FINAL REPORT

on
investigation of a serious incident with Ka-26 helicopter, reg. LZ-6013, owned by Balkan Agro Aviation Ltd Air Operator, town of Vratsa, occurred on 02.04.2004

2004

The materials on the investigation of the serious incident have been classified under state file number 03/02.04.2004.

Owner: Balkan Agro Aviation Ltd, town of Vratsa, with main office in Vratsa 3000, Krivodolsko shose Str, P.O. Box 15

Aircraft Manufacturer: MAP - SSSR

National and Registration Marks: LZ-6013, according Certificate of Registration No ……/18.08.1999

Place and Date of the aviation occurrence: village of Chomakovtsi area, District of Vratsa.

Notified: Aircraft Accident Investigation Unit, Ministry of Transport and Communications and CAA. The aviation occurrence was classified as a serious incident.

A commission has been appointed to investigate the aviation occurrence by order RD-08-197/09.04.2004 of the Minister of Transport and Communications.

Type of Flight: Aero-chemical work (ACW) flight for herbicide spraying, according AW 7 specification of the Certification of Air Operator (CAO) No BG 411, valid till 01.09.2004.

On the 02.04.2004 the commander of Ka-26 helicopter, reg. No LZ-6013, was performing his fifth ACW flight for the day.

After the engines start and check the pilot took-off from a temporary landing site in Chomakovtsi village area. He treated the first block planned and flew for treatment of the second one, where he performed two working passes. At the end of the third pass an intense vibration of right-hand engine started. The commander climbed up to 50 m height, when the engine self-shutting down occurred. The pilot saw a smoke from the right-hand engine in the retrospective mirror. He chose an appropriate site and started left-hand turn for a forced landing. The helicopter commander performed forced landing in straight ahead direction in heading 190° on a lawn, situated at 750 m southwest of Chomakovtsi.

1. Factual Information

1.1 History of Flight

1.1.1 Flight Number:

Fifth ACW flight for the day – herbicide spraying.

1.1.2 Preparation and description of the flight and events:

The flight mission was assigned by the manager of Balkan Agro Aviation Ltd. according the request received.

In the day of the aviation occurrence the helicopter commander created the necessary organization for works from the temporary landing site in Chomakovtsi village area. After the fourth flight the helicopter was refueled with 110 liters of gasoline B-91 from a barrel being on the landing site, and filled with herbicide, and after that took-off for the fifth flight. During the third spraying pass a strong vibration started in the right-hand engine. The commander climbed to 50 m height, when the engine self-shutting down occurred. The pilot saw a smoke from the right-hand engine in the retrospective mirror. He chose appropriate site and started left-hand turn for forced landing. The pilot performed forced landing in straight ahead direction in heading 190°.

1.1.3 Location of the Occurrence
750 m southwest from the Chomakovtsi village.

1.2 Injuries to Persons
No injuries to persons.

1.3 Damage to Aircraft
During the inspection of the aircraft the Commission determined: no damages and destruction on the helicopter airframe.

The damages and destructions were localized in the right-hand engine, which allowed classifying the aviation occurrence as a serious incident.

Engine damages: torn fixing pins of the first cylinder to the engine housing, the cylinder was cut off from the housing. The lower bracelet of the piston rod was destroyed; the piston was jammed into the cylinder liner, which was destroyed. There were bruises on the fly-wheel and the piston rods of the other cylinders.

The engine was not repairable.

1.4 Other Damages
No other damages were established by the Commission

1.5 Personnel Information
1.5.1 Commander
Type of license: CPL(H), date of issue 10.10.1977.
Validity of the license: till 21.07.2004.
Medical fitness: Protocol No …./11.02.2004, valid till 21.07.2004.

1.6. Aircraft information

1.6.1. Airworthiness information
Helicopter Ka-26, registration number LZ-6013, was manufactured on the 23.03.1972 by the Ministry of Aviation Industry of USSR; it possesses Certificate of Airworthiness,

issued by CAA on the 21.03.2002, re-attested on the 04.04.2003 and valid till the 04.04.200.

The helicopter has accrued 7893:32 hrs and 33 866 cycles since new. The last overhaul was certified on the 30.07.1988 and after it the helicopter has accrued 1850:32 hrs with time between overhauls 2500 hrs and 15 years (by "Special Complex Program for Continuous Airworthiness of Civil Aviation till 2010", registered at CAA under No 45-13-283/ 16.10.2003).

Two M-14V26 engines were installed on the helicopter as follows:
1. Left-hand engine, has accrued 992:12hrs and 19 years 2 months since new with total service life of 2750 hrs, without limitation of calendar operational life. After the overhaul the engine accrued 491:49 hrs and 15 years, 1 month (the last engine overhaul was certified on 20.02.1989) with life time between overhauls of 500 hrs determined, without limitation of calendar life time.

2. Right-hand engine has accrued 1424:39hrs and 24 years 5 months since new (manufactured on 25.10.1978) with total service life of 2750 hrs, without limitation of calendar operational life. After the overhaul the engine accrued 147:21 hrs and 14 years, 1 month (the last engine overhaul was certified on 09.02.1990) with life time between overhauls of 500 hrs determined, without limitation of calendar life time.

A rotor gearbox R-26 type produced on the 08.07.1980 has been installed on the helicopter. Since new the rotor gearbox has accumulated 3409:09 hrs with predetermined total service life of 4000 hrs and without limitation of calendar operational life. After the last overhaul the rotor gearbox accumulated 554:06 hrs and 13 years 7 months calendar time and the last overhaul was certified on 22.08.1990 in the technical logbook of the rotor gearbox, but it was not confirmed by the respective signature and stamp of the repairing organization.

A column H2000-0/A type was installed on the helicopter, and it has accrued 3237 hrs and 22 years 2 months since new with predetermined by the manufacturer total life time of 7000 hrs and 35 years. After overhaul the column accrued 926 hrs and 14 years and 11 months (the last overhaul was certified on 27.061989) with predetermined life between overhauls of 1500 hrs and annual prolongation of the calendar life time; the last prolongation of the time between overhauls was certified on 29.03.2003. (By "Technical Condition Assessment of Column N2000-0/A new calendar life time limit was established till 29.03.2004). On the base of this information a conclusion could be made, that as to the moment of the serious incident the calendar life time of the column was expired.

6 propeller blades N-1M were installed on the helicopter.
The blades with serial numbers 18552, 18584 & 18580 have accrued 1576 hrs and 14 years 9 months since new (manufactured on 28.06.1989) with predetermined life time of 4000 hrs and 14 years and after the 12th year an annual prolongation should be made. In the blade's passports it was written that on 28.03.2003 a check of their technical

condition was made by a representative of Kamov Design Bureau and the calendar life time was prolonged till 28.12.2003. On the base of this information it was possible to conclude that as to the moment of serious incident the total life time of the blades with above mentioned serial number was expired.

The blades with serial numbers 18397 & 18459 have accrued 1257 hrs and 14 years 9 months since new (manufactured on 28.06.1989) with predetermined life time of 4000 hrs and 14 years and after the 12th year an annual prolongation should be made. In the blade's passports it was written that on 28.03.2003 a check of their technical condition was made by a representative of Kamov Design Bureau and the calendar life time was prolonged till 28.12.2003. On the base of this information it was possible to conclude that as to the moment of serious incident the total life time of the blades with above mentioned serial number was expired.

The blade with serial number 19133 has accrued 788 hrs and 14 years 1 month since new (manufactured on 13.02.1990) with predetermined life time of 4000 hrs and 14 years and after the 12th year an annual prolongation should be made. In the blade's passport it was written that on 28.03.2003 a check of their technical condition was made by a representative of Kamov Design Bureau and the calendar life time was prolonged till 28.12.2003. On the base of this information it was possible to conclude that as to the moment of serious incident the total life time of the blades with above mentioned serial number was expired.

On the 16.10.2003 CAA received an extract from"Special Complex Program for Continuous Airworthiness of Civil Aviation till 2010", approved by Russian Aviation Authorities, registered under No 45-13-283/16.10.2003, in which the life time limitations for Ka-26 helicopter were determined. In particular it was mentioned that the calendar life time between overhauls for Ka-26 helicopters had been limited to 15 years.

By a letter reg. No 40-00-105/ 27.10.2003 the CAA's Chief Director informed the air operators, who operate Ka-26 helicopters, about the received "Special Complex Program for Continuous Airworthiness of Civil Aviation till 2010", approved by Russian Aviation Authorities, registered under No 45-13-283/16.10.2003 and asked them to consider the limitations, cited in this letter.

Having in mind that the continuous airworthiness and especially the obligatory observing of the life times is a main factor in flight safety ensuring, in accordance with Article 61 of Regulation No 24/15.02.2000 of Ministry of Transport and Communications about issuing of certificates of air operators, it should be necessary CAA to send operational instructions in order to oblige the air operators to adhere the life limitations, determined by the design bureau.

According to the information stated it was possible to conclude that as to the moment of the serious incident the calendar life time of the Ka-26 helicopter, reg. LZ-3013 had expired.

The helicopter possesses Maintenance Certificate, issued by maintenance organization of Balkan Agro Aviation Ltd, town of Vratsa and valid till 04.04.2004.

The helicopter maintenance was executed by maintenance organization of Balkan Agro Aviation Ltd, Vratsa, which was licensed according to the requirements of Regulation No 145/14.01.1999 of the Ministry of Transport and Communications and possessed Certificate No MOA-129/0403 (old certificate No MOA-52/0201) according the program, approved by CAA. But the number of the old license was stamped on the forms of the Maintenance Certificate.

Before the flights on 02.04.2004 a preflight preparation was performed and registered into the monthly logbook. There were no faults registered after the inspection.

1.6.2. Helicopter performance

Maximum take-off weight of Ka-26 helicopter in agricultural variant is 3250 kg. Empty weight is 2248 kg. At the moment of air occurrence there was about 150 liters of fuel and a single pilot crew on board, that gave about 2600 kg flight weight and the center of gravity was in operational range.

Maximum speed 130 km/h.
Long range cruising speed 80…85 km/h.
There are two engines M-14B26 installed.
M-14B26 is nine-cylinder radial engine with air cooling and engine displacement of 10.16 liters, take-off power of 325 horse power. Peak rpm of the crankshaft is 2800 rpm.
Cylinder-head temperature should be in the range of 120…140°C according the Engine Operation Manual.
Carburetor inlet fuel pressure is 0.2…0.5 kg/cm^2. Main oil line pressure should be 5…7 kg/cm^2.

1.6.3. Fuel

Just before the flight, in which the aviation occurrence emerged, the helicopter was refueled with 110 liters of fuel - aviation gasoline 91.
On the scene of the occurrence there was 150 liters of fuel in the tanks.

The fuel for the refueling was bought on the 01.04.2004 from Air Concord Sole Trader from the town of Veliko Tirnovo and a copy of the invoice was attached to the deed materials. The fuel possesses Certificate of Quality and a copy of it is attached to the deed materials.

During the investigation of the aviation occurrence samples were taken from the fuel sediment, from the barrel for refueling of the helicopter and from the helicopter and were given for investigation to the Fuels and Oils Chemical Laboratory at Sofia Airport.

The protocols from the investigation are enclosed to the deed. All three samples didn't meet the requirements of aviation gasoline 91 for the following indicators:

- for the fuel sediment and fuel from the helicopter – the samples analyzed didn't meet the requirements for aviation gasoline type 91 on p.2 (maximum permissible content of lead tetraethyl) and on p.3 (presence of mechanical impurities). In a comment to the laboratory protocol it was written, that the maximum content of lead tetraethyl in aviation gasoline type 91 should be 0.53 ml/l according ASTM D 910-03, and in Quality Certificate, presented in the laboratory, it was 1.2 ml/l. There was also a discrepancy of the color of the fuel samples, given for analysis. According ASTM D 910-03 aviation gasoline 91 should be brown, and the samples investigated were of light green color. In the Quality Certificate of the company this index wasn't mentioned.
- for the sample from the refueling barrel – the sample analyzed didn't meet the requirements for aviation gasoline type 91 on p.2 (maximum permissible content of lead tetraethyl). In a comment to the laboratory protocol it was written, that the maximum content of lead tetraethyl in aviation gasoline type 91 should be 0.53 ml/l according ASTM D 910-03, and in Quality Certificate, presented in the laboratory, it was 1.2 ml/l. There was also a discrepancy of the color of the fuel samples, given for analysis. According ASTM D 910-03 aviation gasoline type 91 should be brown, and the samples investigated were of light green color. In the Quality Certificate of the company this index wasn't mentioned.

1.7. Meteorological information
Day, visual flight conditions, CAVOK, pulsating wind 1 – 3 m/s from 280°.

1.8. Aids to navigation
Standard navigation aids for Ka-26 helicopter.

1.9. Communications
Standard communication equipment for Ka-26 helicopter

1.10. Airport
Temporary landing site in the village of Chomakovtsi area

1.11. Flight data recorders
No envisaged for the aircraft type.

1.12. Wreckage and impact information
There were no consequences for the helicopter airframe after the forced landing performed.

1.13. Medical and pathological information
According to a protocol of the Air Medicine Certification Commission (AMCC), the pilot was fit for flight work till 21.07.2004.
There were no consequences for the pilot after the forced landing.

1.14. Fire
After the inspection made the Commission established there were no signs for fire.

1.15. Survival aspects

The following main survival aspects may be pointed out:

- Good route choice by the pilot, including the execution of the last phase of the flight outside the built-up area;
- Happy and timely choice of landing site for emergency landing;
- Use of safety belts in flight by the pilot.

1.16. Tests and research

For the purposes of the technical investigation the following was accomplished:

- inspection on the scene of the serious incident and helicopter and engines condition; a recovery of the flight till the forced landing, view and photographing of the helicopter airframe elements, condition and positions of the valves and selector switches in the cockpit and gauge readings;
- laboratory analysis of the fuel;
- laboratory analysis of the oil;
- metallographic analysis of the breaks of the fixing studs of the firs cylinder to the engine housing and the bracelet of the piston rod of the first cylinder.
- an examination of the repair technology was performed of M-14B26 engine in Letets Military Repair Plant.

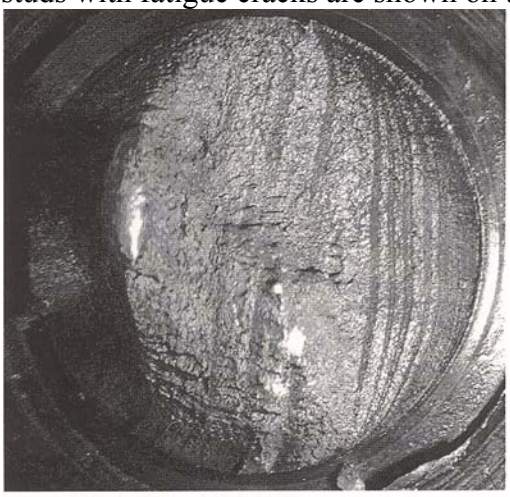
The materials and the results of the tests and research made are enclosed to the deed.

2. Analysis

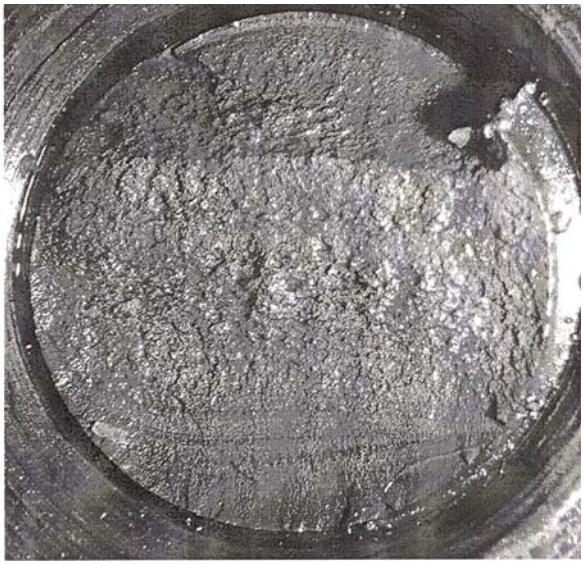
During the examination of the helicopter at the scene of the occurrence the Commission determined, that the first cylinder of the right-hand engine was detached from the housing and the fixing studs were torn, the piston was jammed in the cylinder, the lower bracelet of the piston rod was destroyed and the piston rod was detached from the crankshaft, there were scratches on the balance weights of the crankshaft and bruises, caused by the freely hanging piston rod of the first cylinder. After the removal of the first cylinder with the piston rod the engine rotated freely by a crank. The reason for the engine self-shutting down was destruction of the first cylinder and seizure of the crankshaft by the piston rode of first cylinder.

In order to determine the reason for the first cylinder destruction a metallographic analysis of the breaks of the six fixing studs of the engine first cylinder and the breaks of the piston rod bracelet for connecting to the crankshaft was made in the laboratory for Mechanical Examination and Control at Technical University (TU) in Sofia. The results of the analysis are stated in a protocol, issued by the Scientific and Research Sector of TU – Sofia. The protocol is enclosed to the deed. It is clear from the protocol, that there were fatigue cracks on two of the studs.

The breaks of the studs with fatigue cracks are shown on the Fig. 2.1 & 2.2.



Фиг. 2.1.



Фиг. 2.2.

The fatigue crack on the stud, which broke is shown on the fig. 2.1, comprises more than half of its cross section, and the fatigue crack on the stud, which broke is shown on the fig. 2.2 - about 1/3 of the cross section.

The brakes of the piston rod bracelet and on the other studs were provoked as a result of inadmissible stresses. The possible pattern of inadmissible stresses on the studs and bracelet destroyed matched the general bending and shearing, preceded by fatigue destruction of one of the two studs, for which material fatigue was found.

Having in mind the above mentioned, the conclusion should be done, that the destruction of the first cylinder assembly was a result of the firmness loss of the assembly as a result of fatigue destruction of one of the studs.

The possible causes for fatigue destruction of the studs might be:

- cyclic loadings, caused by the cycling in the piston engine processes;
- vibration stresses, caused by unbalanced masses during the operation of such engines;
- concentration of the stresses, caused by the presence of threads on the studs;
- possible initiation of micro-corrosion nucleuses, acting as concentrators of stresses.

The first two factors are related mainly with the time of engine operation, which is in the frame of the total engine life time and the time between the engine overhauls. The engine has accrued 1424:39 hrs operating time since new with the total engine life time of 2750 hrs and 147:21 hrs after the last overhaul with 500 hrs life time between overhauls. The considerable amount of remaining life time made possible the consideration that these two factors didn't play deciding role for the origin of the micro cracks, which led to the fatigue destruction.

The third factor is related mainly with the observing of the engineering process during the producing of the studs, which might be difficult to determine.

The fourth factor is related to a great extent with the calendar life time of the engine operation.

M-14B26 engine, serial No KE 933062 was operated till the date of the aviation occurrence 24 years 5 months and from the last overhaul 14 years and 1 month passed.

Currently there is no determined calendar life time for the M-14V26 engines. During the overhaul of M-14V26, serial No KE 933062, a calendar life time of 5 years was determined, which was canceled later. It is necessary to have in mind that the engine was operated 147 hrs only during the last 14 years.

The low intensity of the flights with Ka-26 helicopters after year 1990 and the occurrences emerged, related with fatigue destructions, imposes to reconsider the calendar life time between the overhauls of M14V26 engines.

The detection of micro-cracks, which might lead to fatigue destructions, may be performed by nondestructive tests. These methods might be used during the overhauls.

The Commission’s inspection revealed that no nondestructive tests of the fixing studs of the cylinders to the engine housing were used in Letets MRP, because it wasn’t prescribed in the repairing methods.

In order to avoid the occurrence of similar events of destruction of M-14V26 destruction it should be expedient to perform nondestructive test (color crack detection) of the studs of the engine cylinders during the overhauls.

The pilot’s activities after the engine self-shutting down were timely, in accordance with the AOM and adequate to the situation emerged and leaded to limitation of the possible unfavorable consequences.

3. Conclusions

The technical investigation conducted, the results of examination and analysis give the grounds for the Commission to make the conclusion, that the serious incident was a result from the following.

Main cause:
In-flight self-shutting down of right-hand engine because of first cylinder destruction

Immediate cause:
Fatigue destruction of fixing studs of the first cylinder to the engine housing

Contributing factors:
Engine operation with non-standard fuel.

During the investigation the commission revealed also the following
IRREGULARITIES:

1. Sending an information letter instead of operational instructions to the air operators operating Ka-26 helicopters about the changes in life time of Ka-26.
2. Exceeding of the helicopter calendar life time between the overhauls.
3. Exceeding of the column H2000-0/A calendar life time between the overhauls.
4. Exceeding of the helicopter's two propellers life time.
5. There was no certification of the propeller's gear overhaul, performed on 22.08.1990.
6. Non-observance by the air operator of the p.5 of Para.1 of Article 140 of Regulation No 6 of the MTC from 14.06.2001.
7. Inefficient quality control system for the quality of imported air spirits.

Safety recommendations:

1. The flights of AO Balkan Agro Aviation with Ka-26 helicopters were banned by a letter reg. No 10-01-66/ 16.04.2004 till revealing of the cause for the serious incident - fulfilled till 23.04.2004 and after revealing of the cause the flights were permitted.
2. CAA should create conditions for execution the requirements of "Special Complex Program for Continuous Airworthiness of Civil Aviation till 2010" of the Russian Aviation Authorities, by the air operators, operating Ka-26 helicopters.
   Time – one month after submitting of the final report, person responsible – head of ILA Department of CAA.
3. CAA should assess the possibility for introducing of the calendar life time between the overhauls for M-14V26 engines (proposed by a letter reg. No 10-01-68/ 23.04.2004).
   Time –30.09.2004, person responsible – head of ILA Department of CAA
4. CAA should improve the quality control system for the aviation fuels and oils used and to speed up the implementation of "Implementation and Quality Control of Aviation Fuels and Oils and Special Liquids Instruction" of the Ministry of Transport and State Aeronautics Inspection of 13.02.1974.
   Time 01.10.2004, person responsible: CAA

5. A non-destructive test should be included in the repairing methods for M-14V26 engine overhaul (color crack detection) of the fixing studs of the cylinder to the engine housing.
   Time 01.08.2004, person responsible - head of ILA Department of CAA