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USATECOM PROJECT NO. 4-6-0200-03
USAAVNTA PROJECT NO. 66-23

ENGINEERING FLIGHT TEST OF THE CH-47B (CHINOOK) HELICOPTER

PHASE D

INTERIM REPORT

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MARCH 1968

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

Statement 4. Army Materiel Command
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(14) USAAVNTA-66-23

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US ARMY AVIATION TEST ACTIVITY
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INTRODUCTION

BACKGROUND

1. A Chinook Product Improvement Program was initiated to provide significant gains in performance and flying qualities of the CH-47 helicopter. The program (reference 1, appendix I) consists of a two-step process. The aircraft configured for step one has been identified as configuration 1A and designated the CH-47B. The aircraft configured for step two has been identified as configuration II and designated the CH-47C.

2. A test directive (reference 2, appendix I) issued by the US Army Test and Evaluation Command (USATECOM) provided for US Army Aviation Test Activity (USAAVNTA) participation in the product improvement program.

TEST OBJECTIVES

3. The primary objective of these tests was to obtain performance data on the CH-47B helicopter for use in determining contractor compliance with the performance guarantees of the detail specification. The data obtained will also be used for determining compliance with appropriate military specifications, evaluating service suitability, and inclusion in technical manuals and other service publications.

DESCRIPTION

4. The CH-47B is a twin-turbine engine, tandem-rotor helicopter manufactured by Boeing Company, Vertol Division. It is designed to provide air transportation of cargo, troops, and weapons within the combat zone during day, night, visual, and instrument conditions. It is powered by two Lycoming T55-L-7C shaft-turbine engines mounted in separate nacelles on the aft fuselage. The engines simultaneously drive two three-bladed rotors in tandem through a combining transmission, drive shafting, and reduction transmissions. A turbine-engine auxilliary power unit hydraulically drives the aft transmission accessory gear box, which provides hydraulic and electrical power for engine starting and other ground operations when the rotors are stopped. The fuel cells are contained in pods on each side of the fuselage. The helicopter is equipped with four non-retractable landing gear. An entrance door is located at the forward right side of the cabin fuselage section. At the rear of the

cargo compartment is a hydraulically operated combination door and loading ramp. The pilot's seat and controls are located on the right side of the cockpit and the copilot's seat and controls are on the left. The significant changes, as compared with the CH-47A, are as follows:

a. Increased rotor blade area and airfoil camber (droop snoot rotor blades).

b. Increased strength dynamic components to include vertical pin joint assembly, horizontal pin bearing, rotating swashplate, pitch links, and forward and aft rotor shafts.

c. Blunted aft pylon.

d. Forward pylon bleed slot spoilers.

e. Fuselage afterbody strakes.

f. Relocated Stability Augmentation System (SAS) ports.

g. Reduced SAS authority and gain.

h. Lycoming T55-L-7C engines.

SCOPE OF TESTS

5. The performance of the CH-47B helicopter was evaluated to determine compliance with the performance guarantees of the detail specification, ~~(reference 3, appendix I)~~ and to provide data for the flight handbook. A summary of the performance guarantees and comparison of test results are included as appendix IV.

6. Twenty-nine flights, totaling 41.5 hours duration, were conducted with 24 flights and 35.9 hours productive time. All flights were conducted with the HF antenna and the cargo mirror removed. Drag corrections were made for the extension and yaw vane indicator on the forward rotor mast and the Decca dome. The flight conditions for the tests conducted are listed in appendix II.

7. The normal operating limitations listed in reference 4, appendix I, were observed during all tests conducted, however, those limitations did not unduly limit the scope of any test.

METHODS OF TEST

8. Flight test methods as outlined in the CH-47B Flight Test Procedure Document (reference 5, appendix I) and USAAVNTA standard methods were used to acquire test data.

9. A detailed list of the test helicopter instrumentation is included as appendix III. Calibrated engines were installed in the CH-47B for the tests. The fuel flow method was used to determine power required. Actual climb power required was based on extrapolations of the engine calibration curves. A five-foot boom with static and dynamic pressure pickups and yaw/angle of attack vanes was installed on the nose of the aircraft.

CHRONOLOGY

10. The chronology of tests is as follows:

Project test directive received	June 1966
Project aircraft received	8 July 1967
Flight tests started	16 Oct 1967
Flight tests completed	8 Dec 1967
Draft report submitted	16 Feb 1968
Final interim report forwarded	Mar 1968

RESULTS and DISCUSSION

GENERAL

11. The results of these tests show that the CH-47B helicopter met all performance guarantees of the detail specification. An outline of the detail specification performance guarantees and test results are presented in appendix IV. The increase in gross weight and payload capability of the CH-47B in comparison with the CH-47A is particularly noteworthy. The airspeed capability of the CH-47B is approximately 30 knots greater than the CH-47A, however, the vibration levels at the faster airspeeds at light gross weight (below 33,000 lb) and 230 rpm are uncomfortable. A velocity never exceed (V_{ne}) computer or a cruise guide indicator should be installed in the CH-47B to aid the pilot in determining V_{ne} and prevent inadvertent operations above V_{ne}.

MISSION I GROSS WEIGHT

12. The computations used to determine Mission I gross weight are presented in appendix V. The empty weight was determined by weighing the aircraft. The required fuel for the mission was computed from the level flight performance data obtained during these tests. The computed Mission I gross weight was 29,705 lbs, which is 145 lbs less than the estimated Mission I gross weight given in the detail specification.

AIRSPEED POSITION ERROR

13. Flight tests were conducted for the purpose of determining the ship's system airspeed position error and calibrating the boom airspeed system. Figure 1, appendix VI, presents the variation of indicated airspeed with calibrated airspeed for the boom system and figure 2, presents similiar information on the ship's system. Test results show the ship's system airspeed position error varies from a maximum of minus 9.5 knots at 30 KCAS to a minimum of zero position error at 150 KCAS. The CH-47 is primarily used for transportation of supplies, equipment, and personnel over short distances, therefore, numerous takeoffs and landings are conducted and much of the flying time is in the low airspeed range. The airspeed position error in the CH-47B is suitable for service use; however, a reduction of the position error below 70 KCAS is desirable for improved service use. Sufficient test data was not obtained to completely evaluate the airspeed position error during climbs and descents and the results of this data will be presented in the final report.

HOVER PERFORMANCE

14. Flight tests using the free flight hover method were conducted for use in evaluating the out-of-ground-effect (OGE) hover capability of the CH-47B helicopter. Test results from the CH-47 APE I were used to aid in fairing the line through the data obtained. The OGE hover performance of the CH-47B is presented in figures 3 and 4, appendix VI. Test results extrapolated from sea level data show the CH-47B exceeded the detail specification guarantee to hover OGE for 10 minutes at Mission I GW (29,705 lb) on a 95-degree Fahrenheit day at 6000 ft by 1050 ft (17.5 percent). Test results also show the CH-47B exceeded the detail specification guarantee to hover OGE on a standard day at sea level at 38,000 lb by 2250 lb (5.9 percent). The excellent hover performance characteristics of the CH-47B helicopter enhance its operational capability.

LEVEL FLIGHT PERFORMANCE

15. Flight tests using standard methods of test were conducted for use in evaluating the level flight performance of the CH-47B helicopter. Test day data were corrected to level unaccelerated flight conditions by standard energy corrections. The data were then generalized into the following parameters:

$$\frac{GW}{\delta} \qquad \frac{SHP}{\delta\sqrt{\theta}} \qquad \frac{V}{\sqrt{\theta}} \qquad \text{and} \qquad \frac{N}{\sqrt{\theta}}$$

The resultant power required curves, and the power available obtained from the manufacturer's data presented in reference 6, appendix I, were used to determine guarantee compliance.

16. Test results show the CH-47B exceeded the detail specification guarantee to cruise at 150 knots on a standard day at sea level, normal rated power, and 33,000 lb GW by 10 knots (6.7 percent) (figure 5, appendix VI). A qualitative evaluation of the cruise speed capability of the CH-47B indicates that V_{ne} can easily be exceeded when operating at 225 rotor rpm before the airframe vibration levels become too uncomfortable, however, the V_{ne} when operating at 230 rotor rpm would not normally be exceeded because the vibration levels become uncomfortable before V_{ne} is reached. The airframe vibration levels are greater at the lighter gross weights. The level flight vibration characteristics of the CH-47B are assigned a Pilot's Rating Scale (PRS) of A4, (appendix VII). To aid pilots in determining V_{ne} and present inadvertent operations above V_{ne} it is recommended that a V_{ne} computer or a cruise

guide indicator be installed in the CH-47B helicopter. The computer should show the V_{ne} for both 225 and 230 rotor rpm.

17. Test results show the CH-47B exceeded the detail specification radius of action guarantee of 100 nautical mile (NM) during Mission I by 6 NM (6 percent) (figures 5 thru 9, appendix VI). Test results also show the Mission I payload could be increased from 6000 lb outbound and 3000 lb inbound to 7221 lb outbound and 3610 inbound (20 percent increase) for 100 NM (figure 9, appendix VI). The increased payloads meet the range, and OGE hover guarantees for Mission I, however, the single engine service ceiling for the increased payload was not determined.

18. The level flight performance characteristics of the CH-47B are suitable for operational use, however, reduction of the airframe vibration levels when operating at 230 rotor rpm is desirable for improved operational capability.

SINGLE ENGINE CLIMB PERFORMANCE

19. The single engine climb performance of the CH-47B helicopter was evaluated by two methods. The first method consisted of actual single engine climbs and the second method by computation from level flight performance tests data as prescribed in reference 2, appendix I. The results of these tests are presented in figures 10 thru 12, appendix VI.

20. The single engine service ceiling of the CH-47 helicopter was determined from level flight data by conducting power correction (K_p) flight to determine the variation of power with the rate of climb and level flights to determine the minimum power required. The K_p determined and the power available were used to compute the single engine service ceiling. Using the level flight method computation shows the single engine service ceiling of the CH-47B to be 7575 ft, which exceeds the detail specification guarantee of 6000 ft by 1575 ft (26.2 percent). This computation was determined by assuming a linear relationship between climb performance based on level flight data and actual climb data.

21. The single engine service ceiling of the CH-47B was also determined by actual single engine climbs. Corrections for rotor rpm, gross weight variaiton, acceleration, power available, and air density were applied to test day data and these data were then plotted to show the standard day variation of rate of climb with altitude. Test results based on actual single engine climb performance show the single engine service ceiling

of the CH-47B to be 6900 ft (figure 12, appendix VI) which exceeds the detail specification guarantee of 6000 ft by 900 ft (15 percent).

22. Test results show the CH-47B single engine service ceiling calculation, based on the level flight method exceeds the single engine service ceiling obtained from actual single engine climbs by 675 ft. Additional tests should be conducted to fully evaluate the two methods of determining single engine service ceiling. The single engine performance of the CH-47B helicopter is suitable for operational use.

CONCLUSIONS

GENERAL

23. The increase in gross weight and payload capability of the CH-47B in comparision with the CH-47A is particularly outstanding (para 11).

24. The increase airspeed capability of the CH-47B is approximately 30 knots greater than the CH-47A, however, the vibration levels at faster speeds, light gross weights and 230 rotor rpm are uncomfortable (para 11 and 16).

DEFICIENCIES AND SHORTCOMINGS AFFECTING MISSION ACCOMPLISHMENT

25. Correction of the following shortcomings is desirable for improved helicopter operation and mission capabilities:

a. The uncomfortable airframe vibration levels when operating at 230 rotor rpm and light gross weights (para 16).

b. No installed V_{ne} computer or cruise guide indicator (para 16).

SPECIFICATION CONFORMANCE

26. Within the scope of these tests, the performance characteristics of the CH-47B helicopter met all requirements of the detail specifications (para 11).

RECOMMENDATIONS

27. Correction of shortcomings, for which correction is desirable, be accomplished at the earliest possible time.

28. Further testing be conducted to fully evaluate and compare the two methods of determining service ceilings (para 22).

APPENDIX I. REFERENCES

1. Boeing Vertol Document D8-0314, 24 May 1966, title: "CH-47 Product Improvement Program Configuration IA and II."

2. Letter, AMSTE-BG, Hq, US Army Test and Evaluation Command (USATECOM), 17 June 1966, subject: "Test Directive, Product Improvement Test, CH-47B Helicopter."

3. Boeing Vertol Document number 114-PJ-602, 22 September 1966, "Detail Specification for the Model CH-47B Helicopter."

4. TM 55-1520-209-10, "CH-47B Helicopter Operator's Manual."

5. Boeing Vertol Document number 114-FT-600, "CH-47 Configuration 1A Flight Test Procedure."

6. Model Specification T-55-L-7C, "Shaft Turbine Engine Lycoming LTC 4B-8C Specification No. 124.31," 15 June 1966.

7. Boeing Vertol Document number 114-TN-601, "Procedures for Demonstrating Compliance to CH-47B and CH-47C Helicopter Structural and Performance Guarantees."

APPENDIX II. PERFORMANCE TEST FLIGHT CONDITIONS

TEST EVALUATION	GW (lb)	CG (in.FRL)	Altitude (ft Hp)	Airspeed (KTAS)	Rotor Speed (RPM)	Power (ft lb torque)
Hover	36,060 and 37,450	331.0 and 331.5	390 and 427	0 0	216 to 230	770 to 820
Level Flight	24,380 to 34,810	329.7 to 332.2	390 to 6700	35 to 163	223 to 231	310 to 800
Saw tooth climbs and descents	29,640 to 30,200	330.2 to 331.4	2510 to 6990	50 to 119	219.5 to 229.5	0 to 860
Climbs to Service Ceiling	28,807 to 30,414	330.5 to 331.6	512 to 8649	76.1 to 84.9	223.6 to 226.2	720 to 880
Kp Flights	30,110 to 31,330	330.0 to 330.9	3540 to 4590	77 to 84	221.6 to 225.7	0 to 850
Airspeed Calibration	27,000 to 35,000	329.0 to 331.4	2200 to 3500	37 to 158	225 to 230	300 to 780

NOTE: Two water tanks, with calibrated sight gauges mounted internally, were used to provide ballast.

APPENDIX III. SPECIAL INSTRUMENTATION IN TEST HELICOPTER

The following special instrumentation was installed in the test helicopter:

a. Pilot's Panel

Boom airspeed
Sensitive rotor speed
Sensitive boom altimeter
Longitudinal stick position indicator
Lateral stick position indicator
Pedal position indicator
Thrust level position indicator
Angle of sideslip
Sensitive rate of climb indicator
Photopanel event switch
Record light

b. Photo Panel

Boom airspeed
Ship's system airspeed
Sensitive rotor speed
Gas producer speed (N_1) (both engines)
Boom altitude
Ship's system altimeter
Compressor inlet temperature (both engines)
Exhaust gas temperature (both engines)
Free air temperature
Rate of climb
Fuel flow stepper motor (both engines)
Event switch
Event light
Correlation counter
Record coder
Camera counter
Time of day
Torque (both engines)
Fuel totalizer
Fuel temperature

c. Oscillograph No. 1 (Multicolored channels)

Rotor speed (blip)
Vertical vibration @ sta 95
Vertical vibration @ sta 320

Lateral vibration @ sta 95
Vertical vibration @ sta 320
Engine fuel flow cycle (both engines)
Pilot's and engineer's event
Correlation counter
Record coder
Aft pivoting actuator load
Aft swiveling actuator load
Aft fixed link load
Compressor inlet pressure

d. Oscillograph No. 2

Rotor speed (blip)
Rotor speed (linear)
Gas producer speed (N_1) (both engines)
Longitudinal stick position
Pedal position
Thrust lever position
SAS pitch position (both)
SAS roll position (both)
SAS yaw position (both)
Normal acceleration CG
Angular acceleration pitch
Angular acceleration roll
Angular acceleration yaw
Attitude pitch
Attitude roll
Attitude yaw
Angle of attack
Angle of sideslip
Rate of pitch
Rate of roll
Rate of yaw
Pilot's and engineer's event
Correlation counter
Record coder

APPENDIX IV. DETAIL SPECIFICATION PERFORMANCE GUARANTEES AND TEST RESULTS

ITEM	GUARANTEE	TEST RESULT
Max cruise speed at SL/STD, NRP and 33,000 lb GW	150 KT TAS	160 KT TAS
Service ceiling, single engine, MRP and 29,705 lb GW (Mission I GW)	6000 ft	6900 ft actual climb 7575 ft computed fr level flight
Radius of action, Mission I, 6000 lb payload outbound, 3000 lb payload inbound	100 NM	106 NM
Hover OGE, for 10 min at 29,705 lb GS, 95 degree F day	6000 ft	7050 ft
Hover, OGE, SL/STD, Max Power	38000 lb	40250 lb
Payload guarantee 100 NM radius, Mission I	6000 lb outbound 3000 lb inbound	*7221 lb *3610 lb

*These payloads meet all guarantees for Mission I except the single engine service ceiling guarantee, which was not determined at this takeoff gross weight. The limiting factor for the weights presented is the capability to hover OGE at 6000 ft on a 95 degree F day.

APPENDIX V. MISSION I GROSS WEIGHT COMPUTATION

MISSION DESCRIPTION

1. Warm-up 2 min @ NRP
2. Takeoff and cruise outbound
3. Land, exchange payload (inbound P/L equals 1/2 outbound P/L)
4. Warm-up 2 min @ NRP
5. Takeoff and cruise inbound
6. Land with 10% fuel reserve

NOTES:

1. Sea level STD/day
2. Zero wind condition
3. No SFC increase
4. Cruise @ OPT (100%) range speed
5. Weight empty = 19,169 lb
6. Fixed useful load = 719 lb
7. No consideration of climb or descent fuel

MISSION CALCULATION

Basic A/C weight empty	19,349 lb
- Troop seats	-180
Mission weight empty	19,169
Fixed useful load	719
Payload	6,000
Fuel	3,817
Mission I takeoff gross weight	29,705
Engine start gross weight	29,705
-2 min warm-up @ NRP	-98
Outbound gross weight (takeoff)	29,607
-cruise fuel	-1,642
Outbound gross weight (land)	27,965
Unload payload	-6,000
	21,965
Load 1/2 payload	3,000
	24,965
Engine start gross weight	24,965
-2 min warm-up @ NRP	-98
Inbound gross weight (takeoff)	24,367
-Cruise fuel	-1,597

MISSION CALCULATION (continued)

Inbound gross weight (land)	23,270 lb
Unload 1/2 payload	-3,000
	20,270
- Fixed useful load	-719
	19,551
- Mission weight empty	-19,169
10% fuel reserve	382
Avg gross weight outbound	28,786 lb
Avg NAMPP outbound	0.06090
Cruise distance outbound	100.0 NM
Avg gross weight inbound	24,069 lb
Avg NAMPP inbound	0.06265
Cruise distance inbound	100.0 NM
Avg cruise distance (radius of action)	100.0 NM

FIXED USEFUL LOAD

Crew (3)	600 lb
Unusable fuel	16 lb
Unusable oil	25 lb
Engine oil	28 lb
Cargo tie-down devices	50 lb
Fixed useful load	719 lb

APPENDIX VI. TEST DATA

FIGURE NO. 1
AIRSPEED CALIBRATION
BOOM SYSTEM
CH-47B U.S.A. S/N 66-19100

SYM.	FLIGHT CONDITION	DENSITY ALTITUDE FT.	AVG. GROSS WEIGHT LB.	AVG. C.G. IN.	ROTOR SPEED RPM
⊙	LEVEL FLIGHT	1610	26080	332.3	225
⊡	LEVEL FLIGHT	2660	33560	330.8	225
△	CLIMB	6230	33560	330.8	225
◇	DESCENT	5750	33560	330.8	225

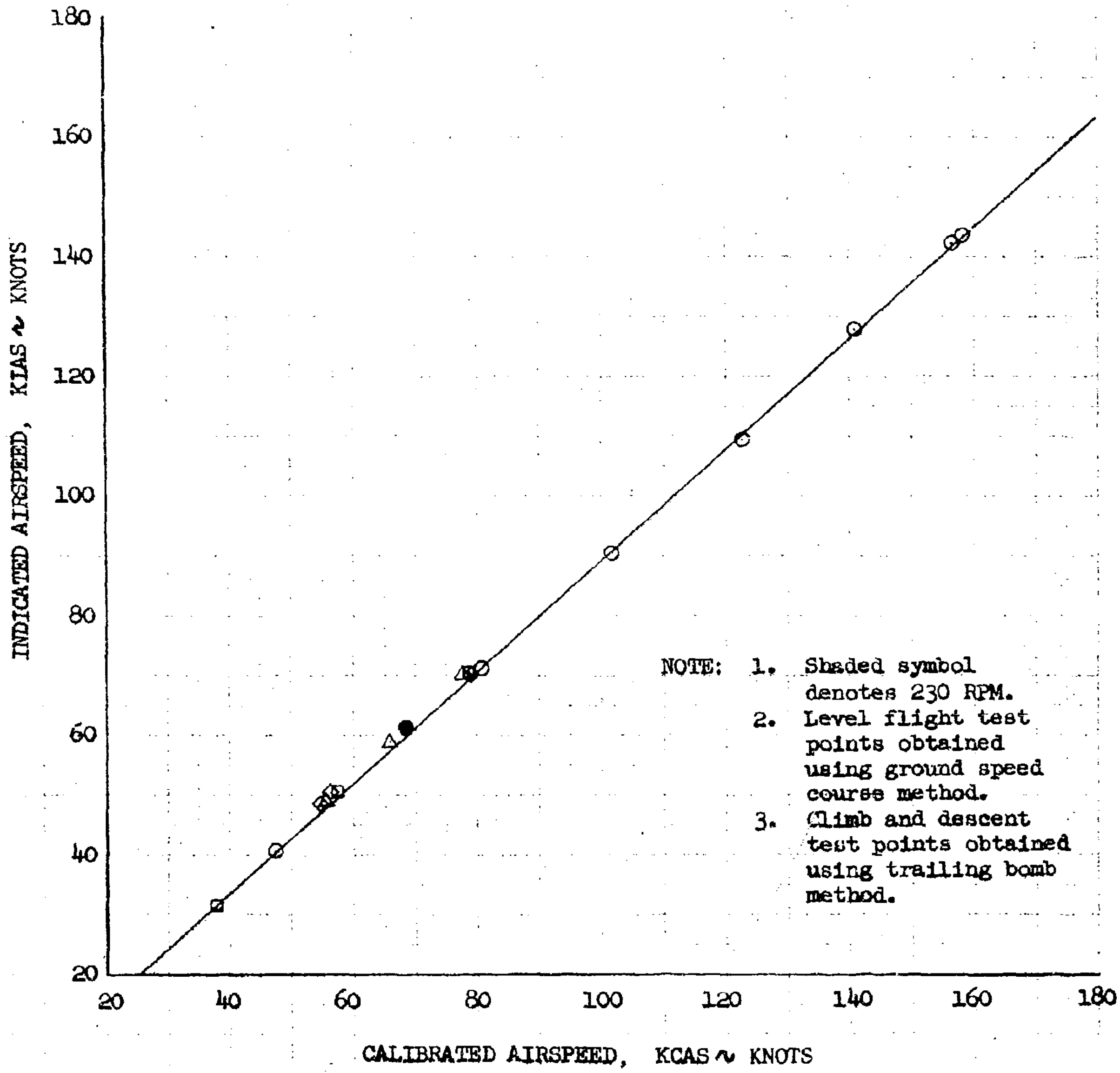


FIGURE NO. 2
AIRSPEED CALIBRATION
SHIPS SYSTEM
CH-47B U.S.A. S/N 66-19100

SYM.	FLIGHT CONDITION	DENSITY ALTITUDE FT.	AVG. GROSS WEIGHT LB.	AVG. C.G. IN.	ROTOR SPEED RPM
○	LEVEL FLIGHT	1610	26080	332.3	225
□	LEVEL FLIGHT	2660	33560	330.8	225

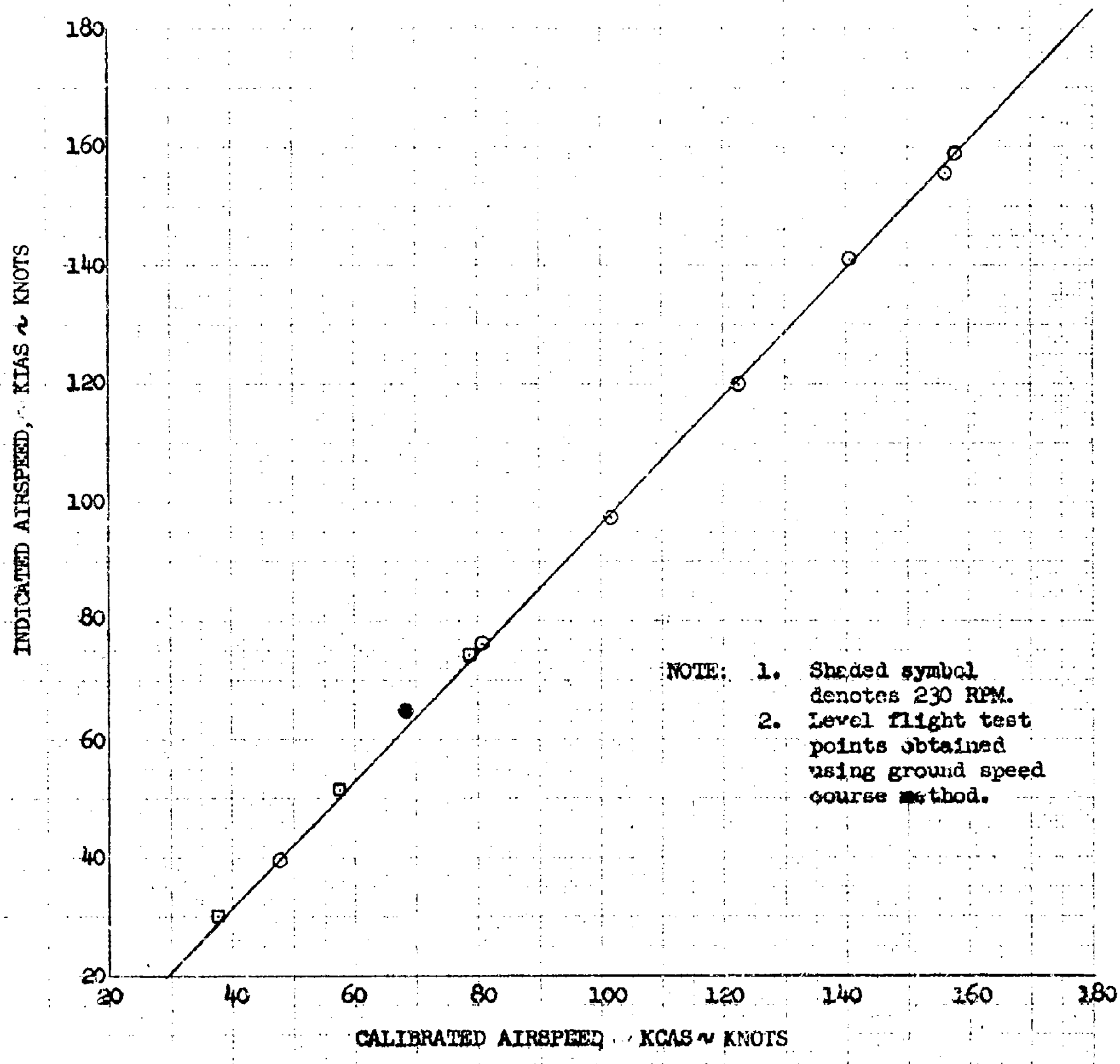


FIGURE NO. 3

NON-DIMENSIONAL O.G.E. HOVERING PERFORMANCE

CH-47B U.S.A. S/N 66-19100

WHEEL HEIGHT 100 FEET

NOTE:

1. Free flight hovering technique.
2. Wind less than 3 knots.
3. All data corrected to 230 rotor RPM and 15° C.
4. Solid line denotes CH-47B performance as determined from APE I test data.

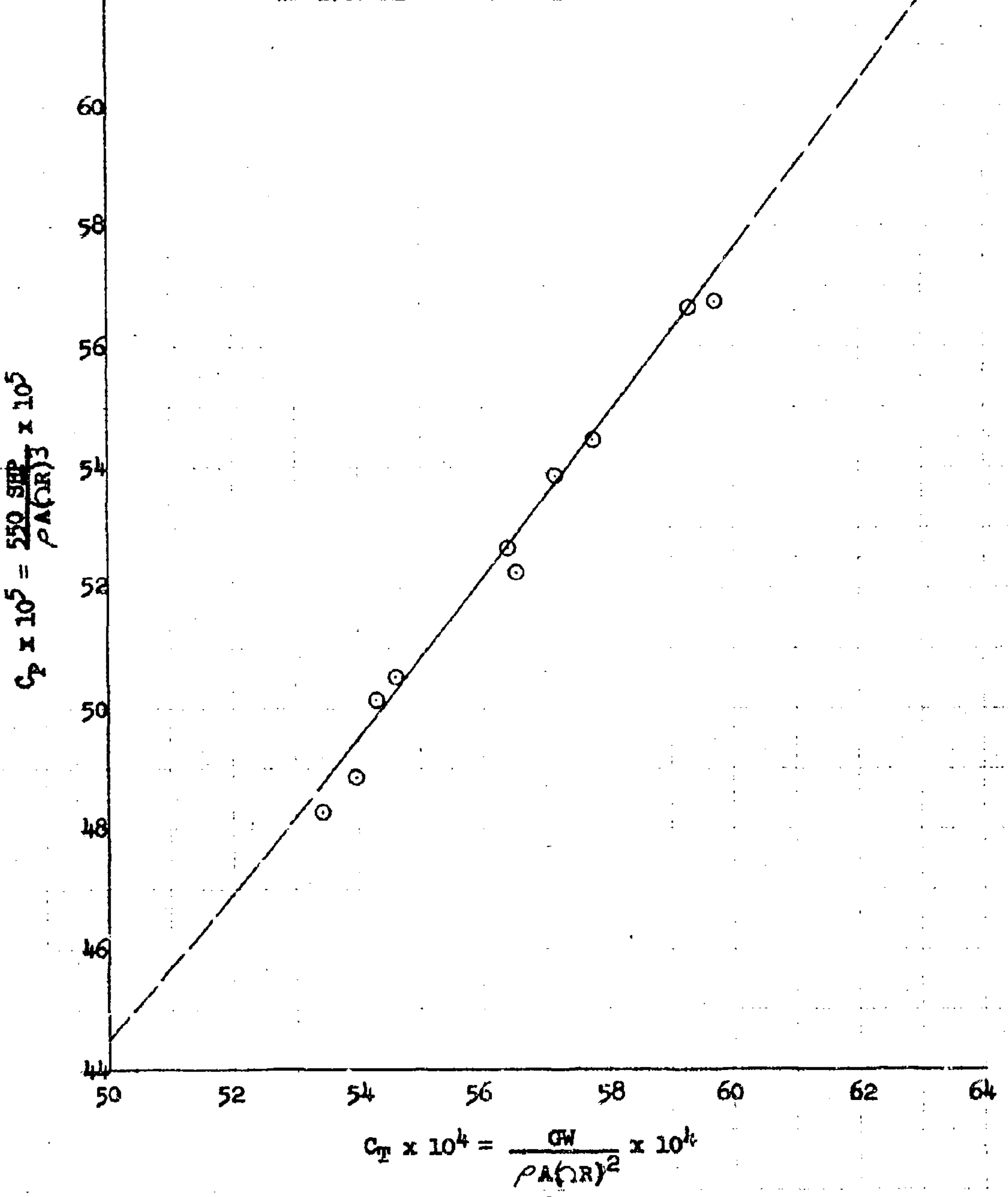


FIGURE NO. 4
C.G.E. HOVERING CAPABILITY
CH-47B U.S.A. S/N 66-19100

NOTE:
1. (2) T55-L-7C Engines.
2. Maximum Power
3. Transmission Limit at 230 RPM = 4970 SHP.
4. Rotor Speed = 230 RPM.

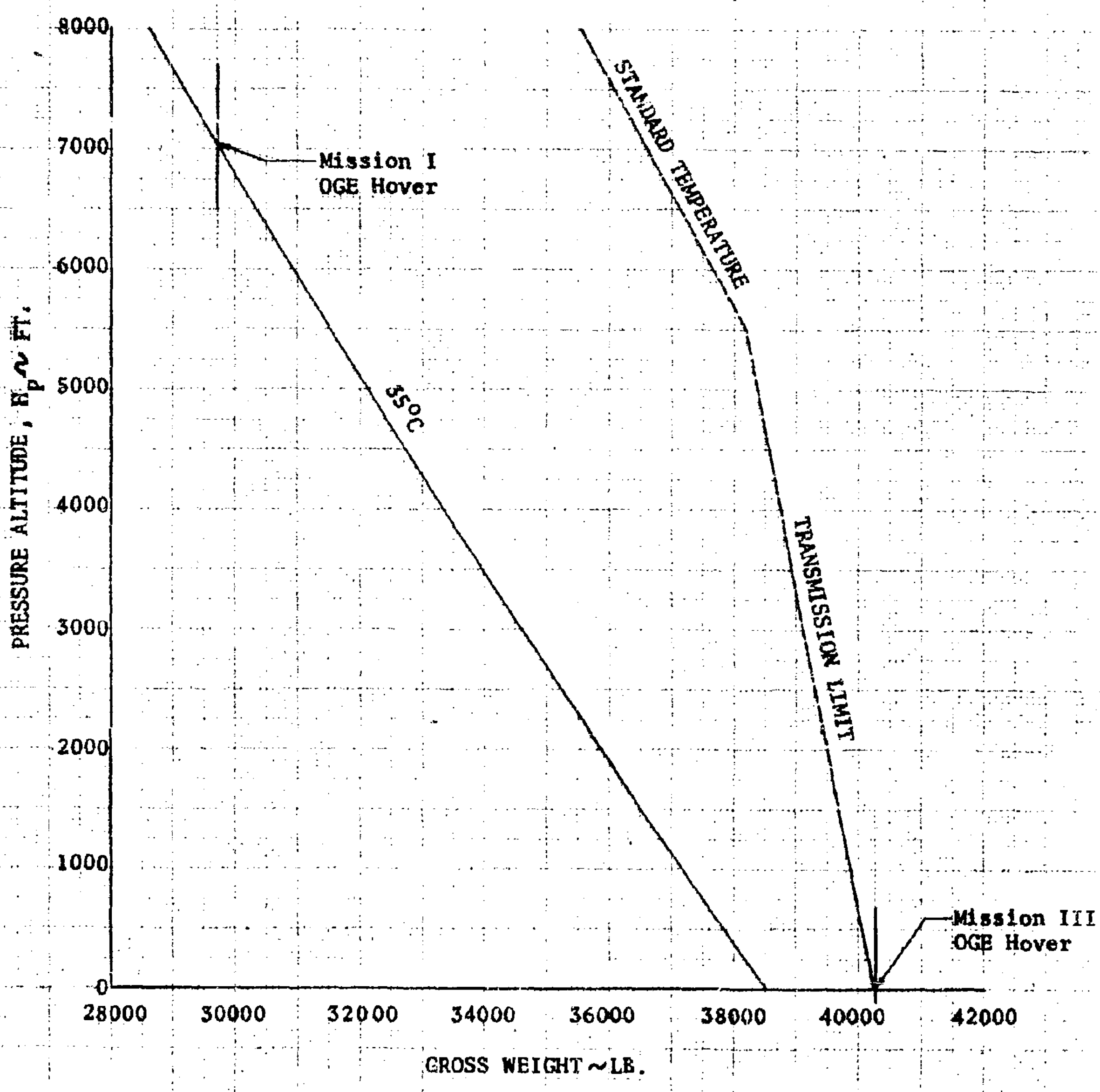


FIGURE NO. 5
LEVEL FLIGHT PERFORMANCE
CH-47B U.S.A. S/N 66-19100

$N/\sqrt{\theta}$ R.P.M.	G.W./δ LB.	AVG. C.G. IN.
230	33,000	331.0

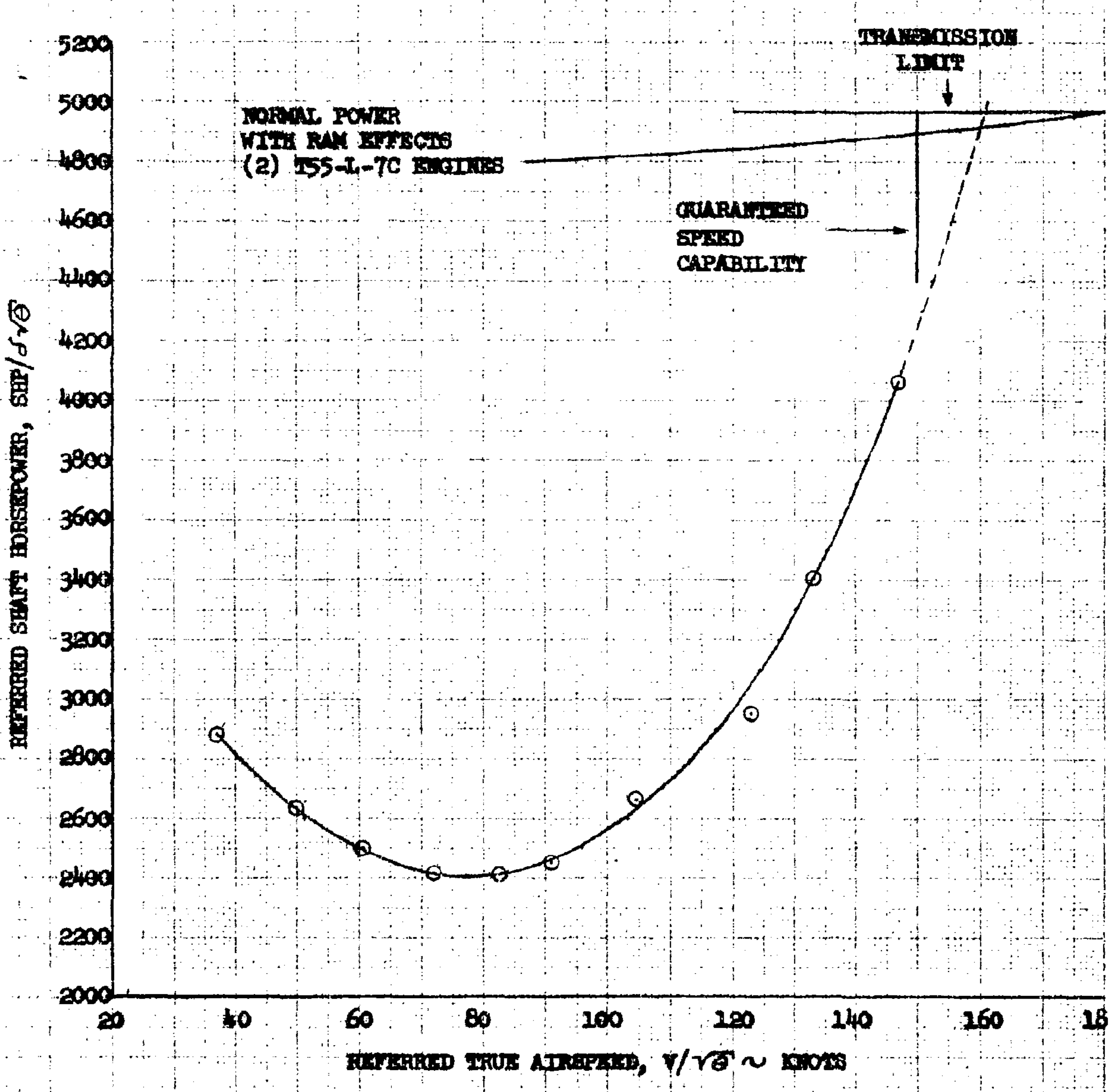


FIGURE NO. 6
LEVEL FLIGHT PERFORMANCE
CH-47B U.S.A. S/N 66-19100

SYM.	$N/\sqrt{\theta}$ RPM	$G.W./\delta$ LB.	AVG. C.G. IN.
⊙	225	27,300	331.0
⊡	225	30,000	330.9
◈	225	35,400	330.9

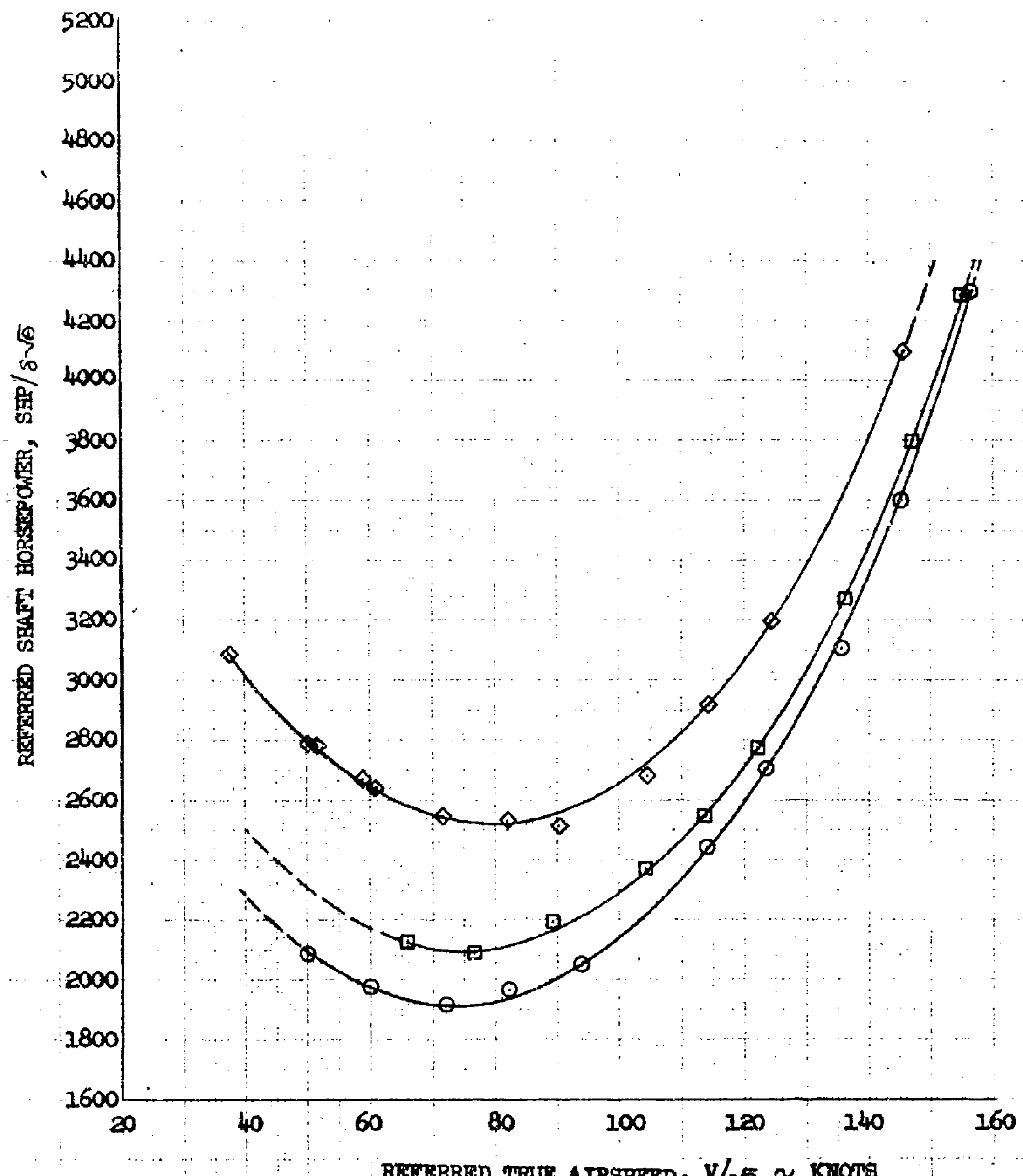


FIGURE NO. 7
MISSION CRUISE SPEEDS
CH-47B U.S.A. S/N 66-19100

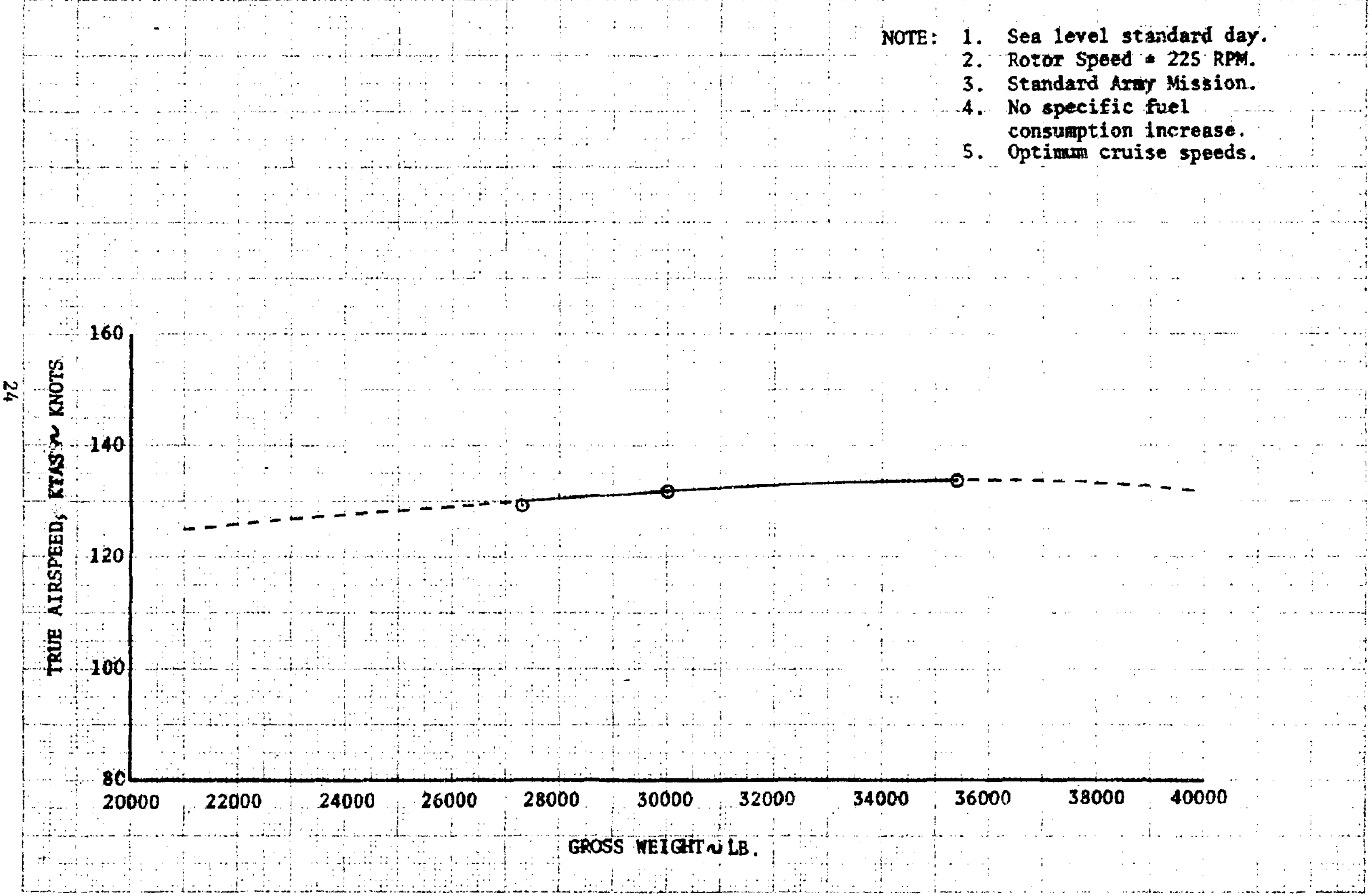


FIGURE NO. 8
MISSION CRUISE PERFORMANCE
CH-47B U.S.A. S/N 66-19100

NOTE:
1. Sea level standard day.
2. Rotor Speed = 225 RPM.
3. (2) T55-L-7C Engines.
4. Fuel flow includes ram effects.
5. No specific fuel consumption increase.
6. Cruise at 100% best range speed.

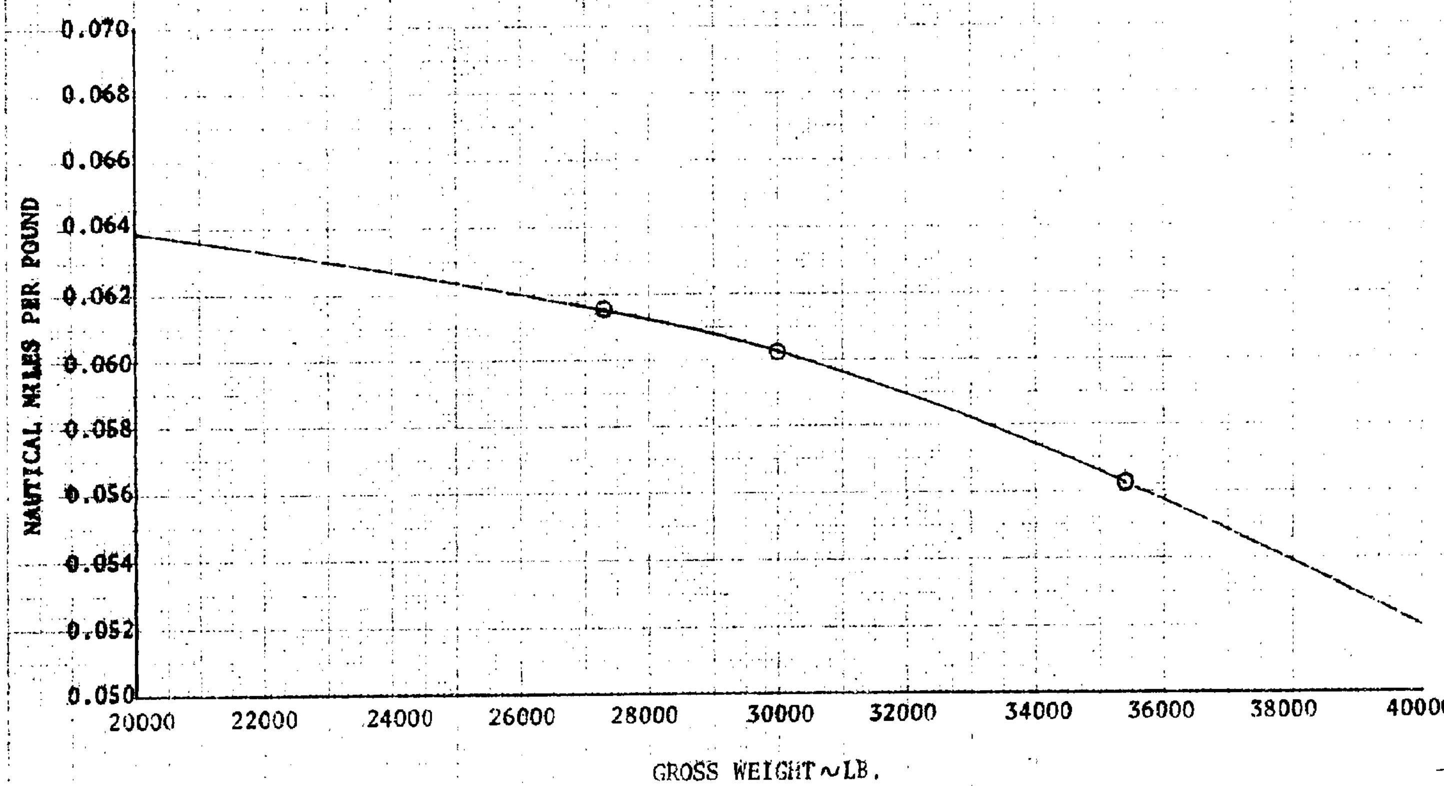


FIGURE NO. 9
PAYLOAD CAPABILITY
CH-47B U.S.A. S/N 66-19100

NOTE:
1. Sea Level Standard Day.
2. Rotor Speed = 225 RPM.
3. Standard Army Mission.
4. Cruise at 100% Best Range Speed.
5. No Specific Fuel Consumption Increase.

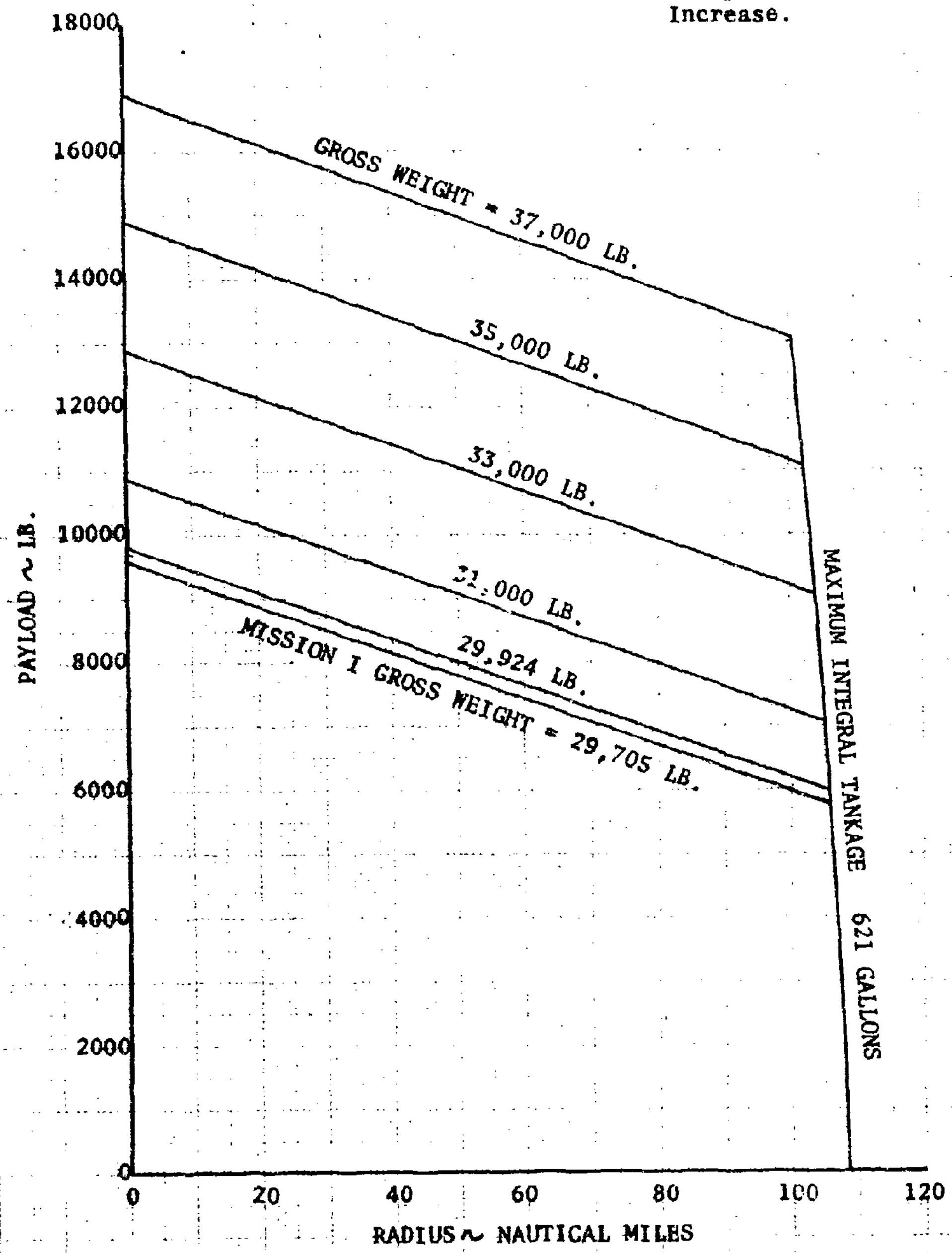


FIGURE NO. 10
LEVEL FLIGHT PERFORMANCE
CH-47B U.S.A. S/N 66-19100

SYM.	$N/\sqrt{\theta}$ RPM	G.W./δ LB.	AVG. C.G. IN.
⊙	230	37,200	330.8
⊡	230	37,200	330.9

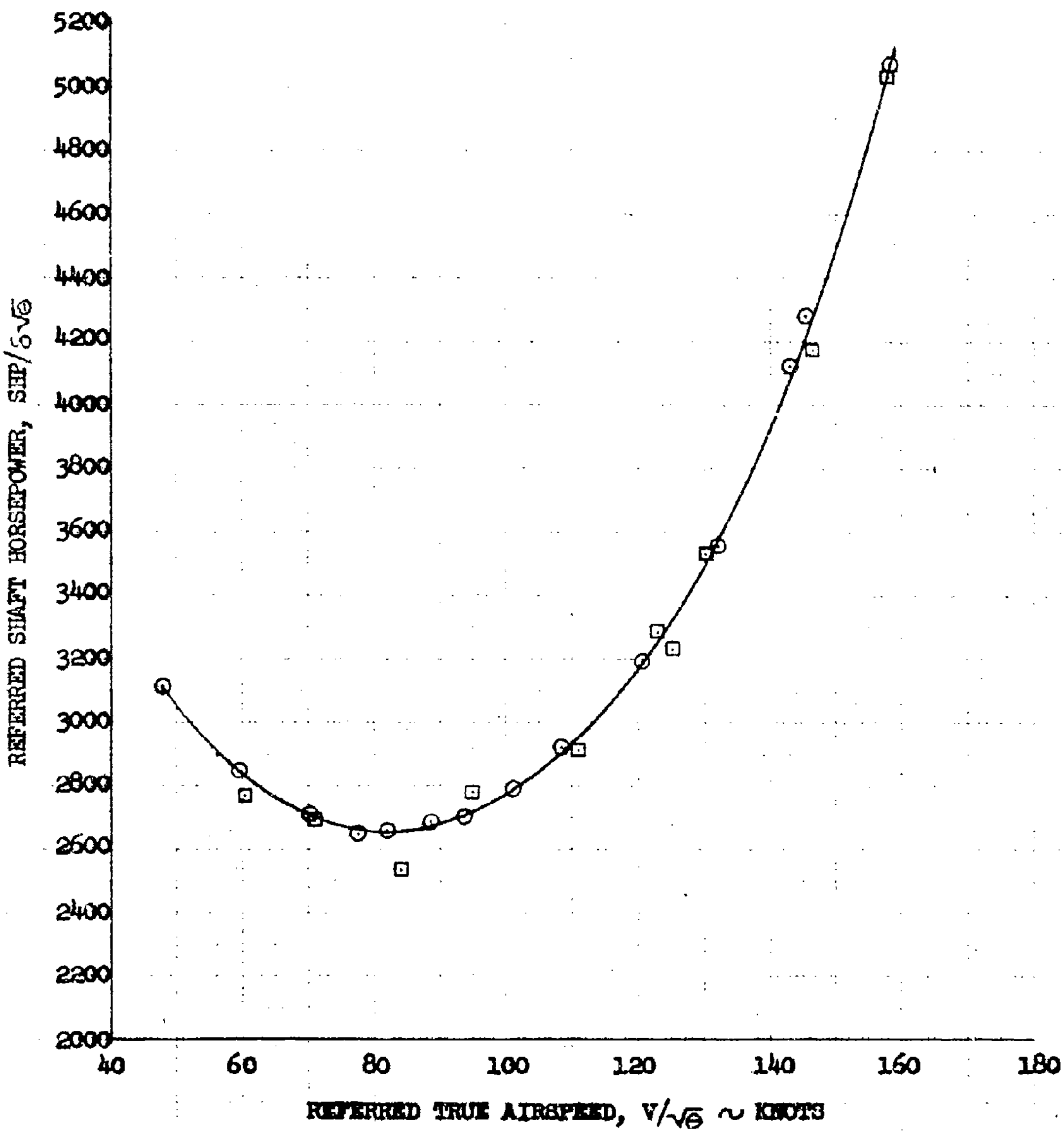


FIGURE NO. 11
POWER CORRECTION FACTOR (K_P)
CH-47B U.S.A. S/N 66-19100

SYM	FLIGHT CONDITION
⊙	Climb and Descent
⊡	Level Flight

$$K_P = \frac{(\Delta R/C)(G.W.)}{(\Delta SHP)(33000)} = 0.929$$

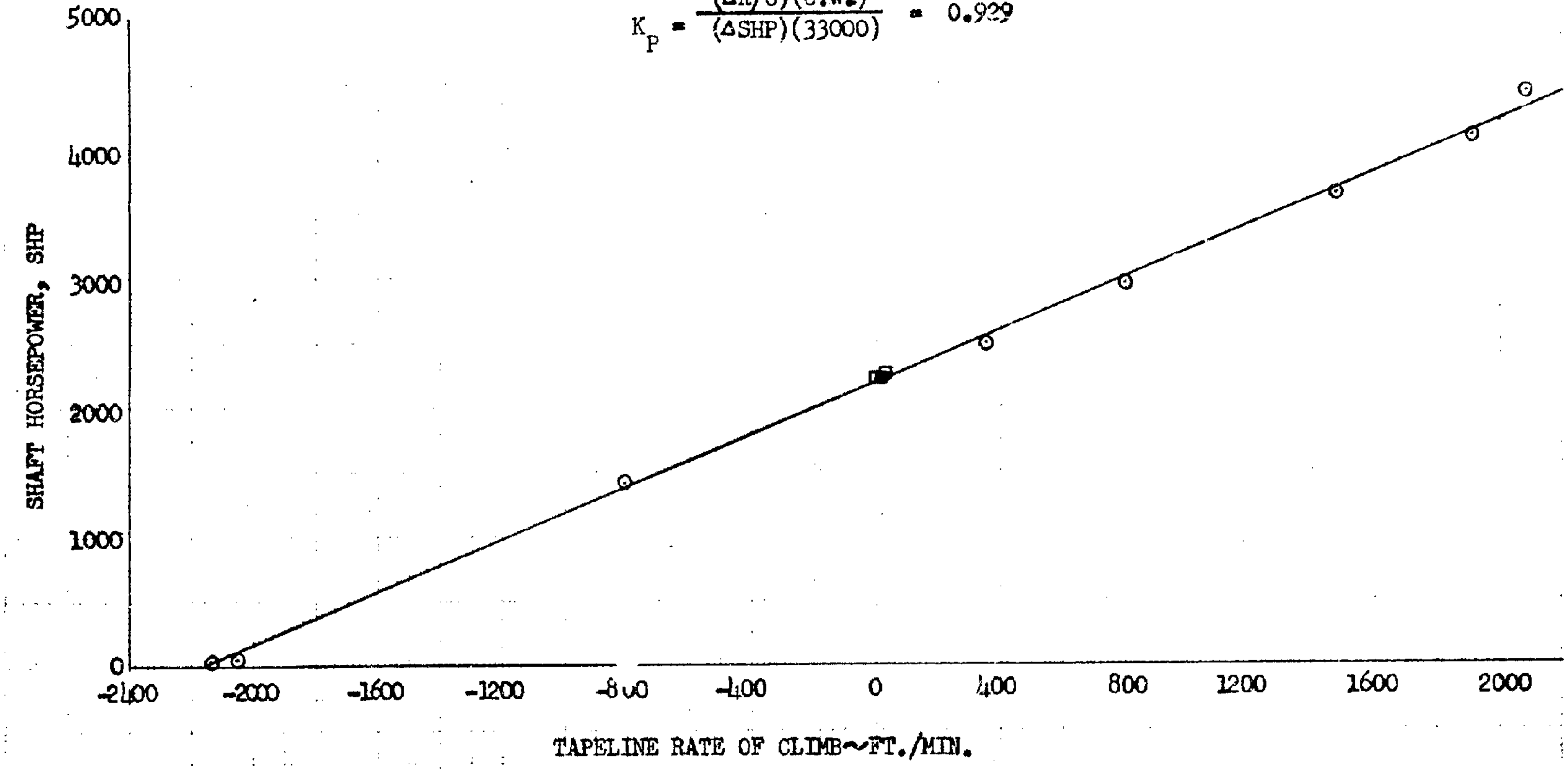
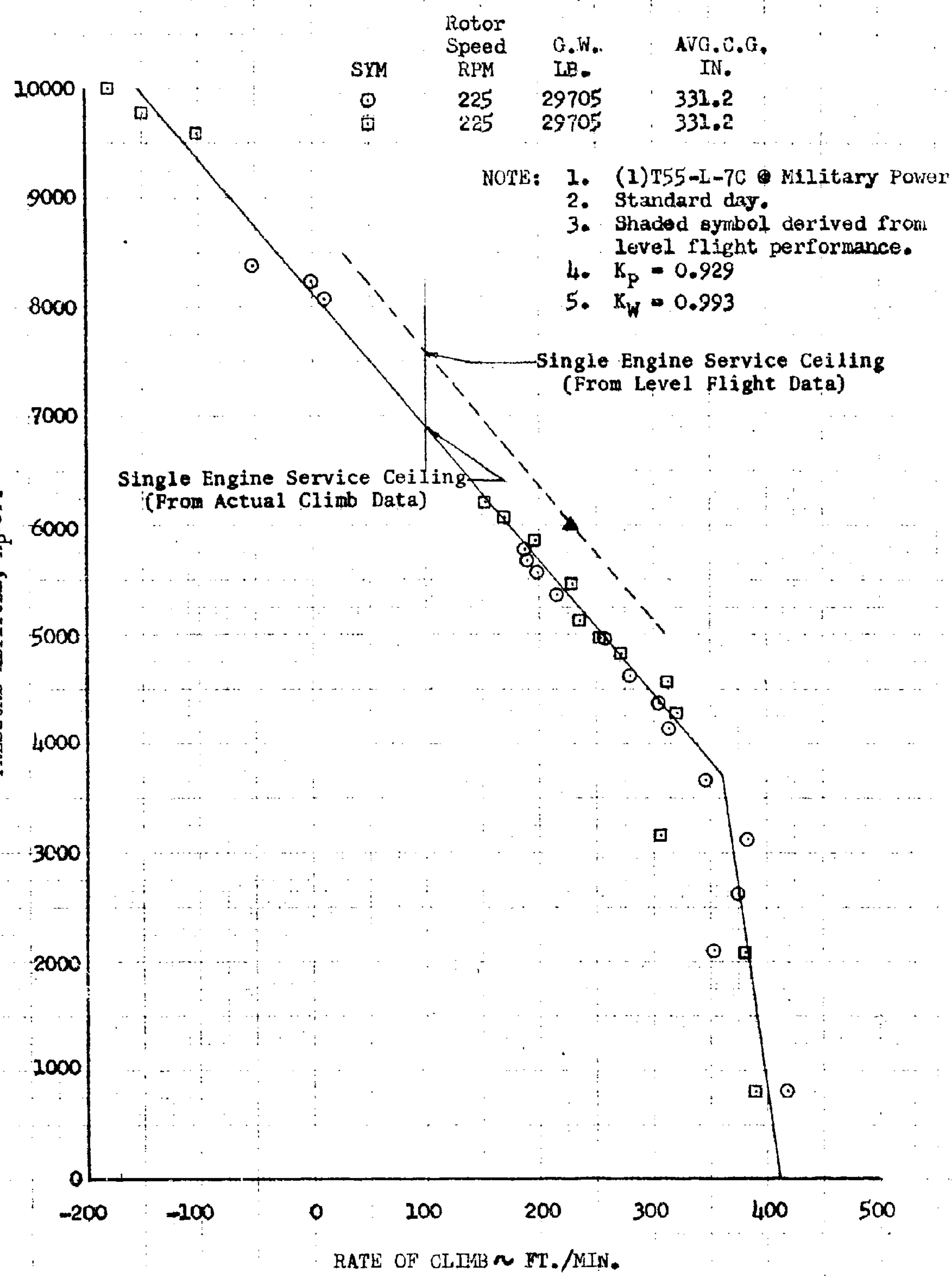


FIGURE NO. 12

SINGLE ENGINE SERVICE CEILING CLIMB PERFORMANCE

CH-47B U.S.A. S/N 66-19100



APPENDIX VII. PILOT RATING SCALE

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

Revised Pilot Rating Scale