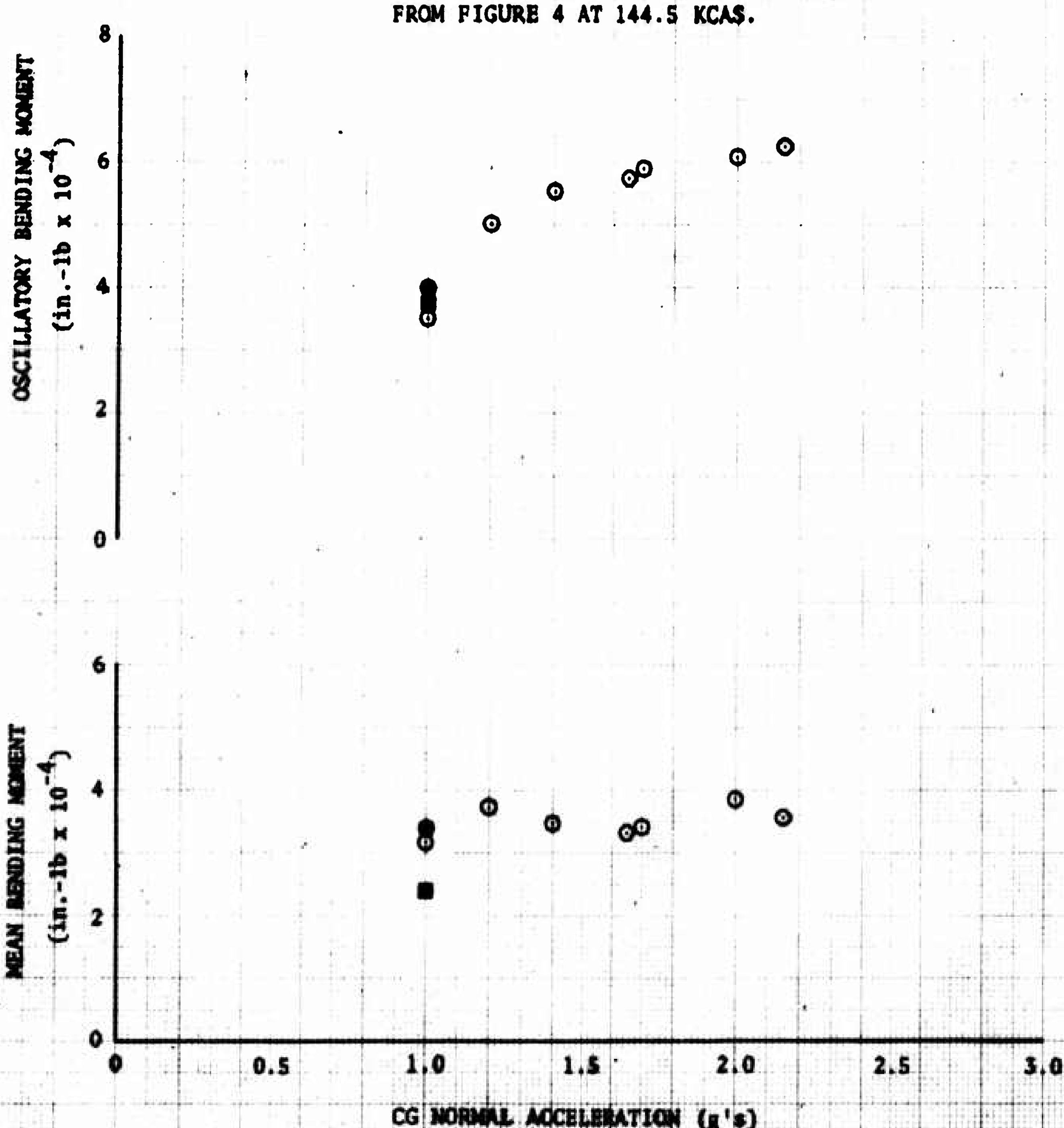


FIGURE 48
DRAG BRACE AXIAL LOAD
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15295

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
⊙	5000	7520	195.6	324	144.5	CLEAN, STD NOSE

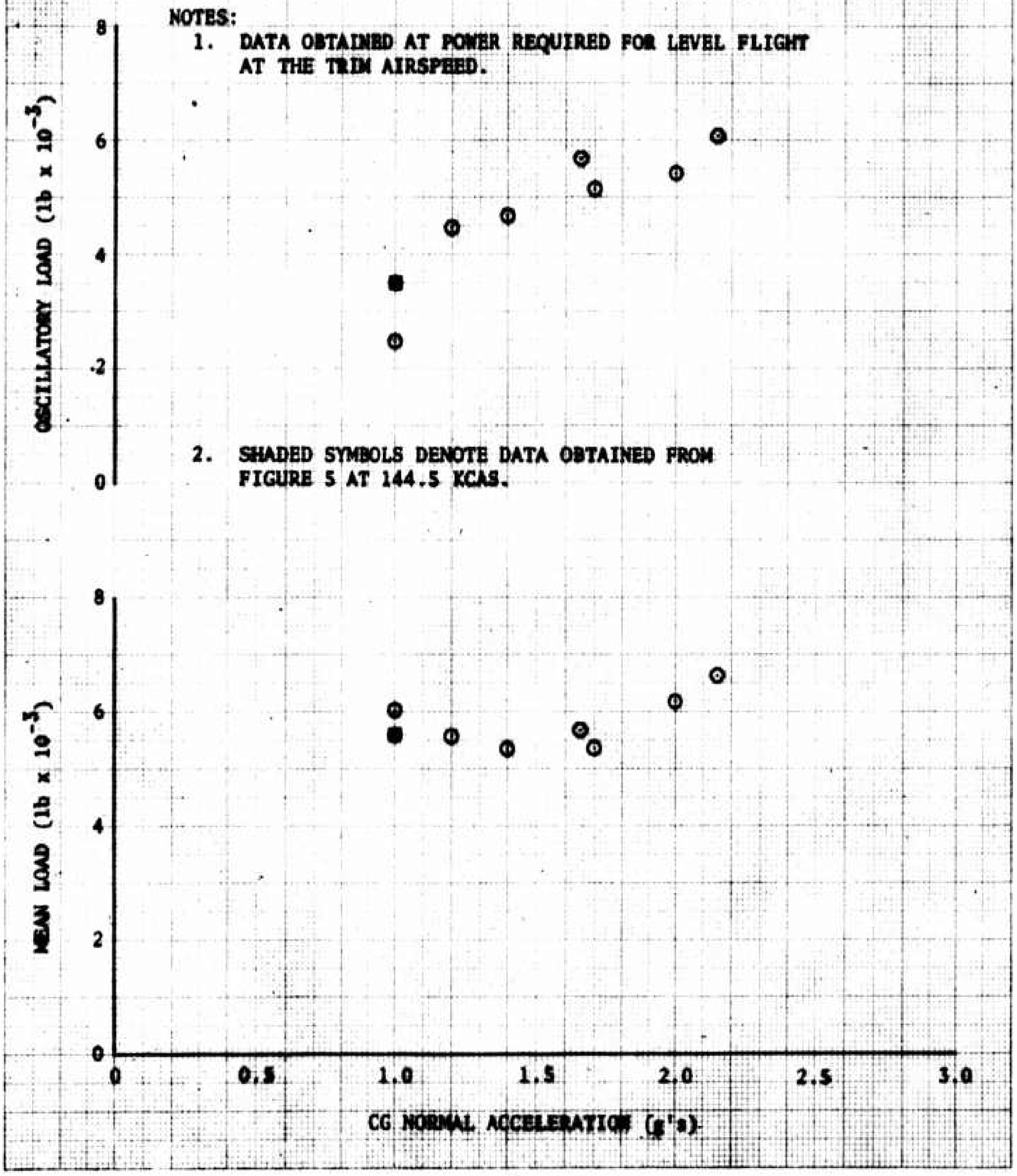


FIGURE 48
LATERAL BOOST TUBE AXIAL LOADS
SYMMETRICAL PULL-OUTS
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	TRIM CALIB AIRSPEED (kt)	CONFIGURATION
O	5000	7520	195.6	324	144.5	CLEAN, STD NOSE

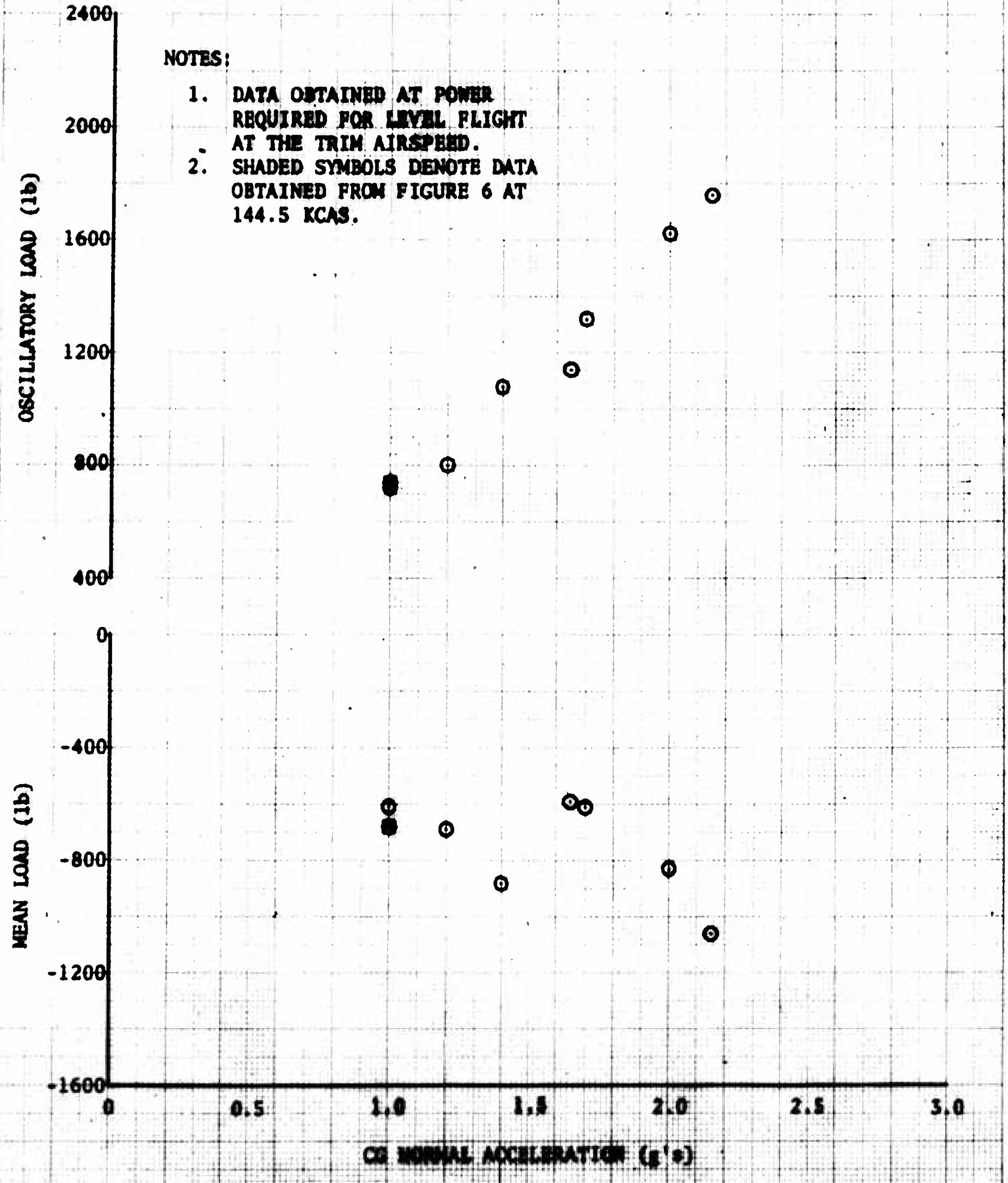


FIGURE 49
STATIC TRIM STABILITY
FORWARD FLIGHT
AH-1G USA S/N 66-15283

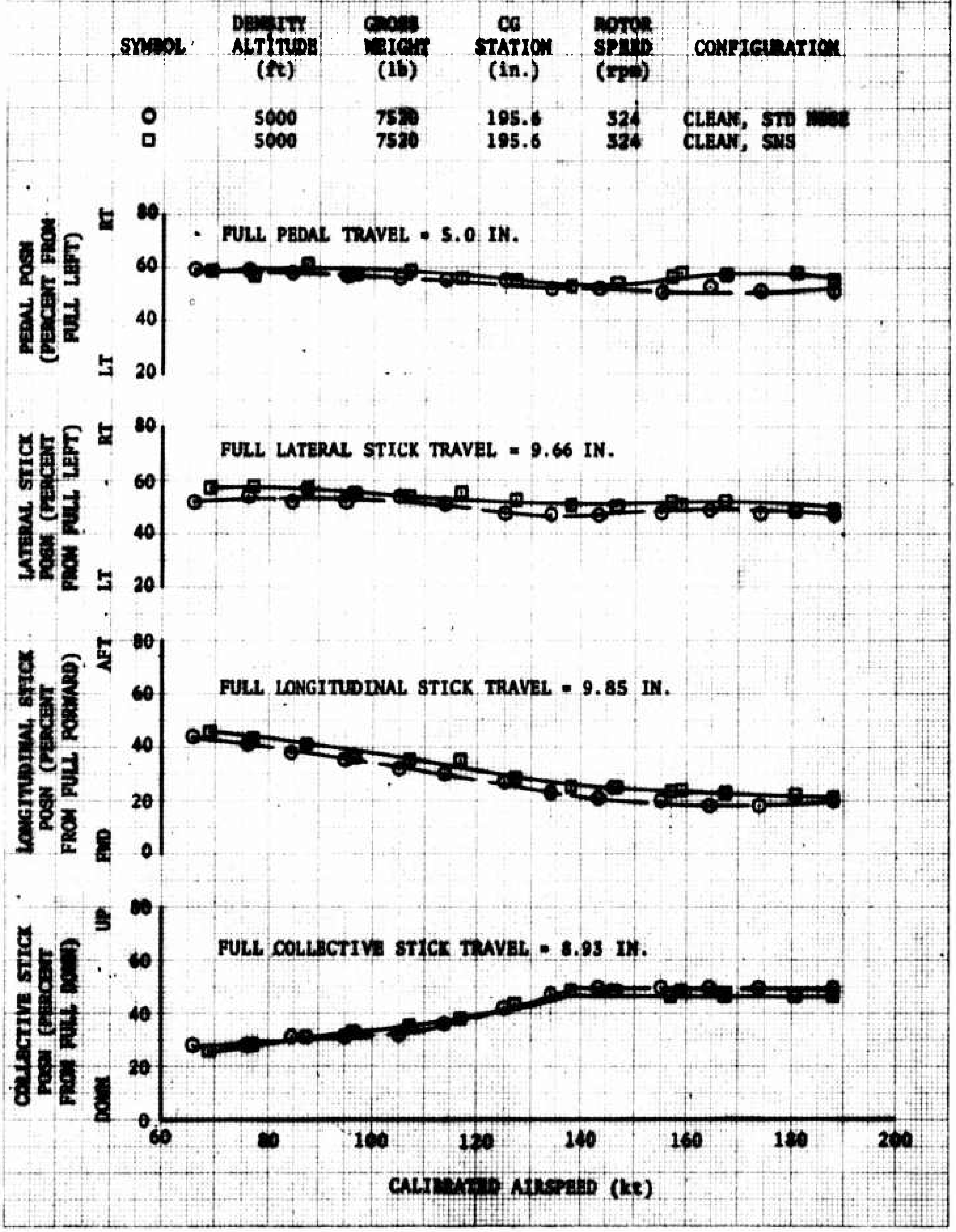


FIGURE 50
STATIC TRIM STABILITY
FORWARD FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5000	9240	195.4	324	HVY SCOUT, STD NOSE
□	5000	9240	195.4	324	HEAVY SCOUT, SNS

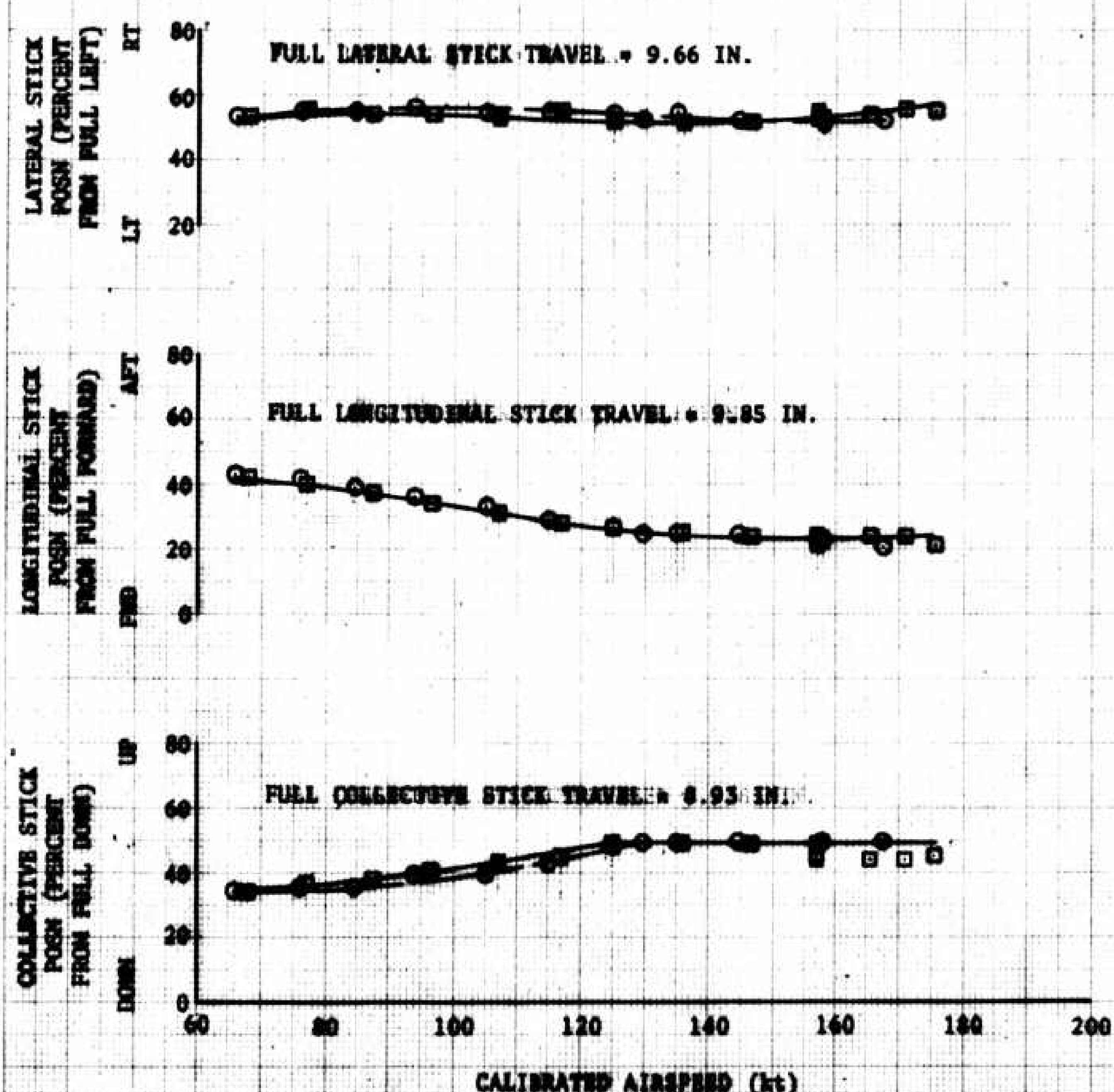


FIGURE 51
STATIC LATERAL-DIRECTIONAL STABILITY
LEVEL FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	GROSS WEIGHT (lb)	CG STATION (in.)	DENSITY ALTITUDE (ft)	ROTOR SPEED (rpm)	CALIBRATED AIRSPEED (kt)	CONFIGURATION
○	9240	195.4	5000	324	129.5	HVY SCOUT, STD NOSE
□	9240	195.4	5000	324	127.0	HVY SCOUT, SNS

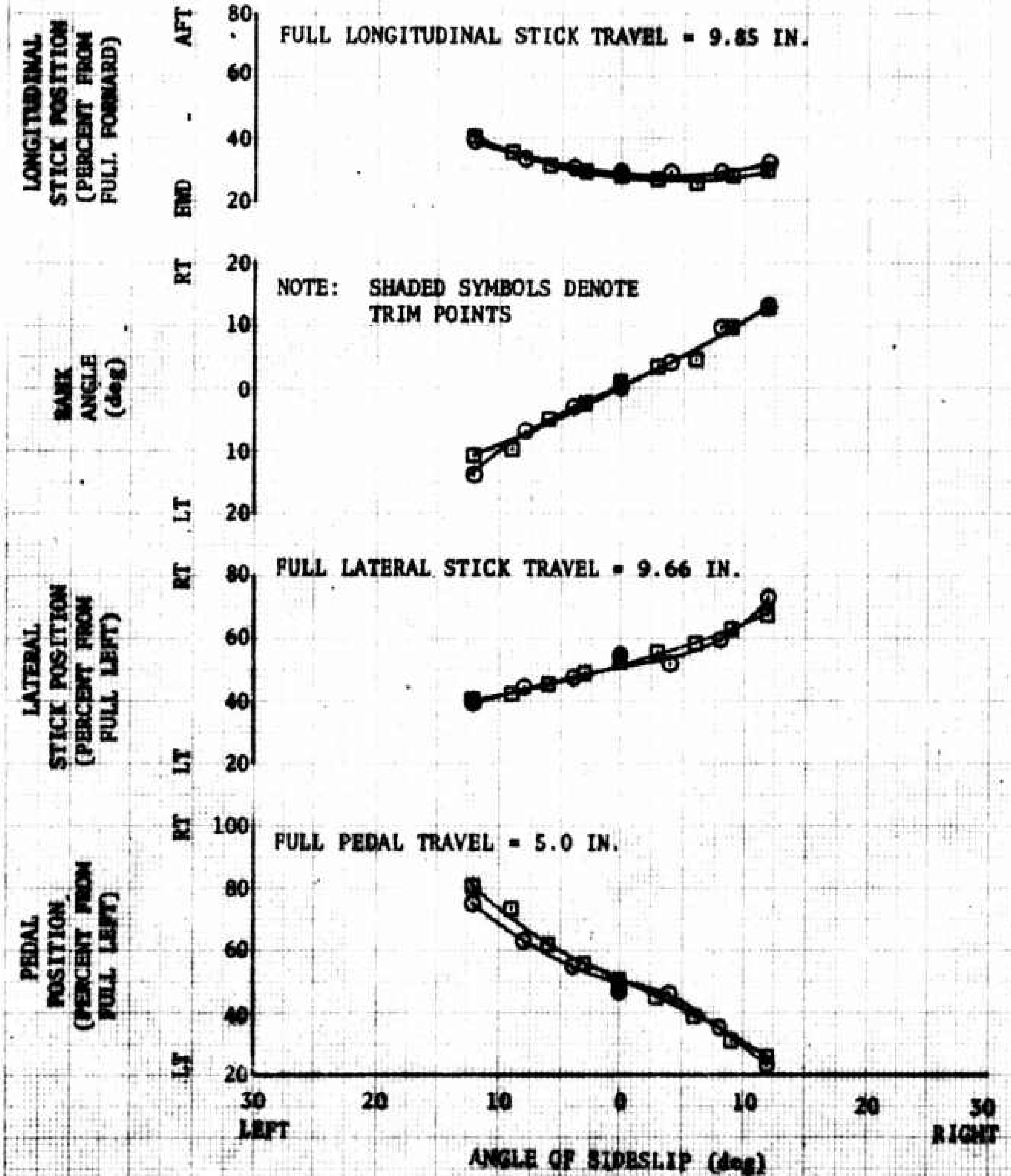


FIGURE 52
STATIC LATERAL-DIRECTIONAL STABILITY
LEVEL FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	GROSS WEIGHT (lb)	CG STATION (in.)	DENSITY ALTITUDE (ft)	ROTOR SPEED (rpm)	CALIBRATED AIRSPEED (kt)	CONFIGURATION
□	7520	195.6	5000	324	127	CLEAN, SNS

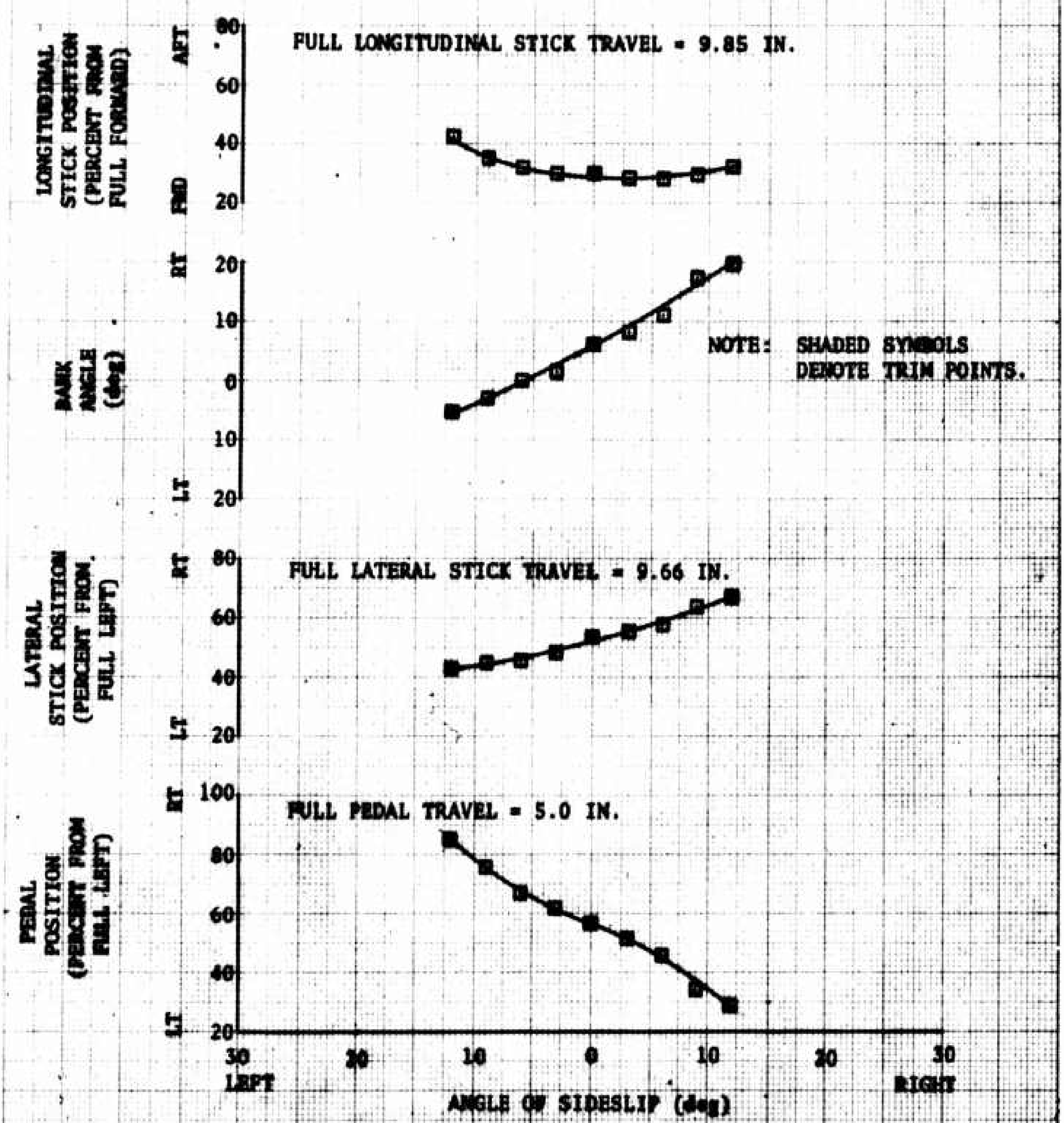


FIGURE 53
STATIC LATERAL-DIRECTIONAL STABILITY
LEVEL FLIGHT
AH-1G USA S/N 66-15293

SYMBOL	GROSS WEIGHT (lb)	CG STATION (in.)	DENSITY ALTITUDE (ft)	ROTOR SPEED (rpm)	CALIBRATED AIRSPEED (kt)	CONFIGURATION
□	9240	195.4	5000	324	158.5	HEAVY SCOUT, SNS

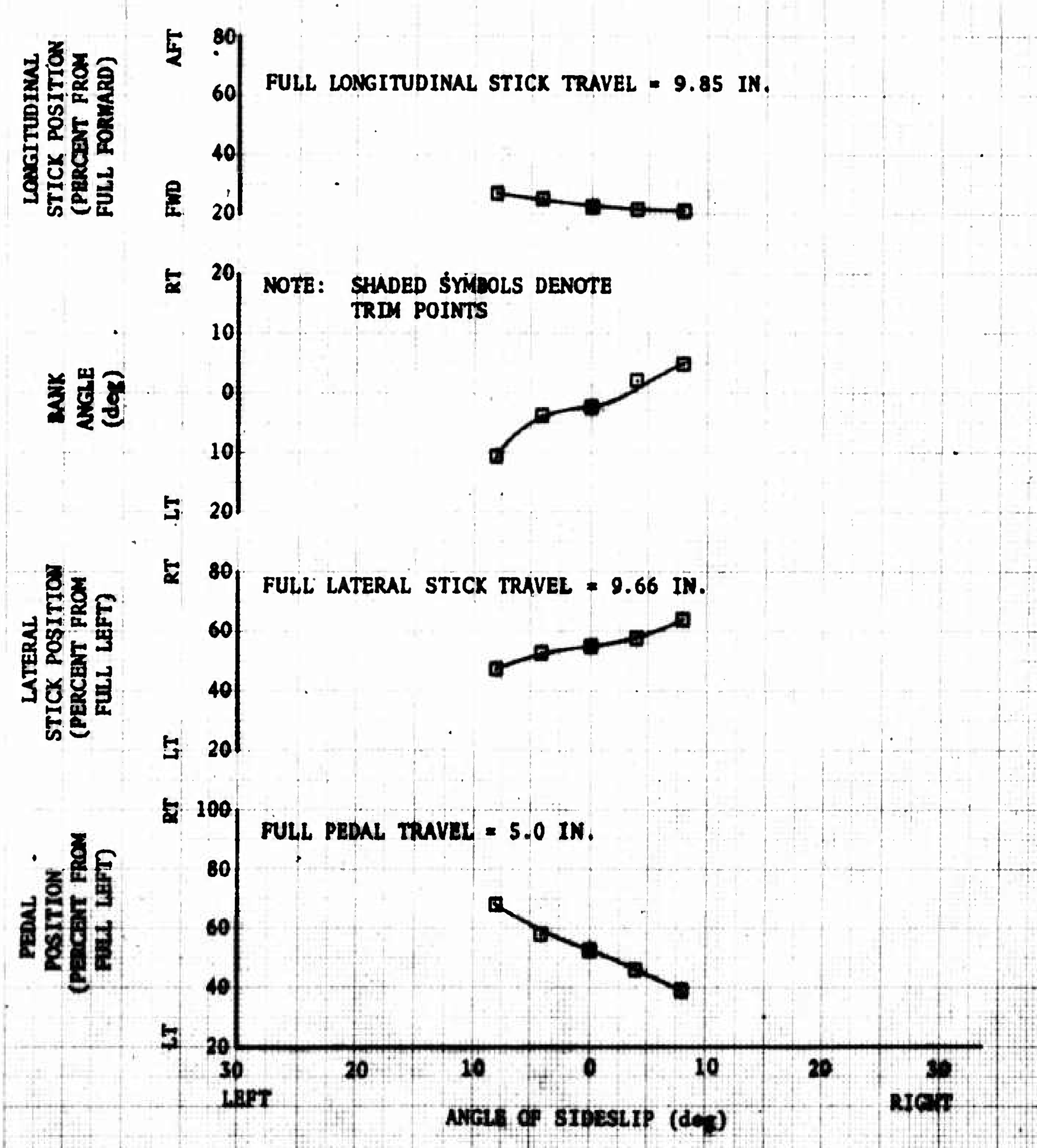


FIGURE 54
NONDIMENSIONAL LEVEL FLIGHT PERFORMANCE
AH-1G USA S/N 66-15293

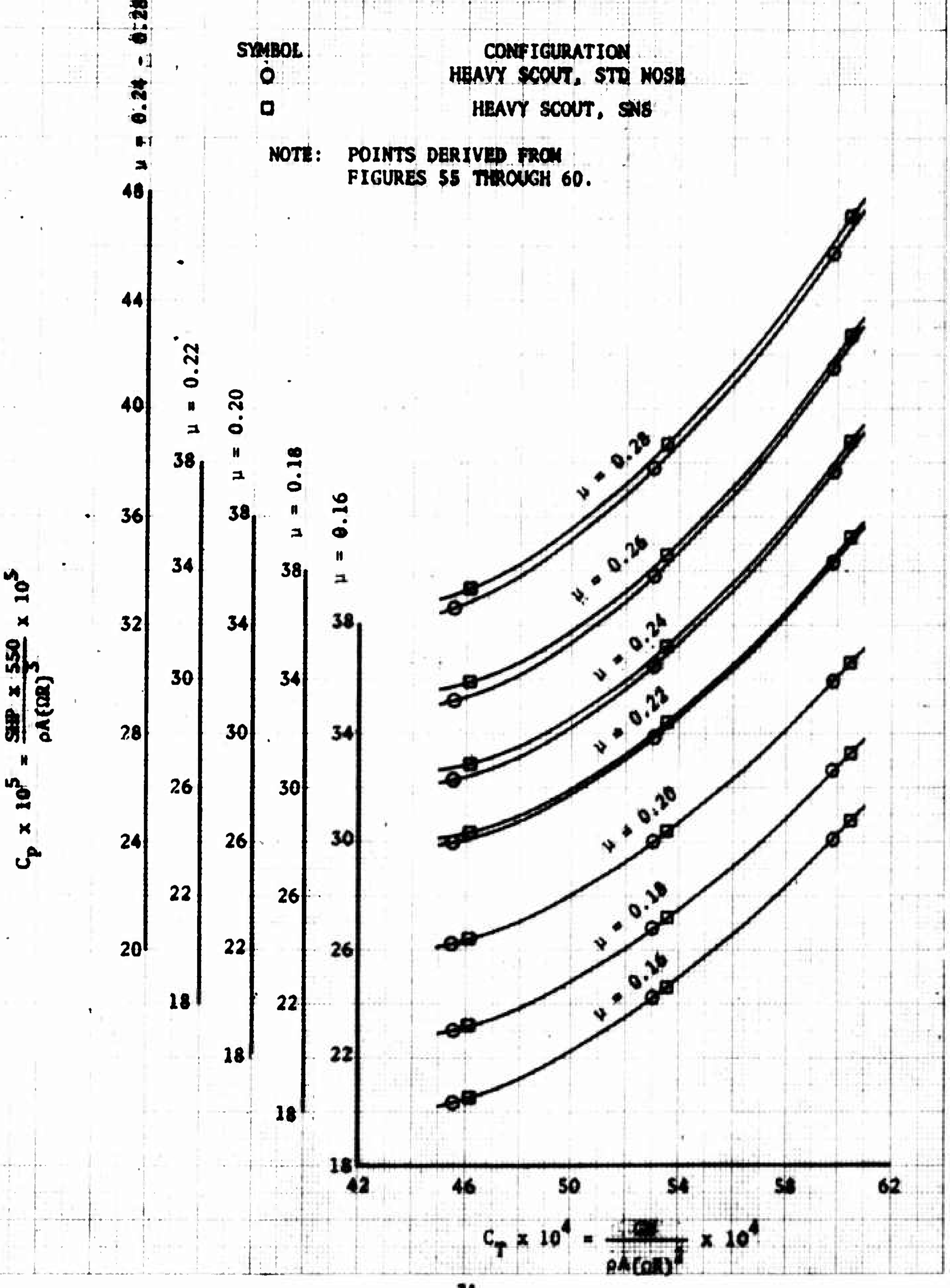


FIGURE 55
LEVEL FLIGHT PERFORMANCE
AH-1G USA S/N 66-15293

DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	THRUST COEFFICIENT	CONFIGURATION
9400	8120	191.8	324	0.005357	HVY SCOUT, SNS

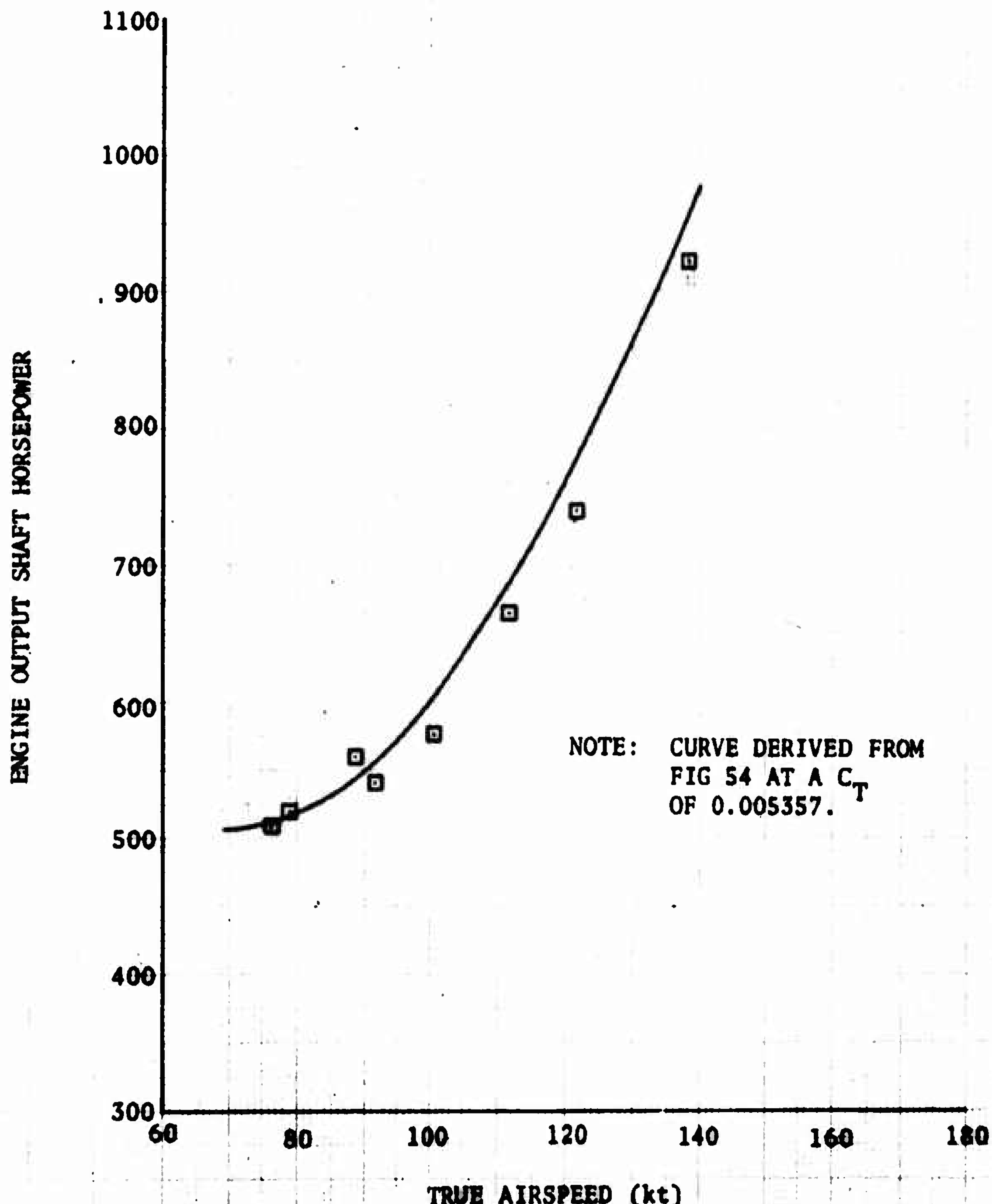


FIGURE 56
LEVEL FLIGHT PERFORMANCE
AH-1G USA S/N 66-15295

DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	THRUST COEFFICIENT	CONFIGURATION
4690	8080	191.8	324	0.004612	HVY SCOUT, SNS

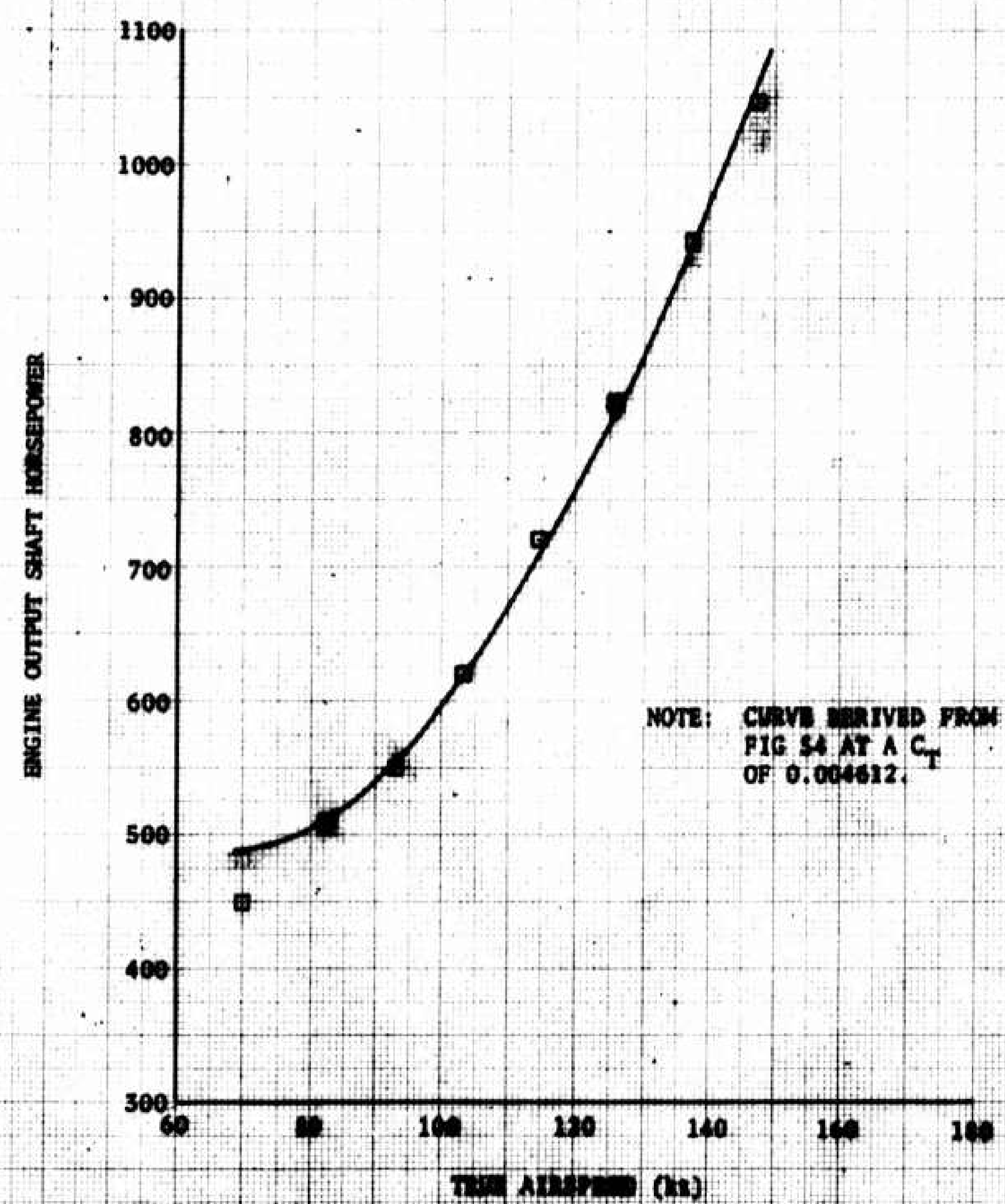


FIGURE 57
LEVEL FLIGHT PERFORMANCE
AH-1G USA S/N 66-15295

DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	THRUST COEFFICIENT	CONFIGURATION
9270	9200	192.7	324	0.006051	HVY SCOUT, SNS

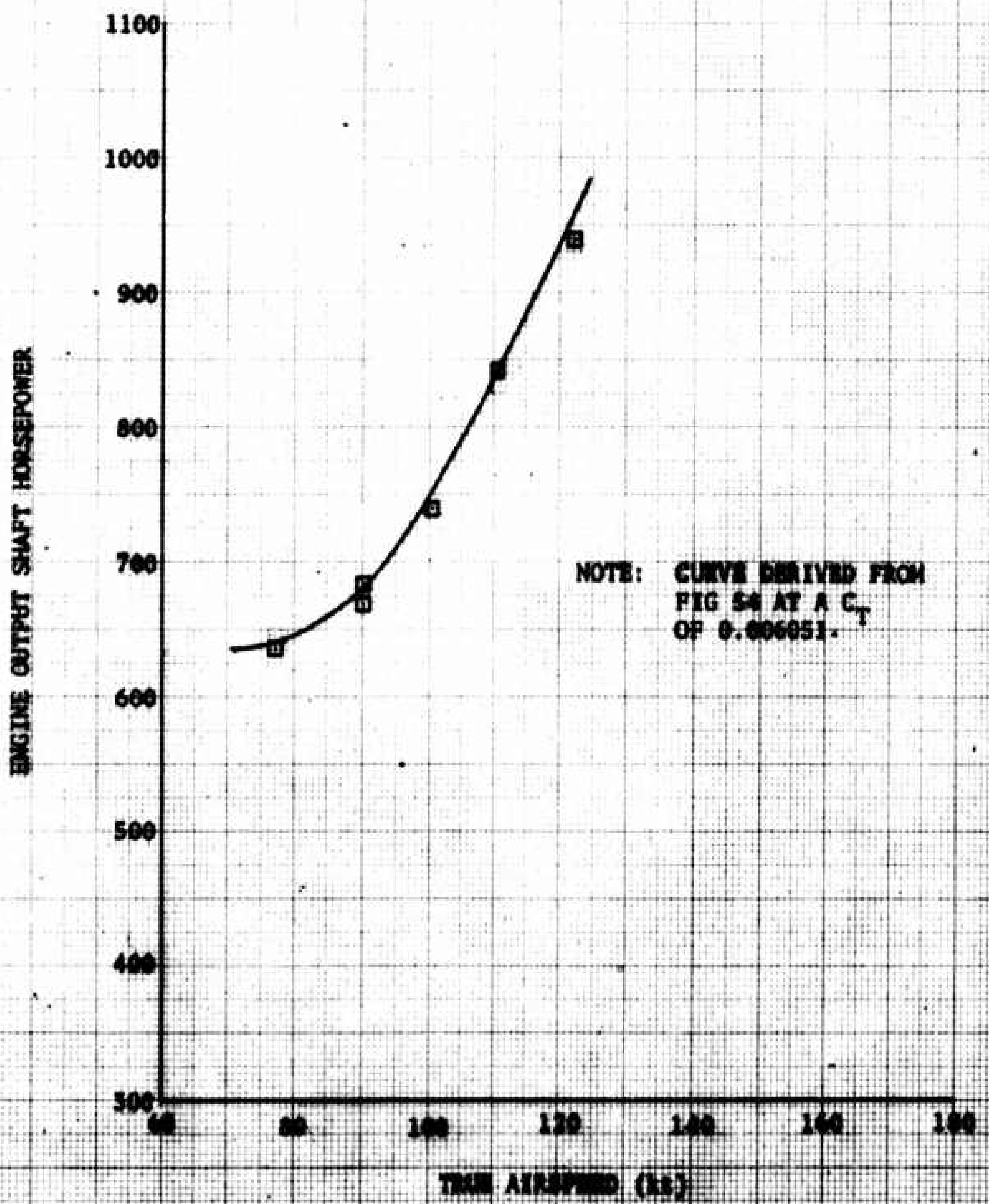


FIGURE [illegible]
LEVEL FLIGHT PERFORMANCE
AH-1G USA S/N 66-15293

DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	THRUST COEFFICIENT	CONFIGURATION
9770	7940	192.6	324	0.005303	HVY SCOUT, STD NOSE

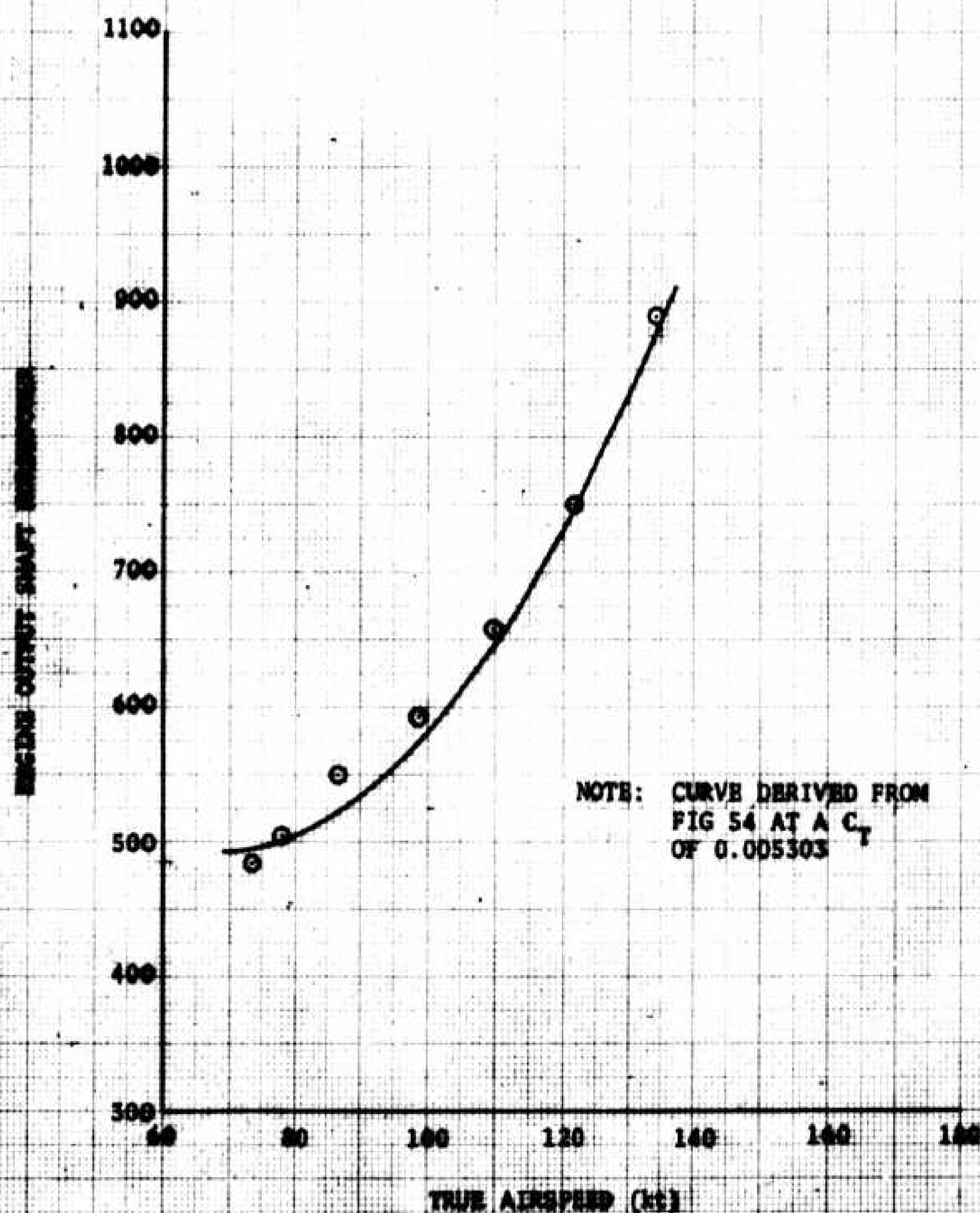


FIGURE 59

LEVEL FLIGHT PERFORMANCE

AH-1G USA S/N 66-15293

DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	THRUST COEFFICIENT	CONFIGURATION
9360	9080	193.1	324	0.005985	HVY SCOUT, STD NOSE

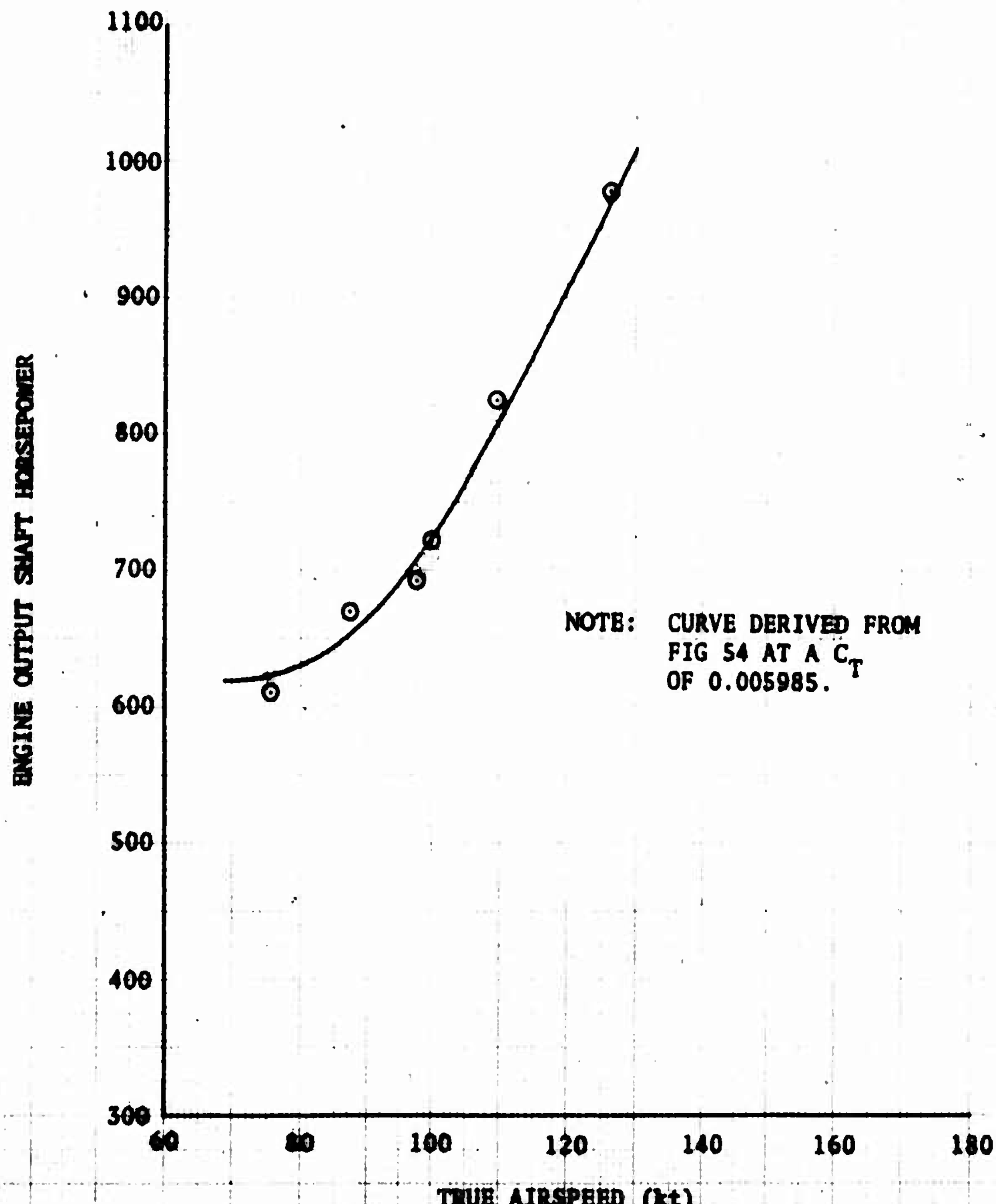


FIGURE 60
LEVEL FLIGHT PERFORMANCE
AH-1G USA S/N 66-15293

DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	THRUST COEFFICIENT	CONFIGURATION
4860	7940	192.6	324	0.004555	HVY SCOUT, STD NOSE

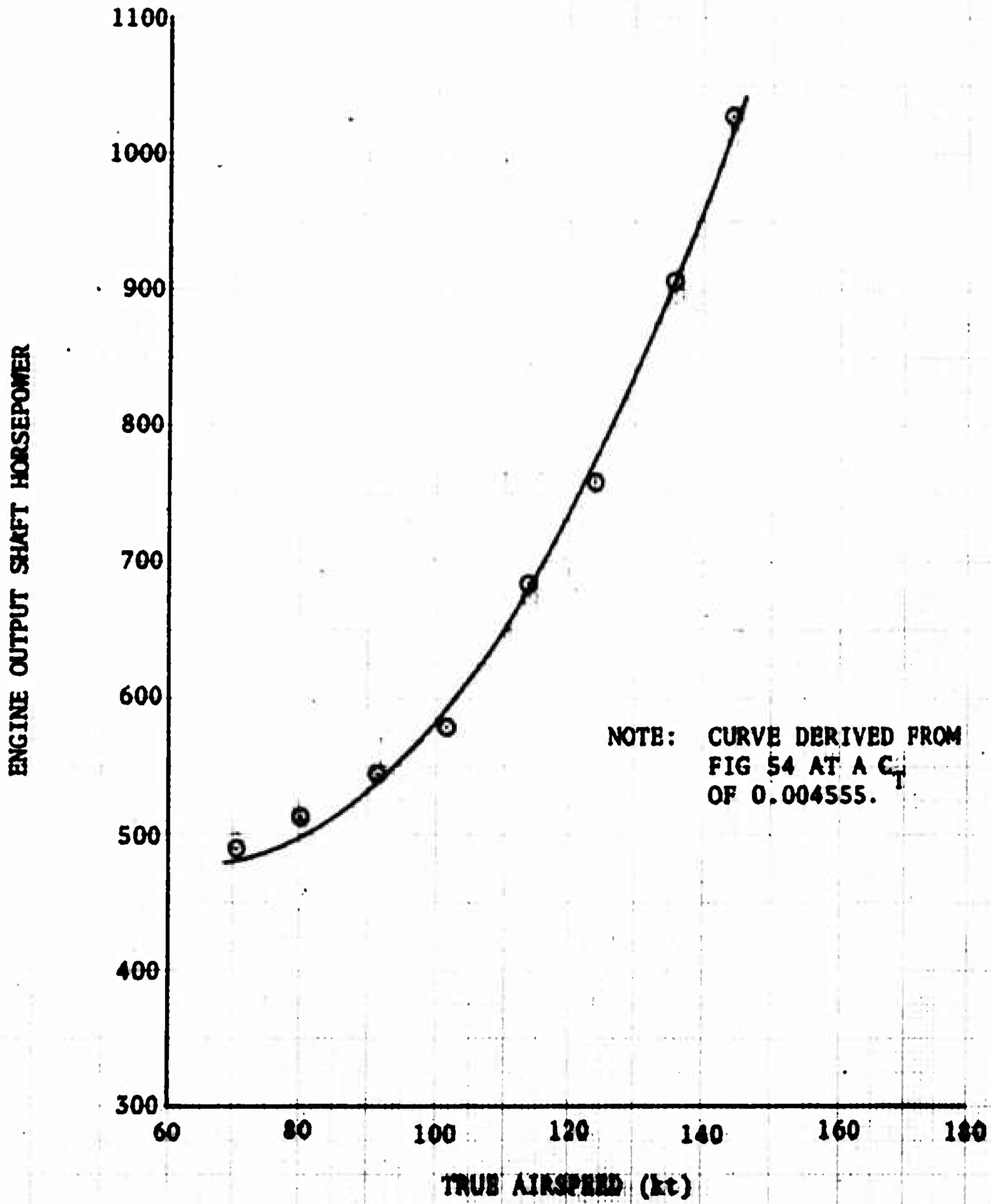
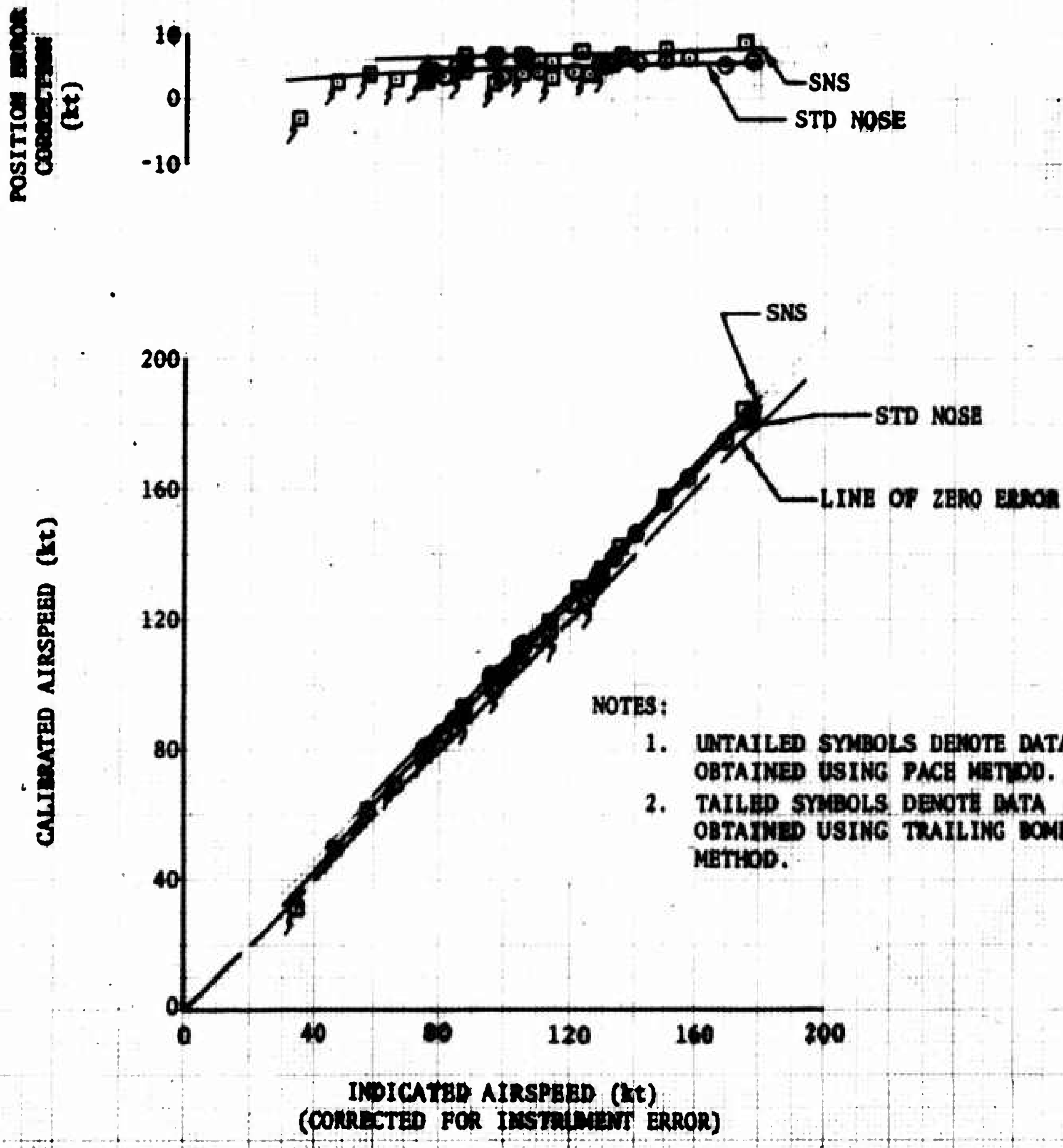


FIGURE 61
AIRSPEED CALIBRATION
AH-1G USA S/N 68-15293
TEST (BOOM) SYSTEM

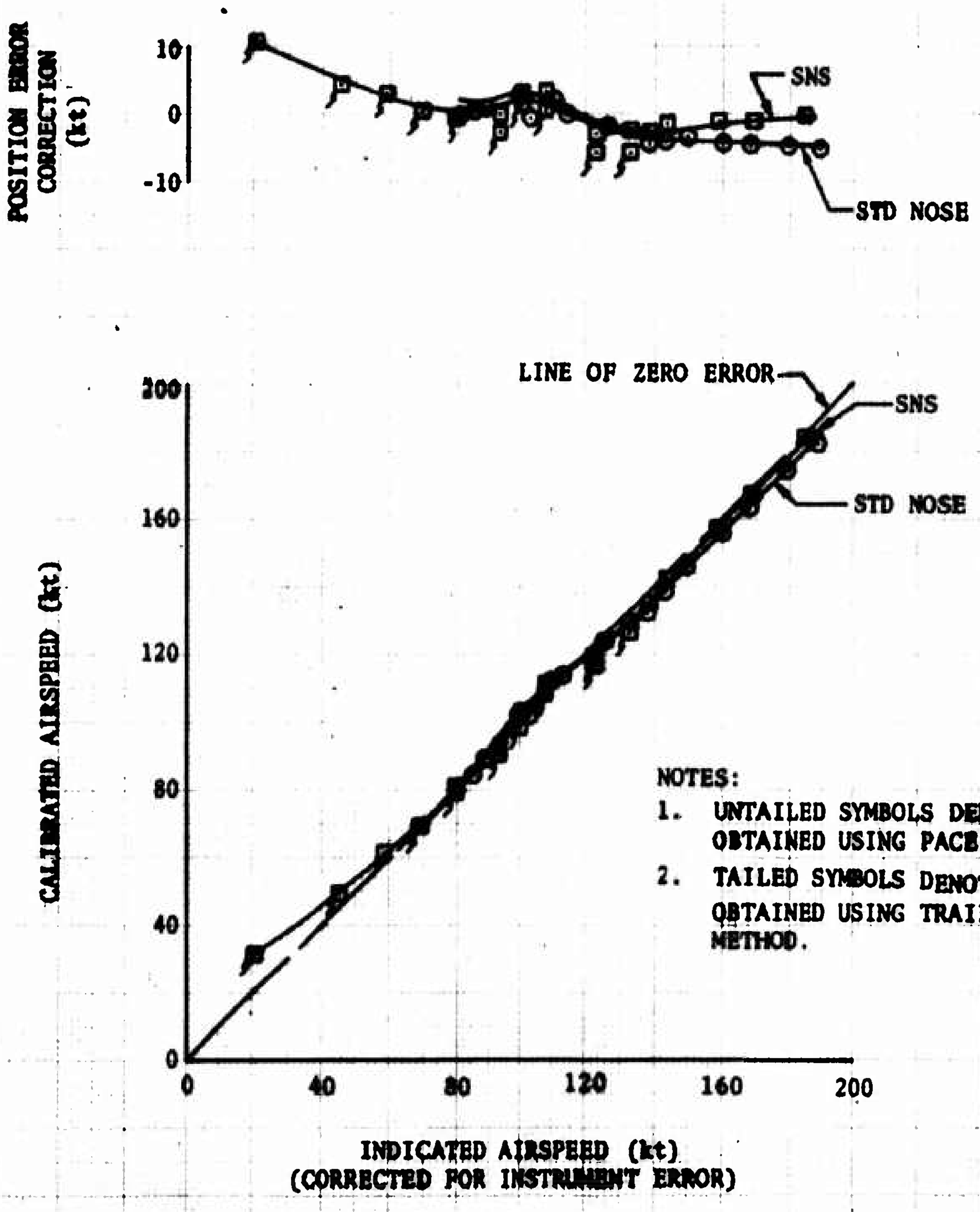
SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5700	7480	196.2	324	CLEAN, STD NOSE
□	5990	7980	195.6	324	CLEAN, SNS



NOTES:
1. UNTAILED SYMBOLS DENOTE DATA OBTAINED USING PACE METHOD.
2. TAILED SYMBOLS DENOTE DATA OBTAINED USING TRAILING BOMB METHOD.

FIGURE 69
AIRSPEED CALIBRATION
AH-1G USA S/N 66-15303
MODIFIED STANDARD SYSTEM

SYMBOL	DENSITY ALTITUDE (ft)	GROSS WEIGHT (lb)	CG STATION (in.)	ROTOR SPEED (rpm)	CONFIGURATION
○	5700	7480	196.2	324	CLEAN, STD NOSE
□	5990	7980	195.6	324	CLEAN, SNS



NOTES:
1. UNTAILED SYMBOLS DENOTE DATA OBTAINED USING PACE METHOD.
2. TAILED SYMBOLS DENOTE DATA OBTAINED USING TRAILING BOMB METHOD.

Table A. Rotor and Control Loads During Maneuvering Flight.

Density altitude: 5000 feet
Rotor speed: 324 rpm

Configuration: clean, standard nose

Gross weight: 7520 pounds
CG station: 195.6 inches

Maneuver	Calibrated Airspeed (kts)	Normal Acceleration (g)	Bank Angle (deg)	Blade Beam Bending at Station 46		Blade Beam Bending at Station 60		Blade Beam Bending at Station 110	
				Mean (in.-lb)	Oscillatory (in.-lb)	Mean (in.-lb)	Oscillatory (in.-lb)	Mean (in.-lb)	Oscillatory (in.-lb)
SPO,[1] collective input	125	1.5	0	11720	14416	2828	11769	-2636	8038
SPO, collective input	125	1.6	0	11720	20532	4377	16414	-1921	8753
SPO, collective input	125	1.8	0	20020	22716	6544	17344	-1743	7502
SPO, collective input	125	1.7	0	14341	20532	4686	15485	-3529	8217
SPO, collective input	125	1.9	0	16962	31016	4686	21680	-2814	9289
SPO, collective input	125	2.0	0	13468	17910	3137	13317	-3172	8574
SPO, collective input	125	1.8	0	11720	18784	4686	14866	-3172	8217
Left RPO[2] (30-psi torque)	166	2.3	-	13031	15726	-1508	13008	-4958	10718
Left RPO (maximum power)	166	2.3	-	15652	24463	6235	21370	-3529	13576
Right RPO (30-psi torque)	166	2.0	-	7789	23589	-2437	20131	-4600	12504
Right RPO (maximum power)	166	2.3	-	19146	30579	2828	22299	-4065	14111

Maneuver	Calibrated Airspeed (kts)	Normal Acceleration (g)	Bank Angle (deg)	Blade Chord Bending at Station 135		Drag Brace Axial Load		Lateral Boost Tube Axial Load	
				Mean (in.-lb)	Oscillatory (in.-lb)	Mean (lb)	Oscillatory (lb)	Mean (lb)	Oscillatory (lb)
SPO, collective input	125	1.5	0	25509	31887	6675	3034	-618	952
SPO, collective input	125	1.6	0	22958	38264	5958	3751	-754	1150
SPO, collective input	125	1.8	0	28698	49743	5571	3917	-452	1341
SPO, collective input	125	1.7	0	27423	52932	6730	3861	-599	1131
SPO, collective input	125	1.9	0	36989	55483	4578	4909	-575	1230
SPO, collective input	125	2.0	0	26785	51019	8164	3861	-531	1238
SPO, collective input	125	1.8	0	22321	58034	7281	4303	-531	1175
Left RPO (30-psi torque)	166	2.3	-	16262	36670	9047	2868	-797	1366
Left RPO (maximum power)	166	2.3	-	26466	63455	7061	6399	-1014	1916
Right RPO (30-psi torque)	166	2.0	-	16900	44323	8054	4413	-1329	1712
Right RPO (maximum power)	166	2.3	-	31887	94385	12687	12687	-785	1774

[1]Symmetrical pullout.
[2]Rolling pullout.

Table B. Rotor and Control Loads During Maneuvering Flight.

Density altitude: 5000 feet
Rotor speed: 324 rpm

Configuration: heavy scout, standard nose

Gross weight: 9240 pounds
CG station: 195.4 inches

Maneuver	Calibrated Airspeed (kts)	Normal Acceleration (g)	Bank Angle (deg)	Blade Beam Bending at Station 46 Mean (in.-lb)	Blade Beam Bending at Station 46 Oscillatory (in.-lb)	Blade Beam Bending at Station 60 Mean (in.-lb)	Blade Beam Bending at Station 60 Oscillatory (in.-lb)	Blade Beam Bending at Station 110 Mean (in.-lb)	Blade Beam Bending at Station 110 Oscillatory (in.-lb)
SPO, collective input	117	1.7	0	12157	15726	2296	11055	-1698	7586
SPO, collective input	125	1.9	0	14778	16600	3491	11652	-2051	7939
Left RPO	134	2.0	-	19146	30579	6777	21512	-4521	12526
Left RPO	135	2.05	-	16525	31453	3491	23006	-4356	13408
Right RPO	155	2.0	-	20894	30579	7076	21213	-4168	12173
Right RPO	155	2.1	-	21331	29268	5881	20616	-3992	10938

Maneuver	Calibrated Airspeed (kts)	Normal Acceleration (g)	Bank Angle (deg)	Blade Chord Bending at Station 135 Mean (in.-lb)	Blade Chord Bending at Station 135 Oscillatory (in.-lb)	Drag Brace Axial Load Mean (lb)	Drag Brace Axial Load Oscillatory (lb)	Lateral Boost Tube Axial Load Mean (lb)	Lateral Boost Tube Axial Load Oscillatory (lb)
SPO, collective input	117	1.7	0	30649	33809	6967	2830	-618	1175
SPO, collective input	125	1.9	0	30017	42024	6749	3048	-649	1329
Left RPO	134	2.0	-	40760	60982	7075	6422	-1354	2207
Left RPO	155	2.05	-	28232	64142	7021	6803	-1304	2244
Right RPO	155	2.0	-	40760	77412	7130	6586	-1341	2355
Right RPO	155	2.1	-	35388	65721	6749	6749	-1341	-1341

Table C. Rotor and Control Loads During Maneuvering Flight.

Density altitude: 5000 feet
Rotor speed: 324 rpm

Configuration: heavy scout, SNS

Gross weight: 9240 pounds
CG station: 195.6 inches

Maneuver	Calibrated Airspeed (kts)	Normal Acceleration (g)	Bank Angle (deg)	Blade Beam Bending at Station 46		Blade Beam Bending at Station 60		Blade Beam Bending at Station 1[illegible]0	
				Mean (in.-lb)	Oscillatory (in.-lb)	Mean (in.-lb)	Oscillatory (in.-lb)	Mean (in.-lb)	Oscillatory (in.-lb)
Right RPO	179	2.4	-	11740	29573	256	22738	-5838	12896
Left RPO	179	2.5	-	10491	10491	1142	21262	-6186	10805
Left RPO	168	2.4	-	11720	18784	3957	7429	-4792	13941
Right RPO	179	2.4	-	10074	26241	-334	18013	-7058	13070
Steady right turn	107	-	45	13823	12496	4686	8859	-2875	6796
Steady left turn	107	-	45	12157	12496	3800	7383	-2700	6274
Steady left turn	127	-	50	12157	21660	2619	16242	-3572	8888
Steady right turn	127	-	50	11324	19160	2619	17423	-3921	9933
Steady right turn	127	-	50	13823	22492	3505	17718	-3398	8975
Right RPO	179	2.1	-	12574	32072	-2186	28085	-6883	12199
Left RPO	179	2.1	-	8408	33738	2893	21[illegible]13	-5141	9759

Maneuver	Calibrated Airspeed (kts)	Normal Acceleration (g)	Bank Angle (deg)	Blade Chord Bending at Station 135		Drag Brace Axial Load		Lateral Boost Tube Axial Load	
				Mean (in.-lb)	Oscillatory (in.-lb)	Mean (lb)	Oscillatory (lb)	Mean (lb)	Oscillatory (lb)
Right RPO	179	2.4	-	28114	62716	7188	6336	-1614	2187
Left RPO	179	2.5	-	28423	62643	7614	6123	-1460	2356
Left RPO	168	2.4	-	33366	59318	7241	5963	-1027	1893
Right RPO	179	2.4	-	53448	49123	7348	5963	-1835	2319
Steady right turn	107	-	45	14520	55301	5431	2875	-741	976
Steady left trun	107		45	33984	29041	5697	2502	-631	851
Steady left turn	127	-	50	28114	46651	7987	4153	-528	1042
Steady right turn	127	-	50	26260	47269	5537	3301	-638	1005
Steady right turn	127	-	50	36147	47887	5484	3887	-638	1064
Right RPO	179	2.1	-	17024	56745	3312	3714	-1648	2476
Left RPO	179	2.1	-	16314	64548	7328	7127	-1441	2520

APPENDIX IV. DATA REDUCTION AND ANALYSIS METHODS

STRUCTURAL LOADS

1. The structural loads data were obtained by an analysis of the strain gage output as displayed on an oscillograph record. The mean load was defined as the average of the maximum and minimum loads recorded during one revolution of the main rotor. The oscillatory load was defined to be one-half the difference between the maximum and minimum loads recorded during the rotor revolution. The calibration zeros on the beamwise bending-moment parameters included the static load of the rotor blade. In the data reduction process, these static load values (obtained from BHC) were subtracted from the mean beamwise bending moments to obtain the mean moment. The sign convention used in the presentation of the loads data is:

a. Positive for a rotor blade beamwise bending moment that creates tension in the lower blade surface.

b. Positive for a chordwise bending moment that creates tension in the blade-leading edge.

c. Positive for tension in the drag brace and the lateral boost tube.

LEVEL FLIGHT PERFORMANCE

2. Standard nondimensional data reduction techniques used at USAASTA were used in reducing the level-flight performance data. The change in equivalent flat plate area caused by the SNS installation was determined at 124 KTAS using the following equation:

$$\Delta f = \frac{2A\Delta C_P}{\mu^3} \qquad (1)$$

3. The nondimensional coefficients used in the data reduction are defined as follows:

Thrust coefficient:

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

Power coefficient:

$$C_P = \frac{SHP \times 550}{\rho A(\Omega R)^3} \tag{3}$$

where: ΔC_P = The difference between power coefficients of the standard AH-1G nose data and the SNS installed data at a constant thrust coefficient

GW = Gross weight

ρ = Air density ratio

A = Area of the rotor disc

Ω = Rotor angular speed

R = Rotor radius

SHP = Shaft horsepower

μ = True airspeed divided by rotor tip speed

APPENDIX V. STANDARD AH-1G OPERATING LIMITATIONS AND DIMENSIONS

LIMIT AIRSPEED (V_L)

Hog or alternate configuration: 180 knots indicated airspeed (KIAS) below a 3000-foot H_D; decrease 8 KIAS per 1000 feet above 3000 feet

All other configurations: 190 KIAS below a 4000-foot H_D; decrease 8 KIAS per 1000 feet above 4000 feet

GROSS WEIGHT - CENTER OF GRAVITY ENVELOPE

Forward limit: Below 7000 pounds, FS 190; linear decrease from FS 190 at 7000 pounds to FS 192.1 at 9500 pounds

Aft limit: Below 8270 pounds, FS 201; linear decrease from FS 201 at 8270 pounds to FS 200 at 9500 pounds

SIDESLIP LIMITS

Five degrees at 190 KIAS; linear increase to 20 degrees at 60 KIAS

RPM LIMITS

Rotor:
- 294 to 324 rpm, continuous operation
- 339 rpm, maximum for autorotation

Engine:
- 6000 to 6400 rpm, 0 to 70 knots
- 6400 to 6600 rpm, continuous operation
- 6600 rpm, maximum
- 6750 rpm, maximum at or below 91-percent gas producer speed (N_1)

TEMPERATURE AND PRESSURE LIMITS

Engine oil temperature	93°C
Transmission oil temperature	110°C
Engine oil pressure	25 to 100 psi
Transmission oil pressure	30 to 70 psi
Fuel pressure	5 to 20 psi

T53-L-13 ENGINE LIMITS (Installed)

Normal rated (maximum continuous)	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

PHYSICAL CHARACTERISTICS

Aircraft length (rotors turning)	54.5 feet
Fuselage length	44.6 feet
Maximum fuselage width (including stub wings)	10.3 feet
Maximum fuselage width (without stub wings)	3.0 feet

MAIN ROTOR

Rotor diameter	44 feet
Chord	27 inches
Disc area	1520.4 ft^2

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13. ABSTRACT
The Phase II airworthiness and flight characteristics test of the AH-1G helicopter with the stabilized night sight (SNS) installed was conducted by the US Army Aviation Systems Test Activity. The tests were conducted to evaluate the flight envelope of the AH-1G with the SNS installed for significant changes in the structural loads, handling qualities and performance due to this modification. The effects of weapons firing on the SNS system were also evaluated. The structural loads, handling qualities and performance of the AH-1G were not significantly changed by the SNS installation. The published AH-1G flight envelope is satisfactory for the SNS modified aircraft with one exception: due to the aircraft's reactions following sudden engine failure, the engine torque should be limited to less than 35 pounds per square inch, indicated, for all dives to airspeeds greater than 150 KCAS. Four deficiencies require correction before further testing in instrument flight conditions or in a combat environment: the lack of adequate, reliable attitude information for instrument flight; the excessive reflections in the canopy of the cockpit and instrument lights; the lack of a visual display or indication to the pilot of the relative position of targets sighted and tracked by the gunner with the SNS; and the directional control pedal interference. Three shortcomings were found. The correction of these shortcomings would improve mission performance.

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