# FINAL REPORT

**on**
**investigation of an aviation occurrence with Ka-32AO helicopter, registered LZ-MOZ, owned by Scorpion Air Ltd Air Operator, city of Sofia, occurred on 28.08.2006 in the area of the town of Gombe, Republic of Turkey**


2006

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# LIST OF ABREVIATIONS

AAIU – Aircraft Accident Investigation Unit;

AC –Aircraft;

ACA – Aircraft Continuous Airworthiness;

AO – Air Operator;

APU – Auxiliary Power Unit;

ASS – Automated Signaling System;

BM – Base Maintenance;

CWS – Central Warning System;

F – Form;

FFP – First Flight Preparation (form)

FM – Flight Manual

FOM – Flight Operations Manual

IAC - Interstate Aviation Committee;

ICAO – International Civil Aviation Organization;

MD CAA – Main Directorate of Civil Aviation Authority;

MR – Main Rotor;

OM – Organization of Maintenance;

QMS – Quality Management System;

RI - Research Institute;

SN – Since new;

## Introduction

On August 28th , 2006 at 14:00 hrs in the area of town of Gombe, District of Kash, Republic of Turkey, a helicopter Ka-32, reg. LZ-MOZ was taking water from the Chaibogazi artificial lake during a firefighting flight. After taking water the helicopter loosed power and fell into the artificial lake and sank. The crew left the helicopter and swam to the bank, where crew members received medical assistance.

The materials on investigation of the aviation occurrence have been classified under state file number 08/28.08.2006 in the archives of the Aircraft Accident Investigation Unit (AAIU).

Air Operator: Scorpion Air Ltd, City of Sofia, with main office in Sofia, Lozenets Municipality, 73 Persenk Str

Aircraft Manufacturer: Kumertau Aviation Plant , Russia.

National and Registration Marks: LZ-MOZ according Certificate for Registration No 1505/09.06.2000 issued by the MD CAA.
Place and Date of the Aviation Occurrence: Chaibogazi artificial lake, Gombe, District of Kash, on 28.08.2006.

Notified: Main Directorate of Civil Aviation of Republic of Turkey, Aircraft Accident Investigation Unit (AAIU) at the Ministry of Transport of Republic of Bulgaria, DG CAA of Republic of Bulgaria, Interstate Aviation Committee of Russia, Civil Aviation Authorities of Ukraine and International Civil Aviation Organization
A commission has been appointed for investigation of the aviation occurrence by an order RD-08-463/27.10.2005 of the Minister of Transport.

Type of Flight: Flight for forest firefighting according bilateral contract between Scorpion Air Air Operator and Turkish company BARIS UCAKLA ILACLAMA.

Main Directorate of Civil Aviation Authority at the Ministry of Transport of Republic of Turkey proposed by fax No B.11.SHG.14.00.00 – 3428/25477 of September 1st 2006 the accident investigation to be conducted by Bulgarian authorities.

In accordance with Article 142, Para 5 of the Civil Aviation Act of the Republic of Bulgaria and Article 2, Para 3 of Regulation No13/2701.1999 about aviation accident investigation and on the grounds of Article 10, Para 1 of Regulation No13 a Commission for Investigation of the accident was appointed by an order of the Minister No RD-08-421/07.09.2006.

## 1. Factual Information

### 1.1 History of Flight

#### 1.1.1 Flight Number

Second flight for the day, firefighting with external water tank type “Bambi Bucket”

#### 1.1.2 Preparation and description of the flight and events

The flight mission was assigned by the manager of Scorpion Air Air Operator Ltd. in accordance with the bilateral contract between the Air Operator and Turkish company BARIS

UCAKLA ILACLAMA. On the grounds of an order for assignment No 148/29.05.2006 in connection with fulfillment of the contract with BARIS UCAKLA ILACLAMA the manager of AO ordered the Ka-32 AO helicopter crew, reg. LZ-MOZ, to take part in firefighting in the area of the city of Antalia for the period from 30.05.2006 to 30.09.2006.

In the morning on 28.08.2008 at the base landing site in the town of Kash area a preflight preparation of the helicopter was conducted, under forms FFP and $A_1$ by two maintenance persons. During the preflight preparation there were no faults established. No fulfilled technical log was found to reflect the activities during the flight preparation, because according the crew explanation it was on board and possibly lost during the circumstances emerged later. The preflight check was performed by the crew in accordance with the requirements of Aircraft Operation Manual. No faults were established during the preflight check. During the engine running check no deviations of engine, reduction gearbox and systems were established.

From 7:30 h the crew executed two-hour flight for firefighting, taking water from a special pool, situated to the south from the fire site. Commander, first officer and a person as a "fire flight operator" were onboard of the helicopter, all of them Bulgarian citizens, and also two Turkish citizens, one of which fulfilled the obligations to designate the area and the other was a representative of the forest authorities. After the flight the helicopter landed on a landing site in the area of Kasaba village. After landing the maintenance persons executed a post-flight check of the helicopter and form $A_1$ and refueled the helicopter with 2000 l of fuel.

The crew waited at the landing site for next request for firefighting and receiving the call at 13:40, took-off, taking water from the special pool. The above mentioned persons were on board. The water was used and according the instruction of the Turkish navigator the helicopter headed to Chaibogazi artificial lake, elevated at 1200 m, for water refueling. The pilot-in-command was at the controls and executed an approach over the artificial lake and turned the helicopter against the wind. On instruction of the flight operator the commander executed the procedures for refilling of the Bambi Bucket with water. The Bambi Bucket was refilled with water up to the upper surface, what means 2500 l and was raised at a height of about 2 m over the water surface. The flight operator reported the Bambi Bucket was full and there is the necessary altitude, and the first officer reported that the instrument reading of engines and systems were normal. The commander started to accelerate the helicopter, simultaneously climbing up. At the beginning of the procedure he noticed there was no necessary power, heard a strange sound followed by helicopter descent and beginning of strong vibrations. After the strange sound the crew heard in their headphones the sound of central warning system (CWS) and a red warning came on. Because of the strong vibrations the crew couldn't establish which of the emergency indication, notification and information panel SAS-4 was lighted and they didn't pushed the indication pushbutton of CWS. The commander enabled the emergency water ejection system of the Bambi Bucket, but it was of no effect (no increasing of the height over the water surface). The commander by pushing the right pedal swerved the helicopter toward the land. Because of the loss of altitude, strong vibrations and main rotor speed falling the helicopter was almost uncontrollable. The helicopter firstly hit the nose landing gears into a rock on the artificial lake bank. After the hit into the rock the commander shut down the engines. The two forward doors felt after the hit. The helicopter slipped back and to the right into the water. The main rotor blades were destroyed. The crew and other persons left the helicopter through the forward doors and the cabin cargo door and reached the bank by swim. Three people suffered minor injuries and were taken by a Turkish ambulance to give them medical assistance.

The helicopter is shown on the place of the accident on the Figure 1 and Figure 2 of Enclosure 1. It was recovered from the water by Turkish authorities and put under custody of local gendarmerie before arrival of Bulgarian investigation commission. After the recovery from the water the Turkish authorities removed the flight data recorder 2T-3M of the system Tester – 3U, serial number 0659056 and gave it to the investigation commission after its arrival at the accident site on 10.09.2006.

On the Figure 5 of Enclosure 1 the place of the first hit is shown. The footprints of landing gear tires are visible on the rock.

### 1.1.3 Location of the occurrence

Chaibogazi artificial lake, Town of Gombe, District of Kash, Province of Antalia, with coordinates N=$36^0$31'16"; E=$029^0$40'30'', elevation 1205 m. Local time 14:01 h, daylight. On Figure 7 of Enclosure 1 the clock reading at the moment of impact is shown.

## 1.2 Injuries to persons

| Injuries | Crew | Passenger | Others |
|---|---|---|---|
| Fatal | 0 | 0 | 0 |
| Serous | 0 | 0 | 0 |
| Minor/None | 3 | 2 | 0 |

## 1.3 Damage to aircraft

During the examination on the accident site the Commission established that the helicopter was destroyed and the damages on the main structural parts were as follows:

**On fuselage and rotorcraft main rotor:**

- destruction of cockpit windshield, left- and right cockpit doors;
- destruction of the nose landing gears, they were found on the bank of the artificial lake, after discharging about 5-6 meters from the water level;
- destruction of all the blades of the main rotors of the rotorcraft main rotor system and some debris of them were found on the bank;
- disrupted vertical control rod for the cyclic pitch to one of the blades of the lower main rotor and damaged swash plate, without disruption of the structural integrity of the control rods;
- destructions and deformation of the structural elements of the structure in the lower part of the fuselage;
- destruction of radio and electronic equipment compartment;
- deformation of the cockpit and upper beams, as well as the helicopter skin;
- destruction of the vertical stabilizers together with the control surfaces and Doppler antenna;
- a number of deformations of structural elements and skin of the upper and lower part on the right board as a result of the hit into the rocks and falling of the helicopter into water.

On Figures 2 - 4, 6 and 8 – 14 of Enclosure 1 the damages on the fuselage and rotorcraft main rotor

system are shown.

**On rotorcraft engines and Auxiliary Power Unit (APU):**
- on the two engines and APU there were no signs of fuel and oil leaks and no signs of fire;
- there were bruises on the inlet guide vanes of the compressor air intake of the right-hand engine as a result of foreign object damage after the hit;
- exhausting gas temperature (EGT) indicator of the left-hand engine (Engine No 1) showed 785°, the one of the right-hand engine (Engine No2) showed 1240°, and the one of APU indicated 380°;
- in the exhaust pipe of the right-hand engine were observed sediments and crusts of molten metal on the free power turbine aft bearing vertical fairings and burns and destruction of the shroud of the most of the blades of the second stage of the free power turbine;
- after removal of the free power turbine of the right-hand engine in the Maintenance Base of the AO was established full destruction of the first stage of the free power turbine and coked lubrication of the last rotor bearing;
- after borescope examination burns and disturbed integrity of the blades of first and second stage of the turbine were observed.

On Figures 15 – 22 of Enclosure 1 the condition of the right-hand engine of the helicopter is shown. On the left-hand engine and APU no visible damages were established.

**On the reduction gearbox:**
- after removing of the magnetic chip detectors of the reduction gearbox no presence of chips was established to show internal wear and tear and destruction in the reduction gearbox; after its removal at MaintenanceBase it was established no internal destruction on the reduction gearbox.

## 1.4 Other damages

No other damages.

## 1.5 Personnel information

### 1.5.1. AC commander

Male, aged 52, with valid professional license and medical certificate.

### 1.5.2 First Officer

Male, aged 42, with valid professional license and medical certificate.

### 1.5.3 Flight operator's firefighting

Male, aged 52.

## 1.6. Aircraft information

### 1.6.1. Airworthiness information

Ka-32AO helicopter, reg. LZ-MOZ, serial No 5235004519201 was manufactured on 15.01.1986 as a Ka-27 helicopter, on 21.05.1998 it was refurbished as Ka-32T helicopter and

on 07.05.2000 it was modified in Ka-32AO. The modification of the helicopter was confirmed by a type certificate No STOK-190-Ka-32AO, issued on 04.08.2000 and signed by the Chairman of the Air Register of IAC. The helicopter has a Certificate of Registration No 1505/09.06.2000. The Certificate of Airworthiness No:1505 was issued on 09.06.2000. The last revalidation of the certificate was done on 29.05.2006 and it is valid till 28.05.2007. Till 27.08.2006 (one day before the accident) the helicopter has accumulated 1016 flights hours and 1567 cycles since new. According the record in the commander's personal flight log the helicopter was flown 3:14 hrs on 27.08.2006 and 2:25hrs on 28.08.2006. Hence, as to the time of the accident the helicopter was accumulated 1021:39 hrs. The time before the first overhaul of the helicopter is 2000 flight hours and 12 years whichever comes first. The calendar time is starting after the helicopter modification in an AO variant, i.e. since 07.05.2000. As at the time of the accident the helicopter had 978:21 hrs remaining life time and 5 years 8 month remaining calendar life time.

Two TV3-117VMA second series engines were installed on the helicopter.

The engine on No 1 position (left-hand) with manufacturer No 70877894702007 was manufactured on 27.11.1998. The last record about flight hours in the engine log book was made on 16.08.2006 and up to this date it had accumulated 441:16 hrs since new, including 3:43 hrs in take-off power and 15:08 hrs in maximum continuous power. It is obvious from the helicopter log book that during the period from 16.08 to 27.08 the helicopter accumulated 60:36 h, which weren't recorded in the engine technical log book. Taking into account these flight hours, as to the moment of the accident the engine had accumulated 507:31 flight hours.

The engine on No 2 position (right-hand) with manufacturer No 70877894702006 was manufactured on 27.11.1998. The last record about flight hours in the engine log book was made on 16.08.2006 and up to this date it had accumulated 441:16 hrs since new, including 3:43 hrs at take-off power and 15:08 hrs at maximum continuous power. It is obvious from the helicopter log book that during the period from 16.08 to 27.08 the helicopter accumulated 60:36 h, which weren't recorded in the technical log book. Taking into account these flight hours, as to the moment of the accident the engine has accumulated 507:31 flight hours.

On page 53 of Section 6 of the technical log books of the two engines the time before the first overhaul of the engines of Ka-32A and its modifications is set at 500 hours and 6 years. The time at take-off power should be no more than 5% of the engine life time and the time at maximum continuous power no more 40% of the engine life time. By records in the engine log books, made on 30.05.2006, firstly was restored the engine calendar life time of 18 months and after that it was extended by 12 months till 30.05.2007 on the grounds of Bulletin No N78M-117BE-AB.

It is necessary to note that the Certificate of Airworthiness of the helicopter was revalidated on 29.05.2006 and a flight of 35 minutes was recorded on the same day and these activities were done a day before signing of the protocol for engines life time extension.

The extension of the engine life time is on the ground of Bulletin No H78M-117BE-AB. According this bulletin, the engine life time, which is installed on the helicopter, should be extended before the first overhaul depending on its technical condition up to 1500 hrs for 15 years. On reaching the first guaranteed flight hours, or after expire of first guaranteed calendar life time, or after store, given in the engine log book, its maintenance should change to on-condition and for extension of its life time it is necessary to perform the tasks for assessment

of its technical condition as laid down in a Program No78.1.00GA by the representatives of Motor Sich engine manufacturer. Following satisfactory results of the technical condition assessment, according to the abovementioned Program, an extension of the engine life time should be established for 2 years and/or 200 flight hours with the respective documents. In accordance with an agreement with the operator the established periods could be shorter. In the technical act for inspection of the technical condition of the TV3-117VMA engine, manufacturer No 7087894702006, signed on 30.05.2006 it was written, that tasks according to Instruction No78.1.98 were performed together with 100 hrs scheduled maintenance, the wear of blades of compressor 1st stage was measured and an engine run test was performed (no performance of Program No78.1.00GA was recorded). As a result the life time of the engine was extended for one year till 30.05.2007. After an inquiry of IAC, Russia, it was established, that the tasks performed and those in Program No78.1.00GA were identical.

The tasks for on-condition control for two years periods and 200 hours should be preformed with the tolerances established for 100 hrs (12 months) scheduled maintenance. As at the moment of the occurrence both engines have accumulated 507:31 hrs each, i.e. they were at the upper 20 hrs tolerance for performance of the on-condition assessment tasks according Bulletin No N78M-117BE-AB.

The Ka-32AO maintenance of Scorpion Air AO is based on the approved by MD CAA "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program". The last revision of this program was approved by MD CAA on 25.08.2006. In Section 1.4 :"Reasons for the periodicity and the tasks of the maintenance" of this revision "Status of Ka-32AO helicopter, reg. LZ-MOZ, manufacturer No 5235004519201" is shown. According to this status the time between overhaul of the helicopter engines was 500 hrs. Neither the Program revision, nor its basic variant, approved on 08.05.2006, includes the works, laid down in Bulletin No N78M-117BE-AB for engine operation on the grounds of on-condition assessment, which may allow extension of time between overhaul. With the last revision of the maintenance program the tasks under form 10±1 flight hours, form 25±5 flight hours and form $50^{+10}_{-5}$ flight hours were dropped groundlessly from the base maintenance of the helicopter. The maintenance of the flight data recorder Tester-3U is not included in the Program.

The helicopter power plant includes also Auxiliary Power Unit AI-9, manufacturer No N98710041, manufactured on 12.01.1988. The life time of APU is accounted on the base of the number of starts and the number of air bleedings and this time between overhauls is 3000 starts or 3000 air bleedings. The last record in the APU log book was made on 16.08.2006 and it has accumulated 1345 starts and 2852 air bleedings since new. From 16.08.2006 to the moment of the accident 42 starts and 64 air bleedings were made, hence as to the moment of the accident APU has accumulated 1477 starts and 2936 air bleedings, the remaining life time is 1523 starts and 64 air bleedings respectively.

On the helicopter was installed VR 252 reduction gearbox, manufacturer No L8102028K, manufactured on 16.04.1998. The last record of hours flown was made on 16.08.2006 and it has accumulated 441:24 hrs since new. As it was said above, from 16.08.2006 to the moment of the occurrence the helicopter flew 66:15 hrs. Therefore the reduction gearbox has accumulated 507:39 flight hours. On page 27 of Section 6 of the reduction gearbox technical log book the life time before the first overhaul is given as 500 hrs in 9 years. On the same page of the log book in Paragraph 4 the time between overhaul is 500 hrs in 8 years. By a record in the log book from 30.05.2006 the calendar life time was extended by one year till

30.05.2007 on the ground of Decision No 4.252.1.4.-05/19 and a technical act. The life time extension was made by representative of the Plant named after V.Y. Klimov.

As to the moment of aviation occurrence the reduction gearbox was exceeded its life time, given in the Air Operator Maintenance Program by 7:39 hrs.

On 06.08.2006 a base maintenance form 300 (900 flight hours) was performed on the helicopter, for which a Certificate of Release to Service No K32Z-11 was issued. The maintenance was performed in Antalia (Turkey), what constituted an infringement of Regulation 145/11.08.2004 of the Minister of Transport, because there wasn't approved air operator's base in Antalia. The maintenance tasks were done during the period 04.08 – 06.08. 2006. During the same period the helicopter has executed firefighting flights as follows:

- on 04.08.2006 one flight of 2:42 hrs duration, take-off at 15:30 local time, the technical log book was signed for $A_1$ form at 07:00 local time;
- on 05.08.2006 one flight of 2:43 hrs duration, take-off at 15:20 local time, the technical log book was signed for line maintenance at 07:00 local time, without recording the type of form;
- on 06.08.2006 one flight of 1:40 hrs duration, take-off at 12:52 local time, the technical log book was signed for $A_2$ form at 07:00 local time;

The requirements of Section 1.5, page 2 Para7 for base maintenance of "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program" were not followed. "……The AO ACA Department has to issue separate packages of working documents for the different stages of execution of Base Maintenance. Before the beginning of each flight the started package of documents should be accomplished and the respective Certificate of Release for Service should be issued."

A copy of Certificate of Release for Service, issued for this maintenance was found on board by Turkish authorities after the accident.

On 26.08 and 27.08.2006 in Antalia, Turkey, a maintenance under Form B+ was performed for change of fuel regulator pump NR-3VMA+Form 100, for which a Certificate of Release for Service was issued No K32Z-12/27.08.2006. The package of task cards for maintenance included cards for Form B and for removal and installation of fuel regulator pump NR-3VMA. During documentation inspection the maintenance staff noticed that the helicopter was flown hours necessary for Form 100 execution, but no such task cards were ready available. The tasks laid down in task card FB were performed and taking into account the schedule of F100 maintenance procedures, for which the maintenance staff noted in Certificate of Release for Service Form B + Form 100. There was no task card for this maintenance in the set of documents with measured parameters during the power plant test, also there was no report about the test flight after the fuel regulator pump NR-3VMA change.

The change of fuel regulator pump was provoked by the following circumstances. The Head of Maintenance Department (MD) of Scorpion Air received a message from the crew in Antalia, that during the period 18-19 of August, during the engine start of helicopter reg. LZ-MOZ there was a difference of engine RPM at idle power and the right-hand engine RPM was of 80…81% at idle power, which meant about 7% higher than allowed RPM. Instructions to check the fuel filters and fuel regulator pump filters were issued for both engines. It was reported that the filters were clean and there was no improvement. As to 22.08.2006 the Head of MD received information that during the start the right-hand engine RPM at idle power

were almost close to "automate" mode. In this situation he advised the crew in case of necessity of take-off to start the left-hand engine first and after its warming-up and reduction gearbox warming-up to start the right-hand engine. The fuel regulator pump was removed from another engine and sent to Antalia for change of the fuel regulator pump of helicopter reg. LZ-MOZ. This replacement was made during the above mentioned maintenance.

It is necessary to note that there are no comments written in the board log book about failures revealed between the above mentioned maintenance, i.e. between August 7$^{th}$ and 26$^{th}$ and there are no tasks recorded for repair or for implementation of any instructions given. There were no records about engine tests during pre-flight preparation and there was no control on the flight parameters using flight data recorders.

On 27.08.2006 the fuel regulator pump No 16411146104 was removed from the right-hand engine of the helicopter reg. LZ-MOZ and a new one was installed with No 16409014597. As to the moment of installation the pump had accumulated 554 flight hours during 15 years, 11 months and 20 days. According the requirements of Bulletin No N78m-117BE-AB when the pump is maintained on-condition the life time of the pump is respectively 1500 hrs and calendar life time of 15 years. As to the moment of accident the life time was exceeded by 11 months and 21 days.

On 27.08.2006 at 6:30 local time in the technical log book, which was started on 25.08.2006, a line maintenance Form $A_1$ was certified. For the flights conducted on 27.08 and 28.08.2006 a fulfilled log book was not found. According the crew explanation these log books were on board of the helicopter and after the helicopter removal from the water they were not found.

### 1.6.2. Helicopter performance

According Para2.5, General Flight Limitations of the Flight Manual, approved by MD CAA on 20.04.2001 the maximum certified take-off mass of Ka-32AO helicopter is 11 000 kg. The maximum flight mass with external load is 12600 kg.

According Certificate for Airworthiness No 1505, issued on 09.06.2000 by MD CAA, revalidated on 29.05.2006 and valid till 28.05.2007 in the column Maximum Take-Off Mass it was written 12 500 kg. This is the maximum flight mass.

The maximum zero fuel mass of the helicopter is 6899 kg according a Mass and Balance Report of 06.11.2001, issued by Research Institute "Helicopter".

Maximum payload of external load is 5000 kg according "Ka-32 Flight Manual", approved by MD CAA on 20.04.2001.

The helicopter center of gravity range for flights with external load is from +280 mm to 0 mm.

At the moment of the accident the helicopter had about 1700 l of fuel with relative density of 780 kg/m$^3$, (what meant 1326 kg), about 2500 kg water in Bambi Bucket water tank, which mass was 200 kg, three member crew and two Turkish representatives - a fireman and designator, with a total mass of 400 kg and about 120 kg of baggage. With maximum zero fuel mass of helicopter of 6899 kg, the factual mass of the helicopter at the moment of

occurrence was approximately 11350 kg. Given the specific meteorological conditions and elevation according Figure 7.3.2a of Ka-32AO FM the maximum flight mass for those conditions of the helicopter was 11750 kg. The center of gravity position was within the limits laid down in Ka-32AO FM.
Maximum speed is 230 km/h without external loads.
Minimum speed out of the ground effect is 50 km/h.
Maximum speed with external loads is 190 km/h.
Maximum speed in autorotation of main rotor is 100 km/h.
Maximum vertical speed is 3 m/s when the flight speed is less than 50 km/h.
Maximum pitch angle in straightforward flight during acceleration is -30° and in case with external loads it is ± 20°.

Two turboshaft engines TV3-117VMA type are installed on the helicopter with total power output of 4400 HP. The TV3-117VMA engine is with free power turbine with gas relation with the compressor rotor.

According to the Type Certificate No STOK-19-Ka-32AO, issued on 04.05.2000, operational limitations of the engines are as follows:

At Take-off power:
RPM of the free turbine according speed counter of the main rotor:
- maximum 89%
- minimum 87%

RPM of the compressor rotor:
- maximum 101.15%

Turbine inlet temperature:
- maximum 990°C

At maximal continuous power:
- RPM of the free turbine according speed counter of the main rotor:
- maximum 92%
- minimum 88%

RPM of the compressor rotor:
- maximum 99%

Turbine inlet temperature:
- maximum 955°C

According Para23 of FOM, Ka-32AO has the following emergency equipment:
- four emergency exits – at the port side and starboard of the cargo cabin;
- life jackets ASZh-63P for each crew member and passenger for flights over water surface;
- life raft - during the flights over water surface.

It is noted in Para8.23 that the emergency equipment should be determined by the Air Operator depending on the flight mission

Ka-32AO is equipped with triple redundant system for emergency jettison of the external loads:
- When “Emergency” button on the collective pitch of main rotors is pushed, the external load is released together with rods, ropes and DG-65 latch;
- When the button under the helicopter control stick is pushed, only the water is released;
- When the button under the collective pitch of main rotors is pushed, the whole helicopter external load suspension system is ejected;

- According to the report about the modifications activities on Ka-32T helicopter, serial number 5235004519201 into Ka-32AO type, it was written in point 4 "a pedal for mechanical ejection of external suspension system with DG-65 latch and the reinforced ring plate"; the Commission didn't find such a pedal on the helicopter reg. LZ-MOZ.

According Para 6.2.1 g) of Section 6 of "Ka-32AO AOM", Emergency Procedures, the commander must execute emergency eject of the external suspension loads in case of one engine failure, when the horizontal flight is impossible.

The procedures in case of engine failure during take-off after a height of 15 meters are given in Para5.3.2 of Section 5 "Emergency Situations" of AOM for Ka-32AO helicopter.

### 1.6.3. Fuel

The helicopter was refuelled with 2000 l of JET-A1 fuel. As to the moment of aviation occurrence there were about 1700 l, what was enough for the entire flight. A sample from the fuel taken before the flight wasn't found.

## 1.7. Meteorological information

Daylight, visual flight conditions, CAVOK, wind 10-12 m/s from west. A diffused front was visible on the satellite observation, which destabilized the atmosphere, especially in mountain areas, whish is the area at the towns of Kash and Gombe and the artificial lake. As result of this destabilization cumulus clouds emerged and the turbulence was intensified over the mountain.

## 1.8. Aids to navigation

Standard navigation aids for Ka-32AO helicopter.

## 1.9. Communications

Standard communication equipment for Ka-32AO helicopter

## 1.10. Airport

Base landing site at town of Kash, Antalia Province, Turkey

## 1.11. Flight data recorders

The helicopter was equipped with a flight data recording system Tester-3U and voice recording system MARS-BM. After the helicopter recovery from the water Turkish authorities removed flight data recorder 2T-3M from the Tester-3U system with serial No 0659056 and handed it over to the Commission after its arrival at the accident site on 10.09.2006. The removal of recording unit 70A-10M was troubled because of the need to lift up the helicopter by crane. Subsequently the unit was removed, packed, sealed by Turkish authorities and handed over to the Commission for investigation. The serial number of it is 298023. At opening of the unit before the Commission member a small quantity of water was established in it.

Because Bulgarian Civil Aviation Authorities and Bulgarian Air Operators don't possess equipment for decoding of records from Tester-3U system, the assistance of Russia's IAC was asked.

Read-out of the information from the FDR, Tester – 3U flight data recording system and the voice recording system MARS-BM of the accidented helicopter was performed in a laboratory of the Scientific and Technical Commission of IAC in presence of the Chairman of the Commission, a member of the Commission and the authorized Russian representative for Ka-32 reg. LZ-MOZ aviation occurrence investigation.

The results of data recorders read-out were drawn up and received by the Commission in the form of a report, graphics and recorded on a CD. These documents are saved in the main folder of aviation occurrence investigation, registered under No 08/28.082006 in the archives of AAIU. The report was approved by the Chairman of the Scientific and Technical Commission of IAC.

Copying, listening and analyzes of voice information, connected with the last flight of Ka-32 was made by WinSIS and SIS 6.1 programs. During the listening of CVR no recordings from the accidented flight were found .

The information from 2T-3M unit of the flight data recorder was read-out using the Obzor MN-S system. During the first attempt for information read-out it was established multiple snapping into action of the tape reverse with a frequency of about 20 seconds. After the opening of 2T-3M unit traces of water were established in the electronic part, but the tape was intact. After putting the tape in serviceable unit a reading was performed and it was established the quality of record was satisfactory.

During analyzes of the flight information parameters it was established that the Tester – 3U system was registered information about the flight of Ka-32, reg. LZ-MOZ, for 2:21hrs (maximum recording time is 3 hrs). There was a lack of 39 minutes of information. The reason for this might be connected with the fact, that after the occurrence the power supply of the Tester – 3U bus continued from the batteries, the tape continued to move and the first records were deleted. The same might be the reason for lack of voice records, where the time of recording was only of last 30 minutes.

The record of the flight of the aviation occurrence on the tape of 2T-3M unit was 20.9 minutes.

Tester – 3U system was switched on at engine start for the flight. In the Report of flight data recorders investigation was noted, that because of the calibration characteristics given by the Air Operator are from 21.04.1994, they might have some differences with the calibration characteristics of the sensors at the moment of the aviation occurrence. The recorded parameters were in accordance with the parameters for Ka-32 helicopter, but the following parameters were not recorded: indicated air speed, ground speed, directional, lateral and vertical speed, collective pitch of main rotor, pedal position. The record of parameters “Engine 1 throttle”, “Engine 1 vibration level”, “Total fuel” didn’t show the real values. Because Tester – 3U system doesn’t register UTC time, on the interpretation graphics the time of starting of recorder is registered as 00:00:00 (hours, minutes & seconds).

At 00:02:20 the crew moved the collective pitch lever to 19° and started control hovering and take-off. The flight proceeded for 18.5 minutes and was performed at altitudes less then 1500 m. Discrete parameters for technical failures were not registered before the start of emergency situation.

During the period between 00:19:57 and 00:20:21 the crew performed hovering for refilling

of the Bambi Bucket water tank with water from the artificial lake. At that time the values of recorded parameters were within limits.

After that the crew during 17.5 s was moving the collective pitch to 26° and till the time of 00:20:39 there was a intermittent change of the following parameters:

- increase of "Engine 2 vibration level" (right-hand engine) from 13 to 91 mm/s (with maximum allowable value of 60 mm/s);
- drop of "Engine 2 exhaust pressure ratio" from 7.38 to 1.39 kg/cm$^2$ ;
- drop of "Engine 2 turbine inlet temperature" from 900 to 652°C

At 00:20:45 the Tester – 3U system registered discrete parameter "Engine 2 low oil pressure".

The combined alteration of above mentioned parameters might be connected with destruction in the engine hot section, what was established later by a borescope.

One second later, at 00:20:46 the vertical acceleration changed sharply from $N_v = 1.11$ to $N_v = 3.31$. The height at that moment was $H_r = 4$ m and relative bearing 280° (the moment of helicopter hit into the bank of pond).

At 00:20:49 the recorded height was 0 m and discrete parameter "Engine 2 shut-off valve selector in closed position". Flight parameters recording was ceased at 00:20:53

The graphics of recorded parameters changes of Tester – 3U system are given in Enclosure 2.

## 1.12. Wreckage and impact information

The helicopter hit the rocks during commander's attempt for emergency landing. The landing wasn't performed. It is obvious from the pattern of the hit and wreckages, shown on Figure 23 of Enclosure 1 and from the photos shown in the same enclosure that the helicopter hit the rock with right bank about 15°, pitch 8 - 10° and about 3 meters lower than the landing site chosen. The first hit was by the nose landing gears, which were torn away and fall into the water. Next hit was into the lower part of the cockpit and main rotor blades, which were destroyed entirely and smashed into pieces in all directions. Debris of them, a fairing and glasses from navigational lighting were found on the bank after artificial lake water draining. Substantial damages on the fuselage and main rotors mast were established. The cockpit windshields, light beacon, landing headlight and part of radio equipment installed in the lower part of the cockpit were entirely destroyed. At the moment of the impact pieces of rock entered the right-hand engine air inlet and damaged one of the blades of the guide vane. After rotorcraft bank to the right and sliding back it collided with the water. As a result of the impact into the bottom the tail section was damaged, the structural integrity of rudders connection and radio beacon aerial were affected, there were damages to the tail boom. The damages are listed in Para1.3.

## 1.13. Medical and pathological information

Flight operator (mechanic) suffered a fracture of clavicle of the left hand. There were no consequences for the pilots and two passengers.

## 1.14. Fire

After the inspection the Commission established there were no signs of fire.

## 1.15. Survival aspects

As a result of the impact and the helicopter sinking into the water the cockpit sliding left and right-hand doors fell into the water, what gave the commander and the first officer a possibility to leave the cockpit after getting the safety belts unlatched.

Flight operator and the two people in the cargo cabin left the helicopter from the cargo door on the cargo cabin port side and the door was opened normally by sliding back. The door wasn't emergency open.. According the explanation of the flight operator he made several unsuccessful attempts to open the door by normal way and after third or fourth attempt he succeed to open it and to leave the helicopter. The cargo cabin door design and the way the helicopter fell into the water allowed the flight operator and the two persons to leave the helicopter promptly and timely.

The emergency exit in the aft right-hand part of the helicopter cargo cabin wasn't used for AC evacuation.

The Commission established that during the flight there were five safety jackets ASZh-63P, which the crew members and other persons on board didn't use.

All people on board used lap safety belts, which saved them from more severe injuries during helicopter impact into the rock and its falling into the water.

The commission established a lack of proper clothing for the crew and the commander had piloted in slippers.

On the place of the aviation occurrence the Commission established that the safety belts of the helicopter crew and passengers in the cargo cabin were intact.

As a result of right-hand nose landing gear destruction, the fore right-hand part of the cockpit was destroyed, the cockpit floor was deformed and the right-hand pilot seat fastening was destroyed.

All crew members and the two persons in the cabin rescued themselves by swimming.

According to the crew and the two persons' information, first medical aid was rendered by habitants from the town of Gombe, which was at about 2 km distance and they brought them to the closest medical unit. After that the crew and the two persons were transported to Antalia hospital for medical examination.

## 1.16. Tests and research

For the purposes of technical investigation the following activities were accomplished:

- Examination of the accident site, helicopter and engines condition and a restoration of the flight since the hovering over water till the impact into the rocky bank after the forced landing attempt;
- Inspection and photographing of the fuselage and rotorcraft flight structure;
- Read-out and analyses of the flight data recorders Tester – 3U and MARS-BM records;
- Partial disassembly of particular assemblies and components of the right-hand engine;
- Borescope inspection of the core of the right-hand engine;
- Analysis of helicopter continuing airworthiness documentation;
- Interview with the helicopter crew;

- Logical and probabilistic analyses of the possible reasons for the aviation occurrence.

## 2. Analysis

### 2.1 Analysis of the succession of the events, leaded up to the aviation occurrence and the factors influenced the events

According the information of flight data recorders, at 00:19:57 hrs after the engines start the helicopter hovered over the water surface of Chaibogazi artificial lake. The crew lowered Bambi Bucket into the water for filling. After filling the flight operator reported the Bambi Bucket was 2 m over the water surface and the commander took decision to accelerate simultaneously climbing. Till this moment the flight data recorders didn't registered any deviation from the normal flight parameters. The crew members also didn't observe such deviations. Three seconds after that, at 00:20:38 the commander established fall of thrust of the main rotors, the crew heard uncharacteristic metallic noise in the engine area with subsequent intermittent vibration increase. The light of CWS came on, accompanied by an audible signal. After noticing the main rotors thrust decrease, the commander sharply changed the course to 280° toward the artificial lake bank. The wind in the defile was gusty, with values over 10-12 m/s and influenced considerably the stability and control of the helicopter, as it was crosswind for the flight.

During the analyses of the flight data records and the results of the inspection and borescope inspection, the Commission established that just at that moment an uncontained failure of right-hand engine occurred, what was unexpected for the crew. The failure revealed as an abrupt falling of the engine power and vibration increase over the limits. The engine failure changed the flight situation, which turned from normal to abnormal one. The flight in such situation is given in Para5.1&5.2 of helicopter FM. The strong vibration, conditions specificity at the moment of failure and the limited time hampered the crew to undertake adequate actions, what turned the flight conditions from abnormal into emergency ones.

The analysis of situation emerged was hampered because of lack of records in the flight data recorder for the following parameters: indicated air speed, ground speed, directional, lateral and vertical speed collective pitch of main rotor, pedal position. The Doppler wasn't turned on during the flight, even the safety fuses were removed, what made impossible the recording of the first five of the above mentioned parameters by Tester – 3U system. No maintenance and parameter calibration was executed of the system itself.

The commander didn't identify the right-hand engine failure as a reason for the abnormal situation. At the moment of engine failure the left-hand engine was a take-off power. The high vibrations of the right-hand engine influenced considerably the rotorcraft structure vibrations and also those of the instrument panel, what hampered the commander to assess timely the abnormal and later emergency situation. At 00:20:39 he decreased the common pitch for about 1 s in order to relieve the main rotor. Pushing the right-hand pedal, he changed the heading to 280° toward the right artificial lake bank. The commander increased the common pitch from 25° to 31° in 4 s in order to keep the helicopter horizontal attitude. He attempted several times to jettison the water from the Bambi Bucket by the control stick button, but because of the decrease in height it was without effect because the Bambi Bucket was already in the water. During the next 5-6 s because of almost maximum pitch and overloading of main rotor and sinking Bambi Bucket the helicopter unintentionally descended to a height of 3-4 m. During the time of recording from 00:20:40 to 00:20:45 the commander didn't activate the

emergency load ejection button by opening of DG-65 latch (the cover of this button wasn't painted in red color) or the emergency ejection button for the whole external load suspension system. From the records of bank, pitch and height during this time the conclusion could be done that the helicopter was difficultly controllable. Because the Bambi Bucket was in the water, in spite of the fact that the Bambi Bucket valve was opened, it created strong drag and influenced the forward motion of the helicopter and the helicopter reached the bank with a height of 2-3 m lower than the height of the bank itself. At 00:20:46 the right-hand engine was in the process of self shutting-down, the left-hand engine was at take-off power, the helicopter was some meters lower then the coast, speed of 15-20 km/h with right bank of about 15° and it hit the rock.

Following in detail the chronology of the parameters, recorded by flight data recorders, it should be noted that the indication on the instrument panel, the light and sound signalization, uncharacteristic metallic noise and intermittent increase of the vibrations to very high values in one second time was sufficient condition for the commander to decide for an emergency ejection external load suspension system together with the load. It could decrease the drag and weight and might ensure speed vertical gradient.

After the impact the helicopter fell into water and the crew members and Turkish representatives left it without serious injuries.

## 2.2 Analysis of the factors for right-hand engine failure

As it was noted, the right-hand engine failure revealed itself as an almost abrupt decrease of the engine power and vibrations increase over the limits. Having in mind the graphics on Figure 3 and 4 of Enclosure 2 and the results of partly disassembling and borescope inspection of the engine it was possible to assume that just at that moment the turbine blade shroud rings were destroyed and separated, what was probably heard by crew as uncharacteristic noise, resembling metal rope break. The absence of turbine blade shroud rings of these stages of the turbine is visible on Figures 15, 16 and 17. An imbalance of the turbine and free turbine rotors appeared. This imbalance caused sudden increase of vibrations of the engine and helicopter as a whole. The turbine power decreased sharply. The drop of the turbine power and the possible presence of fragments from turbine blade shroud rings leaded to sharp deceleration of the turbine rotor and intensive, in 1 second, decreasing of the compressor RPM. This assumption is supported by the fact that for this 1 second the compressor exhaust pressure ratio fell from 7.38 to 1.39 kg/cm$^2$, what is visible on Figure 3 of Enclosure 2. The pressure continued to fall and during the next three seconds it got equal to the atmospheric one. The engine self shut-down occurred. Five seconds after the intensive vibrations beginning, a discrete parameter "Engine 2 low oil pressure" was recorded. It is an indicator for oil leak as a result of internal destructions in the engine. These destructions probably resulted from the imbalance of the rotors. Intensive temperature decreasing after the almost intermittent decreasing of pressure was related with the abrupt change of the RPM of the compressor rotor, which rotated the delivery part of the fuel regulator pump, what leaded to intensive decreasing of available fuel consumption.

What could be the reasons for destruction of the turbine blade shroud rings?

Large centrifugal and gas loading act on the blades in high temperature conditions. High temperature stresses are also typical for turbine blades, which have cyclic character during the change of power settings. Centrifugal and gas forces combined with high temperatures without exceeding the maximum limits may cause destruction when the rotor goes to RPM

over the limits. There is a blocking in the regulatory system preventing the rotor from such RPM. According to the flight data records and crew explanations there was no reason to consider that in the moment of failure the rotor was rotating at RPM exceeding the limits. It means that the centrifugal forces didn't exceed the limits. The raised temperatures may cause destruction of turbine blades at RPM within limits. For this type of engine according the written in Para1.6.2 the temperature at take-off power is limited to 990°C and at maximum continuous power to 955°C. There were no data about exceeding of these temperatures during maintenance engine tests and in-flight parameter records, shown on Figures 1 and 2 of Enclosure 2. But it deserves to be noted the fact about irregular recording by the operator of the engine test parameters. In Chapter 14 of technical log book "Parameter Monitoring" only four tests were registered, one for year, respectively for years 2000, 2001, 2003 and 2004. As it was said in Para1.6.1, there was no task card with measured parameters during the power plant test in the set of documents, performed by the Operator, engine parameters of the test made during the preflight check by the crew are not recorded and the flight data recordings are not used for monitoring of these parameters in case of lack of records in the log book.

The maximum temperature of 990°C is limited also by the engine regulation system. There were no data about activation of the regulator for maximum temperature. During the initial inspection of the helicopter at the accident site the following readings of the temperature gauges were established:

- right-hand engine 1240°C;
- left-hand 785°C;
- auxiliary power unit 380°C.

On Figure 7 of Enclosure 1 a photo is shown with the temperature gauge of main engines. As result of comparison between these readings and flight data recorder records, shown in Enclosure 2, especially having in mind that during the occurrence APU was shut down, the Commission assumes as authentic the records for turbine inlet temperature, made by the FDR.

On the grounds of above-stated it is possible to conclude that the destructions in the engine resulted not from exceeding of the maximum RPM of the rotor and turbine inlet temperature exceeding the limits.

The rotor destruction might be caused also by of one of both cases of unstable work of gas-turbine engines – surge stall or surge. The flight data recorder records, shown on Figures 1 and 2 of Enclosure 2 don't give the grounds to suppose rise of one of these phenomenon.

The reason for destruction of turbine blade shroud rings might be also burnouts and destructions related with cooling deterioration of the engine hot section, deterioration of fuel injection by the fuel nozzles and rise of phenomenon like injector abnormal burning, malfunction in the automatic regulation of the engine modes, cyclic material fatigue, random factors, like foreign object damage, non-compliance with the operational limitation during the engine start. Detailed examination of all of these possibilities needs equipment and resources, which Commission don't possess, but hereinafter the findings of the Commission are formulated during their consideration.

The possibility for emerging of burnout, melting and cracking of the elements of the engine hot section because of deteriorated cooling was examined. This possibility was supported by the high outside air temperature during this time of the year in Antalia region, where the helicopter was operated. The inspection made on turbine cooling pipe didn't establish any deviations from the technical requirements except some rubbing, but without tube perforation.

Some photos were taken during the borescope monitoring of the fuel nozzles. Their appearance, shown on Figures 21, 22 and 23 of Enclosure 1 suppose the possibility for deviation of spray pattern cone. But for proofing of it the stand test of nozzles has to be performed.

As it was said in Para1.6.1, on 26 and 27.082006 during the helicopter maintenance the fuel regulator pump NP-3VMA of the right-hand engine was replaced. The circumstances about the pump replacement were described in detail in Para1.6.1. It should be noted here that from the period from 19.08 till 26.08.2006 the helicopter has flown 57:46 hrs and have fulfilled 35 flights with the deviations of the right-hand engine functioning, described in Para1.6.1 The reason for the deviation shown was a maladjustment of pump assembly, which should ensure the fulfillment of the program for compressor RPM=const, where the fuel consumption at idle and modes before the beginning of automated regulation is higher than the necessary. It is connected with at turbine inlet temperature at these modes and reduction of compressor stall margin. This might be a reason for local overheating and cracks on the blades, what might cause loss of structural integrity at some time. In the helicopter log book there were no failures or malfunctions registered between the last two maintenances, including on the automatic regulation system of the engine modes.

Concerning the cyclic material fatigue it is necessary to note that in the firefighting flights, during one flight, 5-7 cycles of water refilling of the Bambi Bucket are executed and the respective number of engine cycles is as much times bigger in comparison with the routine flight. In Para1.6.1 the life time limitations of engine TV3-117VMA, serial number 7087894702006, installed as right-hand engine of Ka-32AO reg. LZ-MOZ, were described in details. According to the records the engine has exceeded the fixed in accordance with approved by the MD CAA "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program" time to first overhaul by 7:31 hrs.

The air operator combined the function of flight firefighting operator with technician in charge for helicopter line maintenance. It leads to work overload of this person and created conditions for omissions, especially in the days when he took part also in base maintenance.

During the external inspection and borescope examination of the engine compressor a deformation of one of blades of inlet guide vane and presence of pieces of rock and pieces of main rotor blade skin in the air intake were found. These pieces and the blade deformation probably resulted from the helicopter impact into the rocky bank and main rotor destruction. Their presence wasn't related with visible damages of the air intake and especially on the blades of the last two compressor stator vane stages.

The maximum temperature of the engine during the start is a function of outside air temperature by a graph on Figure 501 of TV3-117 Engine Maintenance Manual, Book 3. There were no records in operational documentation from which the character of variation of this temperature might be assessed. Furthermore, no records of flight data recorder were read-out and stored.

Having in mind the abovementioned ,as the most possible reason for the destructions in the engine may be pointed out the malfunction of the fuel regulator pump normal functioning, combined with possible violations of nozzle spray pattern in conditions of accumulation of considerable number of cycles.

## 3. Conclusions

The technical investigation conducted, the results of examination and analysis give the

grounds for the commission to make the conclusion, that the accident was a result from the following

**Main Cause:**
Uncontained engine failure of No 2 helicopter engine, accompanied by high vibrations and main rotor speed decreasing.

**Contributory factor**
The crew didn't eject external load by pushing on button "EMERGENCY" on the collective pitch lever.

**Immediate Cause:**
Destruction of turbine blade shroud rings of turbine stages of TV3-117VMA engine, serial number 7087894702006, installed as a right-hand engine on Ka-32AO, reg. LZ-MOZ.

**During the investigation the following deficiencies were also established:**

1. The failures and malfunctions are not registered in the working documentation.
2. Some of the tasks executed for repair were not documented.
3. The Bulletin No N78M-117BE-AB of the engine manufacturer is not included in "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program".
4. Exceeding of the life of TV3-117VMA engines defined in "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program", approved by MD CAA.
5. Replacement of components with ones with expired life time..
6. The actual "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program" does not include base maintenance of the Tester – 3U flight data recorder.
7. The last revision of "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program", approved by CAA on 25.08.2006 excluded the following forms of maintenance – Form 10±1 flight hours, Form 25±5 flight hours and form $50^{+10}_{-5}$ flight hours.
8. The copy of the log book used for Ka-32AO reg. LZ-MOZ didn't correspond to the given in the enclosure to the Scorpion Air Maintenance Control Manual.
9. A copy of log book for the flights conducted on August 27th and 28$^{th}$ 2006 wasn't left on the ground.
10. No records of the engine parameters were made in their log books and FDR records weren't used for monitoring of their condition.
11. AO executes base maintenance at places not approved by CAA as a maintenance base.
12. The helicopter Ka-32AO, reg. LZ-MOZ has flown during the base maintenance. The documentation for base maintenance and for releasing to service wasn't formalized according "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program".
13. For the last maintenance, certified on 27.08.2006 an execution of Form 100 was registered, but in technical documentation there were no task cards for this form.
14. The FDR records of Ka-32AO, reg. LZ-MOZ are not read-out and stored.
15. The Doppler of Ka-32AO was disconnected by removal of melting fuses and because of this the following parameters were not recorded by Tester – 3U system: indicated air speed, ground speed, directional, lateral and vertical speed.
16. Lack of red marking on the cover of "Emergency" button on the common pitch of main rotors lever.
17. Dismantle of the pedal for emergency jettison of the external load wasn't recorded in the technical documentation.
18. Operation of the fuel regulator pump NP-3VMA of the right-hand engine was allowed with established malfunction during 57:46 flying hrs.
19. Lack of proper working clothing for crew and the commander was piloting in slippers.

20. The commander didn't possess in his flight licence FF(H) – Firefighting from air with helicopter.
21. In Scorpion Air Flight Operation Manual the procedure for firefighting using Bambi Bucket system is not included.
22. No calibration of Tester – 3U system for flight data recording was made since 1994.
23. The crew left the helicopter without switching off the fire cocks and electric supply from the battery.
24. Omissions in operator's quality management system.
25. MD CAA approved "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program" with the defects given in points 3, 4, 6 &7.
26. MD CAA didn't supervise Scorpion Air Air Operator regarding the base maintenance performance in the bases determined in the licence.
27. The MD CAA issued Certificate for Airworthiness to Ka-32AO helicopter, reg. LZ-MOZ, with maximum take-off mass with 1500 kg more than the value laid down in FM.

Having in view the above described, the commission proposes the following

**Safety recommendations:**
During the time of investigation with a letter reg. No 10-01-124/08.09.06 to MD CAA the following immediately safety measure was recommended:
1. The crew of Ka-32AO to be precluded of flights till clarification of the reasons for the accident.

With results of investigation in mind, on 21.09.2006 the Commission recommended by a fax to Scorpion Air Air Operator for immediate execution the following safety measures:

1. To perform single visual inspection of the engines of all helicopters Ka-32, operated by SCORPION AIR Air Operator with special attention of free turbine condition. The inspection to be recorded in engine logs.

2. To perform full engine run test of all the engines with recording of the test parameters in engine log books.

3. During the procedure for taking water from big artificial lakes the crew must fly using safety jackets.

Taking into account the results of investigation performed the Commission recommended also the following safety measures:

1. Scorpion air AO to correct "Scorpion Air Operated Ka-32AO Helicopter Maintenance Program" taking into account the remarks in points 3, 4, 6 &7 of above mentioned deficiencies and to submit it to MD CAA no later than 1 month from the date of delivery of the final report.

2. Scorpion Air AO to reassess the activities of Quality Management Department of Maintenance Organization in order to exclude such deficiencies like those listed in points from 1 to 18. The reassessment should be done in written and in one-month term after the date of delivery of the final report and to be submitted to MD CAA and AAIU.

3. Scorpion air AO to supply the crews with proper working clothes and shoes for special flights.
Time: continuously.

4. The crew of the helicopter to be allowed for flights after proficiency check on sections 2, 3, 4a, 5 and 6 of FM of Ka-32AO helicopter. The examination should be done by Flight Operations Department of MD CAA.
Term: 1 month after the date of deliver of the final report.

5. Scorpion Air AO should no combine the functions of flight firefighting operator and technical person in charge for helicopter line maintenance when firefighting flights are executed.
Term: Continuously.

6. MD CAA to assess the activities and competency of the Scorpion Air Maintenance Organization managing staff and to take measures for ensuring the fulfillment of their obligations in respect of the flight safety..
Term: 1 month after the date of deliver of the final report.

7. MD CAA to elaborate operational instruction in order to oblige the air operators, who operate helicopters with TV3-117, in implementation of Bulletin No N78M-117BE-AB for extension of engines life time to perform borescope inspection of the engines hot section.
Term: 2 months after the date of deliver of the final report.

8. MD CAA to reconsider Regulation No 1/13.01.2003 for personnel licensing in the part of issuing of flight operator license (F/OL) and to specify the types of helicopter flight operators for execution of special activities (firefighting, medical assistance, geological survey, construction and assembling operations, etc.).

Term: 2 months after the date of deliver of the final report.

The Commission expresses its acknowledgements to the Interstate Aviation Committee of Russia and Main Directorate of Civil Aviation of the Republic of Turkey for their assistance rendered during the investigation.

**Enclosures:**
1. Enclosure 1. Photos and sketches of the scene of occurrence
2. Enclosure 2. Graphs of variations of the parameters recorded by Tester – 3U system