TEARDOWN ANALYSIS REPORT
on
Miscellaneous Aircraft Components
from
UH-1H Aircraft S/N 67-17694

19 December 1969

RVN LOG 907-02694, and -1 thru -4

Prepared by:

J. L. GODDARD
Equipment Specialist (Aircraft)

Approved by:

for RAYMOND S. FARLEY
Chief, Materiel Analysis Branch

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TEARDOWN ANALYSIS REPORT

1. Item:

a. Engine, T53-L-13A; S/N LE16998; P/N 1-000-060-03; FSN 2840-911-7685

b. Transmission, UH-1 main; S/N B12-808; P/N 205-040-001-17; FSN 1615-919-1351

c. Mast assembly, main rotor; S/N CP9-0489; P/N 204-040-366-9; FSN 1560-073-8203.

d. Scissors and sleeve assembly; S/N Q19-3985; P/N 204-011-401-9; FSN 1615-957-7316.

e. Swashplate and support assembly; S/N J19-4959; P/N P/N 204-011-400-11; FSN 1615-060-1062.

f. Hub assembly, main rotor; S/N ABG5903; P/N 204-012-101-3; FSN 1560-788-5321.

g. Stabilizer bar, main rotor; S/N Q19-4804; P/N 204-011-326-7; FSN None.

2. Time Since New: 386 hours

3. Time Since Overhaul: N/A

4. Last Overhaul Activity: N/A

5. Manufacturer: Bell Helicopter Co.

6. Authority for Project: AR 95-5, Change 1; RVN Log 907-02694-1, -2, -3, -4; and ARADMAC Job Order LA6000.

7. Reason for Special Project: To determine the cause of malfunction or failure.

8. Reference: TM 55-1520-210-35P

9. Data Plate Information: This engine will produce guaranteed military rated power at 99.3% N1 speed under standard day sea level conditions. Torquemeter pressure is 1125 ft. lbs at 60.7 psi.

10. Discrepancies and/or Conditions:

a. Condition of the engine as received:

(1) The engine, S/N LE16998, was received in a metal container and was adequately anchored to prevent any further damage during shipment.

(2) The external examination of the engine revealed extensive damage to the air inlet housing, the centrifugal and axial compressor housings, and the accessory gear boxes from being subjected to salt water contamination. The engine appeared to have been submerged in salt water (Incls 1-5).

(3) The external examination also revealed that numerous lines and fittings had been disconnected and were not capped or covered. Impact damage was noted on the oil and fuel pressure transmitter support bracket (Incl 1 & 2).

b. The teardown analysis of the engine revealed the following discrepancies:

(1) The engine reduction gearing assembly was severely damaged from salt water contamination (Incl 6). The damage was in the form of rust and salt water/magnesium residue. There was no evidence of a bearing or reduction gearing failure.

(2) An operational check of the bleed band and actuator was performed prior to any further disassembly and no discrepancies were noted.

(3) Upon removal of the compressor housings, extensive damage was noted internally and externally as a result of the salt water submersion. There was no evidence of foreign object damage on the compressor housings, the stator vanes, or on the compressor blades. There was no evidence of a compressor stall, but there was evidence of residual soot deposits in the compressor (Incl 7). This condition indicates that a burning of gases had occurred without the benefit of air flowing through the compressor.

(4) The external examination of the hot section of the engine through the exhaust outlet revealed severe damage had occurred in the hot section as shown on Incl 8. The disassembly of the power turbine system revealed a severe burn away of the blades had occurred on the first stage power turbine rotor, P/N 1-190-010-02, S/N 24413, and the second stage power turbine rotor, P/N 1-140-550-02, S/N Unknown (Incl 8 & 9). The first stage power turbine nozzle and cylinder assembly, P/N 1-190-000-09, S/N 8E-017, was almost totally destroyed in that the center flange portion was completely separated from the outer portion after all of the vanes were burned and/or torn out (Incl 10 & 11). The second stage power turbine nozzle, P/N 1-140-470-05, S/N Unknown, was also extensively damaged from over-temperature and exiting metal. Log jamming of the blade residue was evident (Incl 8).

(5) Examination of the gas producer turbine system revealed heat damage had occurred to the vanes of the first stage gas producer nozzle, P/N 1-110-520-14, S/N 8E235 (Incl 12). No evidence of any other type of failure was noted. The first stage gas producer rotor, P/N 1-100-880-01, S/N 3429, was also severely damaged from overtemperature (Incl 13). The damage was to the extent that approximately 50% of each blade was missing. Microscopic examination of the blades failed to reveal any other type of failure except from overtemperature. The examination of the second stage gas producer nozzle,

P/N 1-120-000-06, S/N 8D360, and the second stage gas producer rotor, P/N 1-100-820-06, S/N 14234, revealed extensive heat damage to the nozzle vanes and rotor blades. Approximately 40 to 50% of each vane and blade was missing (Incl 14-16). Microscopic examination revealed no other cause of failure except that resulting from overtemperature and exiting metal.

(6) The linear actuator, P/N 204-060-726-1, S/N 805190, and attaching parts, were closely examined on removal. No discrepancies were noted. The cover was removed in an effort to determine the actual position of the actuator shaft. The actuator was near the fully retracted stop, or in the "beeped up" condition (Incl 17).

(7) External examination of the fuel control, P/N 84200A1, S/N 682AS3209, revealed the main T1 bellows spring retainer, P/N 80153, had been removed and incorrectly reinstalled (Incl 18). The "U" shaped boss on the retainer was on the outside of the fuel control in lieu of being installed on the inside against the T1 bellows retainer spring. Flow test of the fuel control and the power turbine governor, P/N 81800A1, S/N 682AM9434, with the retainer plate incorrectly installed, revealed extremely high fuel flow in all operating ranges in the acceleration schedule, high N1 speed in steady state conditions, high fuel flow in the upper deceleration ranges, low N1 speed in the air trigger line, and the IGV schedule could not be run (Incl 19). The fuel control was in the "automatic" condition when it was received. The retainer plate was then correctly installed and the fuel control retested. The control operation improved considerably, but still would not meet the flow test requirements (Incl 20). The results indicated that the T1 adjustment screw, P/N 43285, had also been improperly adjusted. The housing cover was removed and the T1 adjustment was noted to be set at +15°F in lieu of the 59°F that is required by the work specifications (Incl 21). The T1 adjusting screw was readjusted 1 1/4 turns back to the 59° position and reflowed. With the retainer plate correctly installed and the T1 screw correctly adjusted, the control fell within the flow test requirements for proper operation (Incl 22). No further adjustments or repairs were required.

(8) An operational check of the exhaust gas temperature thermocouple assembly, P/N 1-300-177-01, S/N 1437, revealed a short in the No. 3 sensor. The cause of the short could not be determined. All other sensors tested satisfactorily.

c. Condition of the transmission on receipt:

(1) The transmission assembly was received in a metal container, but was not adequately packed to prevent damage during the shipment. Only two of the four attachment points were properly secured as shown in Incls 23-26. The lower portion of the transmission was completely severed and had been fastened to the upper portion of the transmission with wire. No packing was placed between the two sections and the anchor wire had broken. The generator was also lying on one of the transmission mount supports and was not anchored. The transmission housing was broken as shown on Incls 23-25. Water and trash were noted in the bottom of the can (Incl 26).

(2) Preliminary examination, prior to the disassembly, revealed severe damage from salt water contamination (Incls 23-26).

(3) The disassembly and inspection revealed extensive damage had occurred as a result of the salt water contamination. The damage was in the form of rust and salt water/magnesium residue and corrosion (Incl 27). All of the discrepancies noted were the result of the impact or the salt water contamination. There were no discrepancies noted that would indicate a malfunction or failure had occurred.

d. The main rotor hub assembly, P/N 204-012-101-3, S/N ABG5903, and the stabilizer bar assembly, P/N 204-011-326-7, S/N Q19-4804, were both packed in the same metal container as shown on Incls 28 & 29. The stabilizer bar assembly was lying on top of the main rotor hub with no protective packing between the items or their component parts. The stabilizer bar had been tied with wire to the main rotor hub. The wire had broken and allowed additional damages to occur thus making it very difficult to determine the damage caused during shipment. Only one control rod fracture had been covered to prevent destruction of important evidence. Close examination of the main rotor hub, the stabilizer bar, and attaching parts revealed the following significant factors or conditions (Incl 28-38):

(1) When the main rotor assembly was received, approximately 12" of the mast assembly, P/N 204-011-450-01, S/N CP9-0489, was still installed (Incl 28 & 29). The mast fracture area revealed at least one heavy bump had occurred on the "red" blade side of the mast and one lighter bump on the "white" blade side prior to the mast separation. Microscopic examination of the fracture revealed the failure had occurred as a result of bending overstress with no evidence of any high rotational forces or sudden reduction in speed noted (Incl 37 & 38).

(2) The "red" pitch horn assembly, P/N 204-011-120-5, S/N MD1-9105, had completely separated from the "red" grip, P/N 204-011-121-5, under a severe overstress condition. There was no evidence of any fretting between the grip and horn and no evidence of any other type of premature failure (Incl 30-34). It is suspected that the pitch horn separated at the time of the impact, and at or near the same time, the "red" grip rotated approximately 160° on the hub. No strike marks were noted on either the "red" pitch horn or the "red" grip that would have caused the horn separation or the grip rotation and subsequent damage to the grip reservoir. There were some contact marks noted on the "red" pitch horn and the stabilizer bar lever where the horn had contacted the pillow block assembly at an extremely high blade angle (Incl 34 & 36).

(3) Close examination of the "white" blade grip and the pitch horn assembly revealed several significant factors.

(a) The pitch horn, P/N 204-011-120-7, S/N MD1-9106, had not separated from the grip as had the pitch horn on the "red" blade (Incl 30-33 & 35).

(b) The stabilizer bar lever had struck heavily on the pillow block assembly as shown on Incl 31-33. The "white" blade would have to be in a negative attitude for this condition to occur (Incl 34-37). In addition, heavy strike marks were also noted on the pitch arm, the bolt, and the pillow block assembly on the lower side (Incl 31, 33 & 35). In order for this to

happen, the "white" side of the stabilizer bar would have to be all the way down against its stop and the stabilizer bar lever assembly, P/N 204-011-301-5, all the way up. This evidence indicates that the white blade had actually gone to an extremely high blade angle, then to a negative blade angle or vice versa during the final portion of the flight or during the impact. In either case, these conditions occurred after the controls had started their breakup sequence, and could not occur under normal operating conditions.

e. The remaining portion of the main rotor mast assembly, with the swashplate and support assembly, P/N 204-011-400-11, and the scissors and sleeve assembly, P/N 204-011-401-9, installed, were closely examined (Incl 39-41). The examination revealed several significant factors:

(1) The "white" damper assembly, P/N 204-010-937-5, was damaged. The reservoir was broken off and the shaft had failed in a torsional overstress in the upward direction. The damper was in the up position (Incl 39 & 41). The control rod from the white damper to the stabilizer bar had not failed.

(2) The "red" damper did not appear to have experienced any damage from the accident. The damper arm was in the "down" position (Incl 29). This is inconclusive since the arm was free to move. The control tube assembly, P/N 204-010-925-9, from the stabilizer bar to the "red" damper had failed from compression and bending overstress (Incl 29 & 30). The end of the control tube that attached to the "red" damper itself had been removed and was not received for analysis (Incl 29-33).

(3) The "red" rigid connecting link, P/N 204-011-442-1, had failed in compression and bending overstress as a result of impact. This control tube connects the stabilizer bar lever assembly and the scissors assembly (Incl 34, 39 & 41).

(4) The "white" rigid connecting link, P/N 204-011-442-1, had also experienced severe compression overloads (Incl 39 & 41). The tube was bent to some extent and the upper fork assembly was forced apart by the overstress. A portion of the attaching bolt was still in the fork when received. The bolt had also failed from the overstress. Damage on the outer portion of the tube had also occurred where the tube had passed up through the stabilizer bar after the end had separated. This control tube connects the white scissors to the stabilizer bar lever assembly. Damage during handling and shipping had also occurred.

(5) The trunnion assembly, P/N 204-011-451-1, attached to the "white" scissors link, P/N 204-011-407-1, was broken out of the swashplate outer ring assembly, P/N 204-011-403-1 (Incl 40). The broken off portion of the trunnion attachment on the outer ring assembly was not received for analysis. Microscopic examination of the fracture surface on the ring revealed the failure was from overstress as a result of the impact. No evidence of any other type failure or malfunction was noted. The trunnion had not failed and no evidence of fretting or corrosion was noted either on the trunnion or the outer ring.

(6) The swashplate and support and the scissors and sleeve were disassembled and removed from the mast assembly. Inspection and microscopic examination of failed areas did not reveal any type of failure except those overstress failures that resulted from the impact (Incl 30-41). These discrepancies were as follows:

(a) One attachment horn was partially broken out on the "white" scissors attachment to the sleeve hub assembly, P/N 204-011-405-9.

(b) Both attachment points were broken on the swashplate support assembly, P/N 204-011-404-5, where the swashplate and support ring connects.

(c) The bearing and liner assembly, P/N 204-011-443-1, located on the left collective lever assembly, P/N 204-011-438-1, had failed from overstress as a result of the impact. Microscopic examination of the failed bearing did not reveal any other type of failure. The overstress failure is borne out by the strike mark on the race and the split bearing balls as shown on Incl 30.

11. Summary and Conclusions:

a. The teardown analysis revealed a premature engine failure had occurred as a result of overtemperature operation. The cause of the overtemperature condition was the result of an improperly installed main T1 bellows spring retainer, P/N 80153, and the improper adjustment of the T1 adjustment to a setting of 15°F in lieu of the 59°F setting required by appropriate overhaul specifications. These discrepancies resulted in an extremely high fuel flow at all operating ranges in the acceleration schedule, high N1 speed in the steady state condition, high N1 droop, high fuel flow in the upper deceleration, low N1 speed in the air trigger line schedule, and also a possible malfunction of the inlet guide vanes. The evidence noted in this investigation indicates that the temperature sensing probe had been removed, an unauthorized field adjustment made on the T1 adjustment screw to an increased fuel flow position, and the spring retainer incorrectly reinstalled.

b. The teardown and analysis of the aircraft component parts received failed to reveal evidence of any malfunction or premature failure except as a result of the impact and/or breakup sequences. The seesawing and/or severe bumping actions, noted in this investigation on the stabilizer bar levers, the main rotor hub on the mast, the pitch horn strikes or separations, and the fractures noted on the swashplate and support and the scissors and sleeve, are typical of those conditions found on several previous accidents where low rotor rpm and/or water strikes were known to have occurred. Both conditions are suspected in this case.

12. Recommendations:

a. It is recommended that an immediate one-time inspection be performed on all aircraft to determine if the retainer, P/N 80153, is correctly installed. If the retainer is incorrectly installed, the fuel control should be removed from service immediately and returned for proper installation of the retainer, and flow test and adjustment of the control.

b. If the retainer is found incorrectly installed, a hot end inspection should also be performed to determine how much damage has occurred so that necessary repairs can be made prior to a catastrophic failure in the engine.

c. It is also recommended that necessary action be taken to assure that only those adjustments specifically authorized in the appropriate maintenance manuals are performed.

J. L. Goddard

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J. L. GODDARD
Equipment Specialist (Aircraft)