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MAINTENANCE AND OPERATIONAL ANALYSIS

SUMMARY

PURPOSE:

1. The purpose of this report is to present a users evaluation of the maintenance and logistical requirements of this type helicopter design with particular emphasis on those components, systems and procedures that reduce these requirements. Support concepts that increase the tactical capability are also included. In order to conduct a controlled test, an H-34 helicopter was used for comparative purposes; therefore, data concerning any aircraft manufacturers products is factual and is not intended as derogatory.

2. It is not the intent of this publication to provide detailed data about characteristics or performance of the aircraft discussed, as these data are the subject of a separate technical report.

3. Line maintenance requirements include daily, periodic and unscheduled maintenance necessary to maintain flight status of the aircraft. Data obtained on the H-36 helicopter was under controlled test conditions without trained maintenance personnel and without manufacturer support. For this reason, inspections were conducted more frequently to maintain a close observation of components and systems. This was accomplished by subjecting the machine to 12.5, 25, 50 and 100 hour periodic inspections and highly detailed daily inspections.

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INTRODUCTION

1. Maintenance data furnished in this report is considered representative of controlled test conditions. One should not assume that the same requirements exist for combat or service utilization since greater utilization would result in reduced maintenance with exception of dynamic component replacements. The test aircraft H-36 is a 1954 production model.

2. An uninstrumented H-34A helicopter was used to chase the test aircraft, to perform logistical and related flights and for a comparative vehicle.

3. The test objectives were:

a. To determine maintenance requirements.

b. To determine design effects on maintenance in terms of skills and time required.

c. To evaluate handbook provisions and concepts.

d. To evaluate the support package furnished with the machine.

e. To determine ground support requirements.

4. The following equipment included on other models of this design was not installed or received with the aircraft:

a. Radio command set, extreme range (classified) and destruction control system equipment.

b. Parachute jump cable.

c. Ventral container for machine gun and electrical ejection system equipment.

d. Electrical warning system for machine gun travel.

e. Truss lock bar for clam shell doors when aircraft is flown with the doors partially open.

f. Operational data for special warfare cartridges fired through the flare system.

g. Flame dampeners for engine exhaust system.

h. Swing-type boom and winch for in-flight rescue of personnel and equipment.

i. Litters for carrying patients.

j. Pneumatic system for recharging the machine gun.

k. Navigation table.

TEST HISTORY

1. During the course of test, the engine oil cooler failed in flight and a forced landing was made. Initial cause of the oil cooler failure was attributed to failure of the oil cooler flap actuator thermo-sensing unit. In automatic position, the flaps closed which caused excessive heating, thereby melting the solder in the oil cooler. Six successive failures resulted from stress concentrations builtup during the repair process. The aircraft was modified to incorporate a C-124A aircraft oil cooler designed for the P and W engine. The cooler operated satisfactorily in this installation. Sixty (60) man-hours were required to install the new cooler. The C-124 cooler weighed 77 pounds less than the original.

2. The fuel injection pump was not adjusted properly when the aircraft was received and adjusting procedures outlined in the manuals did not prove adequate. Through a reiterative process, the fuel injection pump was adjusted to an acceptable degree; however, it is felt that a more desirable setting could be obtained if the necessary equipment was available. Design of the injection nozzles appears good since no cylinder barrel lubrication problems occurred. Engine starting characteristics with the injection system were very good.

3. Difficulty experienced with the main transmission oil pressure transmitter line was loss of fluid between the transmission diaphram and the transmitter. Compass fluid was used and failed. Regular 30W grade oil was installed and the system operated satisfactorily.

4. During assembly of the tail cone to the fuselage, the original bolts failed during the torqueing operation. NAS 3007-20 bolts were obtained and installed as replacement items.

5. The supercharger actuator motor failed. This was returned to service with the parts kit furnished with the aircraft.

6. The rotor brake micro switch failed and clutch engagements could not be accomplished. A like item available in military channels was installed with only minor modifications.

7. The radio altimeter could not be aligned by radio technicians since no handbook or schematic coverage was furnished. By process of elimination, instrument adjustments were accomplished successfully by adjustment of the vertical and horizontal screws on the back of the receiver transmitter package. No in-flight adjustments are required with proper ground adjustments.

8. The main rotor blade mechanical dampers required adjustment due to temperature differential of fall and winter seasons.

MANUFACTURING AND DESIGN

1. The fuselage design is comparable to the H-19 helicopter, modified to incorporate rear loading clam shell doors. The helicopter has an articulated main rotor which incorporates pitch cone and pitch flap coupling. The blade attach lugs lead the mast by 60MM. In addition, mechanical friction type blade dampers are provided. The horizontal stabilizer is connected to the collective pitch system. This, with contribution from the C.G. location and mass tilt, provides a relatively level attitude of the fuselage in forward flight. The main rotor blades are constructed of a steel tube spar covered with plywood and fabric. The blades are very flexible; therefore, incorporate split trailing edge stringers to allow for deformations when the blades are bending.

2. The engine appears to be similar to the R-2600, except for the fuel injection system. Failure of the supercharger oil seal ring in the impeller section revealed that the R-2600 engine utilizes the same seal. One was procured to return the engine to a serviceable condition.

3. Design specifications for the helicopter were apparently directed toward simplicity and operational structural reliability.

MAINTENANCE TABLE

(3 August 1960 - 17 February 1961)

	H-36	%	H-34	%
Daily Maintenance	361:00	41.9	192:05	25.5
Periodic Maintenance	165:00	19.2	462:50	61.5
Unscheduled Maintenance	335:15	38.9	97:45	13.0
	861:15		752:40	
Maintenance to Flight Hour Ratio	5.9 - 1		3.3 - 1	

NOTE:

H-36 unscheduled maintenance resulted from engine oil cooler failures, fuel control adjustments and modification of the oil cooler system. Daily maintenance man-hours were substantially increased to assure safe and continuous operations throughout the test; therefore, would compare favorably with the H-34 under normal operating conditions. H-34 periodic maintenance resulted from component replacement.

H-36 Flight Time Accumulated During Test (Includes 24 hrs of ground operation) 147:40

H-34 Flight Time Accumulated During Test 230:20

Maintenance hours were based on time to complete the job. (Includes procurement of tools, parts, etc.)

AVAILABILITY TABLE

(3 August 1960 - 17 February 1961)

Month	Days	In Commission H-36	In Commission H-34	Out of Commission H-36	Out of Commission H-34
Aug	28	23	26	5	2
Sep	30	15	30	*15	0
Oct	31	31	28	0	3
Nov	30	26	28	**4	2
Dec	31	13	31	***18	0
Jan	31	16	25	****15	6
Feb	17	17	17	0	0
	198	141	185	57	13
Percentage		71.2	93.4	28.8	6.6

* First engine oil cooler failure including engine teardown and repair.

** Second oil cooler failure requiring down time.

*** Third oil cooler failure requiring down time and modification to C-124A aircraft oil cooler.

****Down time required to return original instruments to service operation.

NOTE:

H-36 out-of-commission time would be reduced to 16 days if the oil cooler had not failed.

H-34 out-of-commission time would be reduced to 6 days if dynamic components had not reached their operating times between overhaul.

The increased availability rate and reduced maintenance to flight hour ratio is attributed to adequate parts on hand at the test site and the capability and authority to conduct third and fourth echelon maintenance.

POL CONSUMPTION TABLE

	H-36
Flights	102
Flight Hours (Includes 24 hrs ground operating time)	147:40
Fuel Used	9290 Gal
Oil Used (Engine)	1395 Qts
Average fuel consumed per hour	62.9 Gal
Average oil consumed per hour	9.4 Qts
Fuel tank capacity	258 Gal
Oil tank capacity	14.5 Gal

HANDBOOK CONCEPTS

1. Manuals furnished with the aircraft were as follows:

   a. Helicopter Description

   b. Operation and Maintenance

   c. Engine Description, Operation and Service Instruction

   d. Operating and Piloting Instructions

   e. Shipping Instructions by Sea

   f. Electric Diagrams

   g. Instructions for Computing Range and Endurance

   h. Handbook of Device Operating Instructions and Illustrated Catalogues.

   i. Manufacturers Guarantee Certificates

   j. Log Books

2. The manuals contain general information only and detailed step procedures are not included. A research of several manuals is required when performing other than routine maintenance. From this standpoint, the manuals are confusing and are considered inferior to those utilized by the Military Services.

3. The warranty books issued on all components are considered very desirable as this would require vendors and prime manufacturers to work together on design applications. The booklets contain general technical parameters for the equipment and set forth guarantee periods and conditions for each component. Our manuals do not contain such data.

4. The Flight Operations Manual contains aircraft operational data for over mountain, sand, snow and water flights, which is very desirable.

SUPPORT PACKAGE CONCEPTS

1. The support package received with the aircraft (reported to assure continuous operations in the field for a minimum of one (1) year) consisted of vendor and prime contractor parts kits and fast-moving small items. The contents of these kits include high mortality hard items such as: bolts, nuts, keys, spacers, screws, brushes, springs, etc. "O" rings and gaskets were furnished in separate packages. The following spare parts kits were received with the aircraft:

a. Main Rotor Hub
b. Magneto
c. Swash Plate
d. Radio Tubes (VHF-ADF)
e. Booster Coil
f. Main Wheels
g. Tail Rotor Drive Shaft
h. Hydraulic Filters
i. Starter
j. Voltage Regulator
k. Main Rotor Drive Shaft
l. Hydraulic Pump
m. Main Gearbox
n. Nose Wheels
o. Fuel Injection Pump
p. Solenoid Priming Valve
q. Radio Altimeter
r. Hydraulic Booster
s. Intermediate Gearbox

t. Electric Actuator

u. Tail Gearbox

v. Electric Motor

w. Main Gearbox Drive Shaft

x. Ignition Switch

y. Slipring Rotor Tip Lights

z. Supercharger Actuator Motor

2. Two of the spare parts kits were used on the main rotor blade tip light slipring and the supercharger actuator motor. Both systems were returned to service. The support package concept is considered sound and very desirable. This concept is believed to be of paramount importance under current tactical requirements as delays resulting from improper provisioning, procurement, lead times and shipping are obviated.

MAJOR DEFICIENCIES

1. The engine oil cooler is warranted for operation at 58 psi; however, is installed in a system that operates at 71 - 90 psi. This is believed to be a contributing factor in the aforementioned failure.

2. Time required to engage the rotor is excessive. External preheating is required during winter operations to reduce engagement time. The oil tank does not contain a hopper and is mounted behind and above the engine cooling fan. This is obviously a design deficiency. Installation of a hopper and relocation of the oil tank would materially reduce rotor engagement time.

3. Engagement of the rotor is critical above a 10 knot wind due to main rotor blade flexibility. The internal and external noise level is quite high and carbon monoxide content is at maximum.

ENGINEERING FOR EASE OF MAINTENANCE

1. Efficiency of design in relation to maintenance is good in some areas and poor in others. Examples are: Inspection panels mounted with straight screws which increase maintenance hours. Although no dynamic components required replacement, maintenance time would be considerably higher than the H-34 due to the fact that the engine cowling panel design requires excessive removal and replacement of sections to replace the components. Access panels are incorporated for maintenance of components; however, the engine package is restricted in work area and increases normal maintenance hours; e.g., a spark plug change required 16 man-hours. An engine cowling change is considered equivalent to H-19 type helicopters (approximately 1/2 man-hour). Replacement of the engine accessory cowling is almost impossible without damage to the cowling. The engine does not hinge down from the top for maintenance; however, it is furnished as a complete built-up assembly for field change.

2. The aircraft is equipped with external systems charge connections. Provisions of this type are considered desirable for fleet operations by Department of Navy personnel participating in this program.

3. Dynamic component lubrication provisions are considered superior in design and reliability when compared to domestic helicopters. All oscillating and pre-loaded bearings are housed in an oil reservoir. The main and tail rotor sleeve and spindle assemblies are lubricated with 90W oil. No addition of oil was required for these reservoirs throughout the test.

4. No seal leakage problems were experienced with the gear boxes or engine. The main transmission is lubricated with grade 1100 oil and the intermediate and tail rotor gear boxes are lubricated with 90W oil. By comparison, seal leakage is a constant problem with the H-34.

5. Corrosion preventive measures are incorporated on the fuselage and components.

6. A refueling panel is incorporated and can be used for refueling from ground reservoirs, drums or can be used to refuel other aircraft. This is considered a unique system and is believed to have definite tactical applications.

7. The instrument panel is mounted in two sections on center hinges which permits each side to be swung out for easy instrument replacement, maintenance and trouble shooting. This is an extremely good feature and considered worthy of adaptation.

8. The instrument mounting devices are unique, simple and logical from a maintenance viewpoint. Wiring harness clamps are simple and reliable from a maintenance standpoint.

9. The ice detection system appears to be reliable and easy to maintain.

10. The cargo clam shell doors and portable vehicle loading enhance the movement of vehicles and heavy cargo.

SPECIAL TOOLS AND EQUIPMENT

1. Special tools provided with the aircraft consisted of thirty-three (33) items and are generally inferior in quality and design with the exception of the inclinometer; however, from a logistical viewpoint, the small number of special tools required is significant (33 items compared to 62 items for the H-34).

NOTE: Special tools referred to for both H-34 and H-36 include those required to perform first through fourth echelon maintenance.

2. One of the common tools, a spark plug wrench, was used on the H-34 successfully and is considered superior from a design and logistical viewpoint (1 piece construction instead of 5).

3. Ground handling equipment provided is considered bulky, cumbersome and inferior, with the exception of the air compressor.

4. Hangar facilities, storage space and camouflage requirements are greater than for the H-34 primarily due to the fact that the H-36 does not incorporate provisions for main rotor blade and pylon folding.

CONCLUSIONS

1. The overall maintenance characteristics incorporated in this design are not as complex as comparable American helicopters. With the exception of deficiencies listed, the equipment required only nominal maintenance primarily composed of inspection and lubrication.

2. The systems and component designs are, in many cases, considered an innovation of simplicity, which is a desirable feature. The aircraft can be maintained with a relatively high availability rate utilizing only average mechanics. Logistical and technical support requirements are less when compared to the H-34.

3. Component design in relation to performance, manufacturing costs, life expectancy and operating efficiency indicate that the items were developed to obtain maximum mechanical reliability and simplicity. It appears that sophistication was sacrificed to reduce logistical and technical support requirements.

4. Design safety features incorporated on the aircraft are questionable when compared to military and civil standards. However, with adequate crew training, the helicopter can be operated with minimum risk.

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