

CIVIL AVIATION DEPARTMENT
MINISTRY OF TRANSPORT AND CIVIL AVIATION
MALE' REPUBLIC OF MALDIVES

TITLE : REPORT OF THE ACCIDENT TO MIL HELICOPTER MI8-P NEAR FESDHOO, ARI ATOLL ON 8TH JANUARY
1994

INTRODUCTION

Maldives is a signatory to the Convention on International Civil Aviation (Chicago 1944), which established the International Civil Aviation Organization. Article 26 of the Chicago Convention obligates the governments of countries that are signatory to the Convention to conduct investigations into aircraft accidents in their territories which involve aircraft of other countries which are signatories to the Convention.

In conducting the accident investigation the fundamental objective of the investigation is the prevention of aircraft accidents and incidents.

It is not the purpose of this activity to apportion blame or liability. The sole purpose of the exercise is the maintenance and enhancement of flight safety.

SYNOPSIS

On Saturday 8th January 1994, at about 11.15 LT, Mil Helicopter Mi-8P helicopter, LZ-CAP, enroute in VMC conditions lost directional control and crashed near Fesdhoo. The helicopter which was operated by Hummingbird Helicopters (Maldives) Pvt Ltd. on a public transport passenger transfer flight from Male' via Bodufolhudoo to Maafushivaru Helipad was destroyed due to impact on water and sank to the bottom of the sea. All eight passengers and the cabin attendant perished. The two pilots sustained serious injuries. The investigation found that the circumstances of the accident were consistent with loss of directional control. This was due to the failure of the tail rotor drive shaft aft of the main gearbox that resulted in complete loss of the tail rotor drive. Laboratory analysis indicate a difference in hardness and material characteristics of the failed part and other similar parts that had not failed. Lack of comprehensive information on the manufacturing specifications and details of maintenance by the overhauling agencies hampered the investigation.

As an interim measure during the investigation process safety recommendations were made to conduct inspections on the rest of the fleet which did not result in any unusual finding. The recommendations are summarised in Section 4 of this report.

1. FACTUAL INFORMATION

1.1 History of the flight

The helicopter, a twin engined Mil Mi8-P operated by Hummingbird Helicopters departed Male' International Airport at about 10.35LT with tourists bound for Bodufolhudoo and Maafushivaru. The flight was flown VFR and the weather was good with visibility 10km or more. The helicopter with two pilots and a cabin attendant was carrying 14 passengers destined for both Bodufolhudoo and Maafushivaru. The helicopter landed at Bodufolhudoo; discharged the six passengers for that destination and departed at 1105lt and continued onto Maafushivaru, about 35 nautical miles away; their next destination.

At about 11.15 LT eyewitnesses at Fesdhoo, an island about 18 nautical miles from Bodufolhudhoo saw the helicopter spin and crash into the sea about two miles off Fesdhoo. An eyewitness contacted the helicopter operator by telephone, who in turn passed the message to the Civil Aviation Department and the Male' Control Tower.

According to the survivors, i.e., the pilots, as the helicopter was abeam Fesdhoo, the gyro indicated bank to the right hand side and an unusual noise was heard, which appeared to come from the helicopter floor. The PIC was handling the helicopter, who dropped the collective and pressed on the right pedal. At that time the speed was about 200kmph. The helicopter began to spin and the pilots were not able to control the attitude. According to the pilots the helicopter was flying at about 1000ft.

The helicopter impacted the water in a matter of seconds. First the aft section hit the water and then the cockpit section. Water ingressed into the cabin and sank within a few seconds.

Immediately search for survivors was initiated by Fesdhoo Tourist Resort management by boat. Float planes and helicopters flying in the atoll joined in while the Coast Guard was being dispatched from Male' around 60 nautical miles away from the scene of the accident. No wreckage or survivors were sighted until about 1200LT when the search party on the Dhoni from Fesdhoo Tourist resort sighted the only survivors, the two pilots of the helicopter. The survivors were flown to Male' International Airport by float plane at 1340LT.

Divers, volunteers and those employed by the National Security Service search team set out to locate any survivors and the wreckage. The search was abandoned at sunset. The operation was resumed on the following day, Sunday the 9th of January 1994, at sunrise. Fuel surfacing from a leaking fuel tank of the helicopter helped locate the wreck lying at a geographical location of 3° 59' N 073° 49' E at a depth of 52 meters.

The passengers and the cabin attendant were found dead inside the cabin of the helicopter that was lying inverted at the bottom of the sea. Except for two passengers who were found in the cockpit, the rest of the passengers were strapped in their seats. The cabin attendant was lying between the seats.

The bodies were recovered from the wreckage on the 9th January 1994 and flown to Male' International Airport for post mortem and handing over to the relatives.

1.2 Injuries to Persons

	Crew	Passengers	Other	Total
Fatal	1	8	0	9
Serious	1	0	0	1
Minor	1	0	0	1
None	0	0	0	0
TOTAL	3	8	0	11

1.3 Damage to Aircraft

The helicopter was damaged beyond repair as a result of heavy impact on the surface of the sea and submersion in salt water for more than 12 weeks. The wreckage was recovered on 3rd April 1994.

1.4 Other Damage

No other damage was reported.

1.5 Personnel Information

	Captain	Co-pilot
Sex	Male	Male
Age	48 years	30 years
Licence Number	004048	004023
Licence Category	ATPL	CPL
Medical Certificate	Class One	Class One
Licence Validity	7 March 1994	19 October 1994
Proficiency Check	22 May 1993	2nd Nov 1993
Instructor rating	27th June 1993	-
Total Hours	4777.25	2914.95
Total on type	4135.25	2430.20

Cabin Crew

The cabin attendant on board was a Maldivian male of 19 years age who had undergone a basic in-house training as cabin crew. No certification was required by the pertinent regulations. The cabin attendant had a 13 month valid certificate granted by the Operator. The cabin attendant did not have a valid medical certificate, as none was required.

1.6 Aircraft Information

1.6.1 Significant particulars

Registration	LZ-CAP
Manufacturer	Ministry of Aviation Industry USSR
Model	Mil Mi8-P
Serial Number	10320
Country of Manufacture	Russia (USSR)
Year of Manufacture	1989
Engines	TB2-117A
Engine type	GAS Turbine
Certificate of Registration Holder:	Helaiar

Issued: 23 May 1989

Aircraft Operator: Hummingbird Helicopters (Maldives) Pvt Ltd

Certificate of Airworthiness No. 862 (Bulgarian)

Issued On: 23 May 1989

Last Maintenance Carried out: 100hrs inspection on 20 Nov 93

Total airframe hours: 1222.59

Last Major check at overhauler: D check , 10 November 1992

Drive shaft time since new: 1222.59 hours

Drive shaft time between
overhauls 4500 hours

1.6.2 Weight and Balance

Aircraft maximum take of weight (MTOW) 12,000kg

- estimated take off weight 11035kg

- estimated weight at impact 10910kg

- estimated fuel remaining at impact 1635kg

The aircraft operating weight and fuel was not accurately recorded as per Maldivian Airworthiness Requirement Series "C" No.10. At the time of accident the aircraft was loaded within the weight and balance limitation specified in the aircraft flight manual.

1.6.3 Aircraft history and significant events

Jan 23rd 1989	Aircraft Manufactured by Ministry of Aviation Industry USSR
Nov, 1992	"D" check (overhaul) was carried out on the Drive Shaft - (time since O/H 273.53Hrs and time since new 1222.59Hrs)
March 4th 1993	After complete overhaul aircraft shipped to Maldives from Bulgaria to be operated by Hummingbird Helicopters Maldives Pte Ltd on wet-lease from Haliar, Bulgaria.
Jul 6, 1993	Aircraft flown from the ship to shore.
Aug 09, 1993	Collective Pitch Indicator Adjusted.
Aug 12, 1993	Main Rotor Track adjustments carried out and tested
Aug 29, 1993	100hrs inspection carried out
Oct 03, 1993	Main gearbox changed
Nov 09, 1993	Autopilot Control box replaced

Nov 20, 1993	100hrs inspection carried out
Jan 01, 1994	Captain recorded "vibration felt above 200km/hr" and direction was given "operation to be conducted below 180km/hr"
Jan 02, 1994	The tail rotor head and blades were changed.
Jan 08, 1994	LZ-CAP crashed near Fesdhoo

1.6.4 Additional Data

Engines

Left:	Type	TB2-117A
	serial No	C94211168
	Time since new:	1154.59hrs
	Time since overhaul	273.59hrs
	Time between overhaul	1500hrs
	Ultimate life	10,500hrs

Right	Type	TB2-117A
	Serial No.	C94301462
	Time since new	3030.59hrs
	Time since overhaul	273.59hrs
	Time between overhaul	1500hrs
	Ultimate life	10,500hrs

Main Gear Box:	Type:	BP-8A
	Serial No.	8521101
	Time since new	1691.59hrs
	Time since overhaul	273.59
	Time between overhaul	1,500hrs
	Ultimate life	10,500hrs

Intermediate Gear Box	Type:	8A 1915 000
	Serial No.	L8412178
	Time since new	1222.59hrs

	Time since overhaul:	3000hrs
	Ultimate life	15,000hrs
Tail gear box	Type:	246 1517 000
	Serial No	L910 1136
	Time since new:	1222.59
	Time since overhaul:	--
	Time between overhaul:	3000hrs
	Ultimate life	15,000hrs
Tail Rotor Drive Shaft	Type	8A 1516 000
	Serial number	L910 1019
	Time since new:	1222.59 one year two months since "D" check
	Time since overhaul	--
	Time between overhaul:	4,500hrs
	Ultimate life:	15,000hrs

1.7 Meteorological Information

The weather was full VMC conditions with visibility 10km or more.

1.8 Aids to Navigation

Not relevant to this accident

1.9 Communications

The aircraft was under VFR although under advisory control of the Male' Tower within 20 miles of Male' International Airport VHF range. No contact was made with the tower prior to the accident.

1.10 Aerodrome Information

The last aerodrome of departure was Bodufolhudhoo, a licensed helipad of H2 category.

1.11 Flight Recorders

The helicopter was fitted with MC61 model CVR and SARPP-12 LM type FDR manufactured in Russia and commonly used on this type of helicopter.

The CVR which was of a 'wire' type when removed from the helicopter from under the sea on the 10th of January 1994, was salt laden and about 30 - 50 cm of wire was lost due to crinkles. No recording of the day of

the accident was found on the tape. It is possible to "switch-off" the tape from inside the cockpit but after the wreckage was recovered and brought for investigation a check for position of the switch showed that it was in the recording position. Therefore the reason for inability to obtain the cockpit voice recording for the day was possibly because of the missing portion of the voice tape which was broken away during the recovery of the tape by non aviation divers at a depth of 52 metre under water.

The FDR was recovered on the 13th of January 1994 and was sent to the Indian DGCA laboratory for analysis. However, due to lack of information from the manufacturer with respect to specification the film remained undeveloped for a month . The film was then taken to Sofia to the Bulgarian DCA. When the FDR was opened it was found that the film had been completely damaged. Hence no information was obtained from the FDR film.

1.12 Wreckage and Impact Information

The helicopter wreck was located under 52m of water in the sea. The wreckage was salvaged for investigation purpose on 3rd April 1994. The wreckage was salvaged in two sections. The pylon tail section just behind the intermediate gearbox, which had separated on impact and was hanging onto the main wreckage by the control cables. These cables were cut to salvage the tail rotor segment. This segment was salvaged on 13th January 1994.

When it was clear from laboratory analysis that the tail rotor segment had failed on impact the main wreckage was salvaged. The wreckage revealed that the impact was extremely severe and the helicopter impacted on water with the rear passenger cabin first. The entire belly of the helicopter had caved in about 1.5 ft.

Investigations of the wreckage indicate that the main rotor had been running whilst the tail rotor did not show that it had any torque.

1.13 Medical and pathological Information

A post mortem examination of the cabin crew member and eight passengers were conducted by a medical team of the Central Hospital Government of Maldives and a further examination of the bodies of the eight passengers were carried out at the Colombo General Hospital, Sri Lanka. The eight passengers and the cabin attendant suffered multiple injuries consistent with the high impact forces and were finally drowned when the aircraft sank in to the sea.

The crew who managed to escape the sinking helicopter also suffered injury. The captain was hospitalized for spine injury while the co-pilot also suffered bruises and fracture of ankle but was later released from hospital with his leg in plaster. Blood, urine and serum samples of the crew examined by the Government Analyst's Department, Colombo, Sri Lanka did not reveal signs of ethyle alcohol in them.

According to the post mortem carried out on the bodies it was revealed that the occupants had sustained injuries which included the following:

- * Dislocation of cervical and lumbar spine fracture of breast bone and laceration of heel of right foot.
- * contusional injuries on both upper limbs and left forehead.
- * multiple fractures of ribs bilaterally with contusions of lungs.
- * spine dislocated in lower neck area and lumbar area.

- * open -fracture- dislocation at left ankle.
- * laceration of face lateral to the right eye.
- * fracture of zygomatic bone, multiple fracture of ribs bilaterally.
- * dislocation of right wrist.
- * fracture of the tibia at the knee and ankle.
- * contusional injuries on left forehead and left side of head.
- * lacerated wound above left eyebrow.
- * contusion of head.

The post-mortem revealed that at least two occupants sustained fatal injuries and that the primary cause of death of the rest was drowning.

1.14 Fire

There was no fire at any stage.

1.15 Survival Aspects

The helicopter was fitted with emergency floatation gear produced by FPT Industries/UK, which is activated by saline switches when immersed in water and works instantaneously. There are 6 floatation bags designed to inflate to neutral buoyancy in 3 to 4 seconds and fully inflate in 6 to 7 seconds. The gear is designed to withstand a vertical descent velocity of 15 ft/sec and forward speed of 30 knots. This is well above the BCAR requirement of vertical speed of 5 ft/sec.

Investigations revealed that all emergency floats except one wheel hub float was activated but due to heavy impact forces the main air bottle was dislocated from its position with its neck broken thereby disconnecting the air supply to the floats. This left some of the floats only partially inflated while many floats were damaged. The split and cave-in in of the helicopter belly did not prevent water gushing in, thus the partially inflated balloons could not support the entire weight of the helicopter. The helicopter sank over turning and drifted indicating some bouancy.

All occupants of the aircraft had suffered injuries consistent with high impact forces on water and aircraft break up. The flight crew who were trained for emergencies regularly and, were at the front most with emergency exit windows on their sides were able to escape with little difficulty.

The cabin crew (one) was according to the statements of the flight crew, perhaps preparing the cabin for the emergency situation and due to the injuries he sustained on impact was unable to escape was lying between the seats.

The infant and his mother were found lying in the cockpit of the helicopter, the infant in the mother's arms. The mother had dislocation of the spine in the upper neck and in the lumber area, breast bone fractured across the middle and the right heel the foot was lacerated. The mother may have been trying to get out of the sinking

helicopter through the same path she saw the flight crew escape, however she was unable to escape due to the multiple injuries and was drowned. The rest of the passengers were strapped to their seats and may have been unable to attempt escape due to the injuries and were drowned.

All passengers sustained injuries and the medical reports suggest that two of the passengers sustained fatal injuries. The passengers, due to the injuries they sustained to the ankles and spines were unable to set themselves free. Consequently the passengers drowned.

1.16 Emergency Services and Search and Rescue

As the accident occurred away from an airport or licensed helipad and over water and due to the geography of the country, there was no proper emergency service available. However, several eye witnesses in the closest island alerted the management of the island resort who immediately called the operator of the helicopter who in turn called Male' Air Traffic Control Centre. The Air Traffic Centre immediately alerted the Civil Aviation Department. The Coast Guard was immediately alerted. The Coast Guard vessels were not anywhere near the sight of accident and took approximately three hours for them to get the diving gear and other arrangement ready before they departed base to attend search and rescue

However, the island nearest to the crash site dispatched a boat searching for any survivors, during their mission they rescued the two pilots who were the only survivors of the crash. Divers were deployed by the helicopter operator, from nearby tourist resorts and the Coast Guard as soon as the teams could organise. By dusk the helicopter wreckage was not located but only some broken pieces of tail rotor blades were located. The wreckage was located on the second day. The rest of the occupants were found inside the wreck.

1.17 Tests and Research

The maintenance and flight operations set up of the operator revealed no inadequacies. This was further confirmed by the accredited representatives of the State of Registry

The drive shaft couplings of the rest of the fleet of Mi-8s were inspected ultrasonically to ascertain any undue wear or distress. None was found.

Inspection of the wreckage that was recovered from the sea 3rd April 1994 showed that the section of the drive shaft just aft the main gear box was free to rotate by hand independent of the main gear box and the next portion rear of the shaft coupled to it. The shaft had detached it self from the rear coupling by unscrewing the retaining nut which is locked on to the shaft by punching the nut at specially designed positions on the female portion of the coupling. The rest of the shaft was not free to rotate. The first and second portions of the shaft were disconnected and brought for investigation. It was revealed that the first hanger bearing had ceased. Further investigations on all other bearings and the intermediate gear box and the tail rotor gear box showed no damage or stress and were free to rotate.

The first hanger bearing was cut open to see corrosion wear and pitting.

The ceased bearing, the male and female parts of the failed coupling and one female and male parts of an intact coupling were analyzed at the Research and Development Directorate of the Civil Aviation, India. An independent laboratory from that of the state of manufacture or the state of registry.

As no details were received from the State of Manufacture of the chemical composition, heat treatment condition, hardness values, wear limits and a copy of the drawing of the failed coupling the analysis was based on a comparison with an intact coupling.

Chemical composition was determined out on an Optical Emission Direct Reading Vacuum Spectrometer having an arc spark source. Case hardening alloy steels had been used in the fabrication of the male and female components of the spline coupling.

Micro-hardness tests were carried out on Vickers Microhardness Tester Model MBT-1. The micro-hardness values on the case and core of intact male component tooth were higher than the failed male component tooth. Micro-hardness values of the female teeth were however, much higher than the male teeth of the intact and failed component. Due to which the female component spline teeth would cause wear of the mating male spline teeth components.

The hardness of the spline teeth of female components was comparatively higher than the hardness of the mating spline teeth of male component. This could initiate wear of the mating spline teeth of the male component. The premature wearing of the spline teeth of the male component and mating surface of female tooth of first stage spline coupling appear to have been caused by ceasure of the No. 1 hanger bearing associated with the discrepancies in the manufacturing process as stated above. It was evident that the quality of case hardening procedures of the corresponding male component of the failed coupling and the intact coupling were not comparable.

1.18 Additional Information

The helicopter was fitted with an underwater sonar locator. This was a Russian model which transmitted on 31mhz. However, receivers on this frequency were not available at the Rescue Coordination Centre.

1.19 Useful or effective investigation techniques

The investigation was hampered due to lack of precise and detailed information from the State of Manufacture. This meant that analysis had to be based on comparing the failed parts and similar intact parts.

2. ANALYSIS

The account of eyewitnesses and declaration of the pilots indicate that the helicopter had developed a directional control problem and began to spin almost instantaneously and the flight could not be controlled and crashed heavily.

Examination of the wreckage confirmed the failure of the first spline coupling and disconnection of the rear coupling of the same section of the tail rotor drive shaft that would have resulted in a complete loss of directional control. There was a definite discrepancy between the hardness values and material composition of the failed part and intact part. The difference in hardness could have initiated the wearing process of the mating parts of the first spline coupling and the ceasure of the first hanger bearing would have caused the final grinding of the male coupling teeth and disconnection of the retaining nut of the coupling at the rear of the some section of the shaft. The loosening of the retaining nut indicated that there was a differential torsional force on the first portion of the tail rotor drive shaft and the rear portion before the coupling failed. The retaining nut of the coupling had a normal thread not left hand thread, and the shaft rotates anti clock wise looking from front. Thereby the rotational force on the shaft by the running gear box unscrewed the nut which was attached to the second portion of the shaft just infront of the ceased No.1 hanger bearing.

As there was no suitable receiver for the type of underwater sonar locator installed on the helicopter, location of the wreckage took much longer than expected. This and the fact that the severity of the crash had resulted in several injuries to the occupants, especially to their limbs; greatly decreased the chances of survival.

3. CONCLUSIONS

a) Findings

1. The helicopter had been properly maintained and was considered airworthy.
2. The pilots were properly licensed.
3. An attempt was made to gain control of the helicopter as it spun.
4. The ceasure of the No. 1 hanger bearing and failure of the first spline coupling of the tail rotor drive shaft resulted in complete loss of drive to the tail rotor.
5. The engines continued to produce power.
6. The emergency floatation gear installed worked as designed but was destroyed due to the severity of the crash, that was well above the design limitations of the system.

b) Cause(s)

Based on the findings the helicopter crashed owing to loss of directional control due to ceasure of the No. 1 hanger bearing and failure of the first spline coupling of the tail rotor drive shaft. This failure of the spline coupling being caused due to a combination of ceasure of the No.1 hanger bearing due to corrosion and pitting and wear and the difference in hardness specification between the male and female components of the coupling.

4. SAFETY RECOMMENDATIONS

It is recommended that to ensure continued safe operation of the type of the helicopter involved in the accident in the current operating environment, consideration be given to the following. ie;

- a) The spline couplings in the batch of tail rotor drive shafts manufactured with that which was installed on helicopter Serial number 10320 be checked for possible discrepancies in material composition and hardness.
- b) The time between overhaul period of the drive shaft be reduced to 1000hrs
- c) Obtain a suitable receiver that is compatible with the type of underwater sonar locator installed on the helicopter(s) and make it available at the Rescue Coordination Centre.
- d) The operator should adhere to proper documentation procedures with respect to load sheets of the technical log.