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

PHASE D

INTERIM REPORT

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MARCH 1968

US ARMY AVIATION TEST ACTIVITY
EDWARDS AIR FORCE BASE, CALIFORNIA 93523
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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 IA 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 auxiliary 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 number (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.


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 per-
formance 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 similar 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 APS I were used to aid in sizing the line through the data obtained. The OGE hovering 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 min at Mission 1 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:

\[
\frac{GW}{\delta} \quad \frac{SHP}{\delta^{1/2}} \quad \frac{V}{\delta} \quad \text{and} \quad \frac{N}{\delta^{1/2}}
\]

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 \( V_e \) 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 $V_{\text{ne}}$ 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 variation, 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 comparison with the CH-47A is particularly outstanding (para 11).

24. The increase in speed 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 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


### APPENDIX II. PERFORMANCE TEST FLIGHT CONDITIONS

<table>
<thead>
<tr>
<th>TEST EVALUATION</th>
<th>GW (lb)</th>
<th>CG (in. FRL)</th>
<th>Altitude (ft Hp)</th>
<th>Airspeed (KIAS)</th>
<th>Rotor Speed (RPM)</th>
<th>Power (ft lb torque)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hover</td>
<td>36,060</td>
<td>331.0</td>
<td>390</td>
<td>0</td>
<td>216 to</td>
<td>770 to</td>
</tr>
<tr>
<td>and</td>
<td>37,450</td>
<td>331.5</td>
<td>and 427</td>
<td>0</td>
<td>230 to</td>
<td>820 to</td>
</tr>
<tr>
<td>Level Flight</td>
<td>24,380</td>
<td>329.7</td>
<td>390</td>
<td>35</td>
<td>223 to</td>
<td>310 to</td>
</tr>
<tr>
<td>to</td>
<td>34,810</td>
<td>332.2</td>
<td>to 5700</td>
<td>163</td>
<td>231 to</td>
<td>860 to</td>
</tr>
<tr>
<td>Saw tooth climbs and</td>
<td>29,640</td>
<td>330.2</td>
<td>2510</td>
<td>50</td>
<td>219.5 to</td>
<td>0 to</td>
</tr>
<tr>
<td>and descents</td>
<td>30,200</td>
<td>331.4</td>
<td>to 6990</td>
<td>to 119</td>
<td>to 229.5 to</td>
<td>to 860</td>
</tr>
<tr>
<td>Climbs to Service Ceiling</td>
<td>28,807</td>
<td>330.5</td>
<td>512</td>
<td>76.1</td>
<td>223.6 to</td>
<td>720 to</td>
</tr>
<tr>
<td>to</td>
<td>30,414</td>
<td>331.6</td>
<td>to 8649</td>
<td>to 84.9</td>
<td>to 226.2 to</td>
<td>to 880</td>
</tr>
<tr>
<td>KP Flights</td>
<td>30,110</td>
<td>330.0</td>
<td>3540</td>
<td>77</td>
<td>221.6 to</td>
<td>0 to</td>
</tr>
<tr>
<td>to</td>
<td>31,350</td>
<td>330.9</td>
<td>to 4590</td>
<td>84</td>
<td>to 225.7 to</td>
<td>to 850</td>
</tr>
<tr>
<td>Airspeed Calibration</td>
<td>27,000</td>
<td>329.0</td>
<td>2200</td>
<td>37</td>
<td>225 to</td>
<td>300 to</td>
</tr>
<tr>
<td>to</td>
<td>25,000</td>
<td>331.4</td>
<td>to 3500</td>
<td>to 158</td>
<td>to 230 to</td>
<td>to 760</td>
</tr>
</tbody>
</table>

**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**

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

*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)

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

### FIXED USEFUL LOAD

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew (3)</td>
<td>600 lb</td>
</tr>
<tr>
<td>Unusable fuel</td>
<td>16 lb</td>
</tr>
<tr>
<td>Unusable oil</td>
<td>25 lb</td>
</tr>
<tr>
<td>Engine oil</td>
<td>28 lb</td>
</tr>
<tr>
<td>Cargo tie-down devices</td>
<td>50 lb</td>
</tr>
<tr>
<td>Fixed useful load</td>
<td>719 lb</td>
</tr>
</tbody>
</table>


FIGURE NO. 1
Airspeed Calibration
Boom System
CH-47B U.S.A. S/N 66-19100

<table>
<thead>
<tr>
<th>Sym. Condition</th>
<th>Flight</th>
<th>Altitude</th>
<th>Density</th>
<th>Gross Weight</th>
<th>Avg. C.G.</th>
<th>Rotor Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ LEVEL FLIGHT</td>
<td>1610</td>
<td>26000</td>
<td>332.3</td>
<td>225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ LEVEL FLIGHT</td>
<td>2660</td>
<td>33560</td>
<td>330.8</td>
<td>225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>△ CLIMB</td>
<td>6230</td>
<td>33560</td>
<td>330.8</td>
<td>225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ DESCENT</td>
<td>5750</td>
<td>33560</td>
<td>330.8</td>
<td>225</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 1. Shaded symbol denotes 230 RPM.
2. Level flight test points obtained using ground speed course method.
3. Climb and descent test points obtained using trailing bomb method.
<table>
<thead>
<tr>
<th>FLIGHT CONDITION</th>
<th>ALTITUDE</th>
<th>GROSS WT.</th>
<th>AVG. C.G.</th>
<th>AVG. RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL FLIGHT</td>
<td>1610</td>
<td>26080</td>
<td>332.3</td>
<td>225</td>
</tr>
<tr>
<td>LEVEL FLIGHT</td>
<td>2660</td>
<td>33560</td>
<td>330.8</td>
<td>225</td>
</tr>
</tbody>
</table>

**Note:**
1. Shaded symbol denotes 230 RPM.
2. Level flight test points obtained using ground speed course method.
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.

\[ C_T \times 10^4 = \frac{GW}{(\rho A(\omega R)^2 \times 10^6} \]
\[ \frac{20} {\rho} \]
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. 6
LEVEL FLIGHT PERFORMANCE
CH-47B U.S.A. S/N 66-19100

<table>
<thead>
<tr>
<th>N/%</th>
<th>G.W./S</th>
<th>AVG. C.G.</th>
<th>SYN.</th>
<th>RPM</th>
<th>LB.</th>
<th>IN.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>225</td>
<td>27,300</td>
<td>331.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>225</td>
<td>30,000</td>
<td>330.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>225</td>
<td>35,400</td>
<td>330.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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) TS5-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

2. Rotor Speed = 225 RPM.
4. Cruise at 100% Best Range Speed.
5. No Specific Fuel Consumption Increase.

GROSS WEIGHT = 37,000 LB.

35,000 LB.

33,000 LB.

31,000 LB.

29,924 LB.

MISSION I GROSS WEIGHT = 29,705 LB.

MAXIMUM INTEGRAL TANKAGE 621 GALLONS

PAYLOAD ~ LB.

18000
16000
14000
12000
10000
8000
6000
4000
2000
0

0 20 40 60 80 100 120
RADIUS ~ NAUTICAL MILES
FIGURE NO. 10
LEVEL FLIGHT PERFORMANCE
CH-47B U.S.A. S/N 66-19190

<table>
<thead>
<tr>
<th>SYM.</th>
<th>RPM</th>
<th>G.V.</th>
<th>AVG. C.G.</th>
</tr>
</thead>
<tbody>
<tr>
<td>☺</td>
<td>230</td>
<td>37,200</td>
<td>330.8</td>
</tr>
<tr>
<td>☼</td>
<td>230</td>
<td>37,200</td>
<td>330.9</td>
</tr>
</tbody>
</table>

Graph showing referred true airspeed versus referred static pressure.
FIGURE NO. 11
POWER CORRECTION FACTOR (Kp)
CH-47B  U.S.A. S/N 66-39100

SYN: 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 66-10100

Note:
1. (1)55-7C Military Power
2. Standard day.
3. Shaded symbol derived from level flight performance.
4. \(K_p = 0.929\)
5. \(K_w = 0.993\)

Rotor Speed G.W. AVG.C.G.
SYM RPM LE. IN.
\(\circ\) 225 29705 331.2
\(\square\) 225 29705 331.2

Single Engine Service Ceiling
(From Actual Climb Data)

Single Engine Service Ceiling
(From Level Flight Data)
## APPENDIX VII. PILOT RATING SCALE

<table>
<thead>
<tr>
<th>ACCEPTABLE</th>
<th>SATISFACTORY</th>
<th>EXCELLENT, HIGHLY DESIRABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>May have deficiencies which warrant improvement, but adequate for mission.</td>
<td>Meets all requirements and expectations, good enough without improvement.</td>
<td>Good, pleasant, well behaved.</td>
</tr>
<tr>
<td>Pilot compensation, if required to achieve acceptable performance, is feasible.</td>
<td>Clearly adequate for mission.</td>
<td>Fair, some mildly unpleasant characteristics, good enough for mission without improvement.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNSATISFACTORY</th>
<th>SOME MINOR BUT ANNOYING DEFICIENCIES, IMPROVEMENT IS REQUESTED. EFFECT ON PERFORMANCE IS EASILY COMPENSATED FOR BY PILOT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reluctantly acceptable deficiencies which warrant improvement, performance adequate for mission with feasible pilot compensation.</td>
<td>Improvemnet is needed, reasonable performance requires considerable pilot compensation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNACCEPTABLE</th>
<th>MAJOR DEFICIENCIES WHICH REQUIRE MANDATORY IMPROVEMENT FOR ACCEPTANCE. CONTROLLABLE, PERFORMANCE INADEQUATE FOR MISSION. ON PILOT COMPENSATION REQUIRED FOR MINIMUM ACCEPTABLE PERFORMANCE IN MISSION IS TOO HIGH.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficiencies which require mandatory improvement, inadequate performance for mission even with maximum feasible pilot compensation.</td>
<td>Controllable with difficulty, requires substantial pilot skill and attention to retain control and continue mission.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNCONTROLLABLE</th>
<th>MARGINALLY CONTROLLABLE IN MISSION. REQUIRES MAXIMUM AVAILABLE PILOT SKILL AND ATTENTION TO RETAIN CONTROL.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control will be lost during some portion of mission.</td>
<td>Uncontrollable in mission.</td>
</tr>
</tbody>
</table>

Revised Pilot Rating Scale