FINAL REPORT
OF CIVIL AVIATION SAFETY INVESTIGATION

CLASSIFICATION: Accident

Owner: Unicredit Leasing Corporation IFN S.A.
Operator: S.C. MIR AERO S.R.L.
Manufacturer: Eurocopter France
Aircraft: EC 130 B4
Registration country: Romania
Registration: YR-BTM
Location: TĂURENI village, MUREȘ County
Date and time: 29.07.2013/ aprox.17:20 UTC/20:20 LT
AKNOWLEDGEMENT

This REPORT presents data, analysis, conclusions and recommendations on civil aviation safety, of the Civil Aviation Safety Investigation Commission appointed by the Director General of CIAS.

The flight safety investigation was conducted in accordance with the provisions of the Government Ordinance No. 51/1999 concerning the technical investigation of civil aviation accidents and incidents, approved with amendments and additions by Law No. 794/2001, of the REGULATION (EU) No. 996/2010 of the European Parliament and of the Council from 20 October 2010 on the investigation and prevention of accidents and incidents occurred in civil aviation and repealing of Directive 94/56/EC and the provisions of Annex 13 to the Convention on International Civil Aviation signed at Chicago on 7 December 1944.

The objective of civil aviation safety investigation is preventing the occurrence of accidents and incidents, by effective determination of causes and circumstances that led to this occurrence and establishing the necessary recommendations for civil aviation safety and it HAS NOT THE PURPOSE of finding guilty, individual or collective responsibilities.

As a consequence, the use of this REPORT for other purposes than preventing the occurrence of accidents and incidents might generate misinterpretations.
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SYNOPSIS

CLASSIFICATION  Accident

Owner  Unicredit Leasing Corporation IFN S.A.
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Manufacturer  Eurocopter France
Aircraft  EC 130 B4
Registration country  Romania
Registration:  YR-BTM
Location:  TĂURENI village, MUREȘ County
Date and time:  29.07.2013/ aprox.17:20 UTC/20:20 LT

On 29.07.2013, the helicopter EC 130 B4 type, registered YR-BTM was planned to perform a passenger transport flight on the route Târgul Mureș –Tăureni - Târgu Mureș, with staying in Tăureni locality.

The flight was performed at the request of the director of the company that rented the helicopter, hereinafter referred to as the flight beneficiary, so that along with other four persons to visit a factory in Tăureni locality.

The aircraft took-off at 13.25 LT, with the flight approval no.130, from the flight field of Târgul Mureș Airclub „Elie Carafoli”, it landed in the vicinity of President Hotel, (at the exit from Tg. Mureș locality) from where the five passengers were embarked, after which it took-off towards Tăureni locality.

The helicopter landed at Tăureni around 15:40 LT, in the yard of a factory that was about to be visited.

After the flight beneficiary informed the helicopter pilot that he was contacted by phone by the National Anticorruption Directorate (DNA), on the reopening of a criminal investigation file in which the two were involved, it was decided to urgently return to Târgu Mureș.
Due to the tensed situation created, the director of the factory insisted that the return to Târgu Mureș to be made with a car he made available for them, but he was refused.

After a short flight to reposition the helicopter on a grassy field, situated in the proximity of the county road DJ-151, at almost 1 Km from the factory and after embarking all the passengers, the helicopter took off at 20.19 LT, on South-West direction, towards lake number 2 from the chain of lakes of Tăureni commune.

The helicopter had a soft climbing slope and at a height of almost 35-45 metres, it entered in a pronounced turn to the left followed by a constant descent towards the lake surface, till impact to the water.

The descent flight of the helicopter, on a slope of approximately 6-8°, was performed over the lake glass, with the sun behind, at sunset (the incidence angle of the sun being of almost 8°).

After the impact with water, with a high speed of advance, with a dive angle, theoretically calculated, of almost 14-16° and an inclination on the left of over 40°, the helicopter rotated to the left, around the gyration axis combined with a rotation around the longitudinal axis witch led to a violent impact of the helicopter front right side with the water, followed by a helicopter projection of almost 40-50 m from the place of the first impact, approximately on its travel direction.

During the helicopter rotation, the passengers who didn’t have the safety belts on were projected outside the helicopter, less the pilot who had the safety belt on (only the abdominal one).

After the accident the aircraft was totally destroyed, and the pilot along with 4 passengers died. The only survivor was the one sitting on the seat behind the pilot who was recovered from water by the witnesses on site.

The most likely cause of the accident is the incorrect assessment of the height from the water glass or the pilot’s physical incapacity of reaction.

The accident was notified to CIAS in written, being registered with the number 7430/29.07.2013.
1 FACTUAL INFORMATION

The accident took place on 29.07.2013 at 20.20 LT. The notification was received by the Civil Aviation Safety Investigation and Analysis Center (CIAS) at 21.00 LT (no. 7430/29.07.2013). Based on this notification CIAS managed an investigation commission that went to the accident site to investigate it. After the findings on site, CIAS took the wreckage in custody and transported it to an approved location.

CIAS informed EASA about the accident occurred, as well as the investigation authorities from Germany (German Federal Bureau of Aircraft Accident Investigation - BFU) and from France (Bureau d’Enquêtes et d’Analyses pour la sécurité de l’aviation civile - BEA) by usual reporting channels.

The French investigation authority „Bureau Enquêtes-Accidents“ - BEA designated an accredited representative of France, as design state and manufacturer of the helicopter and engine, assisted by advisers from Safran Turbomeca (manufacturer of Arriel 2B1 engine equipping the helicopter) and from Eurocopter France (helicopter manufacturer).

The representative of BEA, along with his team actually participated in the investigation of the helicopter wreckage. After investigating the wreckage he issued a technical report.

At the same time, at the request of CIAS, BEA performed, in its facilities from France the following:
- downloading and decoding the information contained in the permanent storage elements from the following equipment installed on the helicopter:
  - VEMD (Vehicle and Engine Multifunction Display) Thales- P/N: B19030MD05, S/N: 4545;
  - ECU (Engine Control Unit) Thales, - P/N: 70BMF01020, S/N: 7086;
  - GNS430 Garmin, P/N: 011-00280-10, S/N: 97141799;
  - GPSMAP695, - S/N.1H8000115.
- expertising the disassembled components of collective pitch lever control, left pilotage post, concerning the determination of the efforts applied on this control lever.

The manufacturer’s expertises made in the facilities from France, were performed under the supervision of the investigation team members from CIAS.

BFU designated an accredited representative of Germany who declared his willingness to ensure expert advice, if appropriate, for the investigation commission, without going to the accident site.

This Final Report is published by the Civil Aviation Safety Investigation and Analysis Center (CIAS).
1.1 History of accident

1.1.1 General

To describe the preparation and the development of flight activity on 29.07.2013, as well as those previous this date, there were used the recordings of the air traffic conversations, the recordings from the flight plan, the flight technical log notes, the witnesses statements, and for the accident investigation ther were also used the data from the technical reports prepared by BEA (the data extracted from the permanent memory elements VEMD, ECU, GPS and detailed inspection of the wreckage).

This flight was a passenger transport flight carried out on daytime, according to flight rules at sight (VFR). On board of the aircraft there were the pilot (main left pilotage post) and five passengers among whom two on the seats in the front and three on the seats in the back.

In the report, for protecting the privacy, it was used the male form for all the persons involved in the occurrence, regardless of gender (male / female).

The time is expressed in LT local time (to express time in UTC there will be subtracted three hours, in accordance with the date of the occurrence).

1.1.2 Actions/activities previous to flight

The pilot of the helicopter, who had also the qualification of pilot instructor, performed frequently flights in Tg Mureș and Tăureni areas as a result of the service contract concluded for a period of 1 year between the helicopter operator and a commercial company with activities in this area. The day before the accident occurred, he performed with the same helicopter the following flight missions:

- passenger transport from Elie Carafoli Air Club, from Tg. Mureș to Miercurea Ciuc (10:16 -10:49 LT);
- passenger transport from Miercurea Ciuc to Sovata (11:22-11:42 LT);
- helicopter positioning flight from Sovata to Elie Carafoli Airport (18:20-18.39 LT) where it supplies with 492 l (398 kg) of Jet A-1 fuel;
- helicopter repositioning from Transilvania -Tg. Mureș Airport to Elie Carafoli Airport (20:02-20:08 LT) in order to park the helicopter.

1.1.3 History of the flight

On 29.07.2013, the helicopter EC 130 B4 type, registered YR-BTM was planned to perform a passenger transport flight on route Târgul Mureș –Tăureni-Târgu Mureș, with stay in Tăureni locality.
The flight was performed at the request of the company Director that rented the helicopter, hereinafter referred to as the flight beneficiary, so that along with four other persons to visit a factory in Tăureni locality.

The aircraft took-off at 13.25 LT, with the flight approval no.130, from the flight field of the „Elie Carafoli” Târgu Mureș Air Club, it landed next to President hotel, (at the exit of Tg. Mureș locality) where the 5 passengers were boarded, then it took off towards Tăureni.

The helicopter landed at Tăureni around 15:40 LT, on an equipped field, situated in the courtyard of the factory.

![The landing field inside the factory](image)

Here, during the visit and the discussions with the administration of the furniture factory, the flight beneficiary was called from the The National Anticorruption Directorate (DNA), related to the reopening of a criminal investigation file involving him and also the helicopter pilot, when he became irascible and decided to return immediately to Targu Mures. Due to the state of stress that was created, the factory Director has made available for the passengers and the pilot a vehicle and he insisted that the return to Târgu Mureș to be made by car, especially because the distance to Tg Mureș was of almost 56 Km, 50-60 minutes drive.

However the flight beneficiary decided that the return would be made by helicopter.

Around 20.00 LT the aircraft was prepared for the return flight to Elie Carafoli Air Club, and even if the pilot frequently took-off with all the passengers from the factory courtyard flight field (according to the witnesses statements) this time he took-off with only two passengers on board (positioned one next to the pilot, on the right pilotage post, and the second on the back seat, exactly behind the pilot).

After a short flight for repositioning, the helicopter landed on a grassy field located near DJ-151 county road, at approximately 1 km from the take-off place. Here, without stopping the engine the pilot waited for the other three passengers to arrive and who were transported from the factory to the helicopter by car.
After boarding of all passengers (the position of the first two passengers did not modify) the helicopter took off on south-west direction (approximately on direction of 230-2400), to lake number 2 from the chain of lakes of Tăureni village.

From the witnesses statements (see their position on fig. no. 3, witnesses no. 1, 2 and 3) it was revealed that the helicopter took a height of about 35-45 m, on take-off direction, after which it went into a pronounced left turn followed by a constant descent to the lake surface. The witnesses also said they were convinced that the helicopter would recover but it entered in contact with the water, overturned, was projected at almost 40-50 m from the place of the first impact and submerged into the water.

During the helicopter rotation, the passengers that didn’t have the seat belts on, were projected outside the helicopter except the pilot who had the abdominal seat belt on.

After the accident the aircraft was totally destroyed, and the pilot along with four passengers died. The only survivor was the one positioned on the pilot’s backseat who was recovered from the water by the witnesses on site.

1.2 Injuries to persons

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Crew</th>
<th>Passengers</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>1</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Serious</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Minor</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>5</td>
<td>-</td>
</tr>
</tbody>
</table>
The pilot and two passengers are of Romanian nationality, and the other 3 passengers of German nationality.

1.3 Damage to aircraft

The aircraft was found in lake no. 2 from the chain of lakes of Tăureni locality, overturned on its left side.

The helicopter wreckage after being pulled from the lake.
1.3.1 General wreckage examination

The wreckage has been recovered, transported and deposited into a hangar CIAS where its detailed examination took place along with BEA representatives.

a) Landing gear (tubular sledge type)

The landing gear exhibited no damage/deformation/failure except the accessories:

- the right foot step was bent and its forward fitting on the skid was broken;
- the left rear fairing on the cross tube was missing;
- the right rear fairing on the cross tube was damaged.
b) Fuselage, fairings, cowlings and doors

The cockpit/cabin floor exhibited compression due to contact with a soft surface (without marks/friction generated by a hard object) in its front part (below the instrument panel and in front of the landing skid) and the associated belly cowls in this area were damaged or missing.

This compression was oriented from downward to upward (slightly), from forward to aftward and from right to left (around 45° against the longitudinal axis in the horizontal plane).
Behind the damaged cockpit/cabin (behind the front part of the landing skid, tubular sledge type), the central structure and the associated cowls exhibited no damage/deformation/failure.

The main structure of the central fuselage and the helicopter tail boom exhibited no damage/deformation/failure.
The right antenna exhibited bending from downward to upward due to contact with a soft surface.

The right horizontal stabilizer exhibited damage/deformation in compression from right to left plus a bending from downward to upward on its right side due to contact with a soft surface and was intact on its left side.

The left vertical stabilizer is broken from right to left due to contact with a soft surface.

The canopy was completely destroyed and was completely disconnected from the aircraft structure (only a piece of inner cowl from the roof was still connected to the structure by electric wire).
The windshield and the roof were completely destroyed and a lot of parts were missing;

The right door was broken in several parts;
The right fixed panel (behind the right door) was intact;
The left door (pilot door) was missing.

The left sliding door was intact but fittings (on the door and on the structure) showed failures of the door movement towards outside. So, the sliding door was in close position during the crash sequence.
The right cargo door has not been found on the wreckage, it was subsequently recovered from water. It exhibited damages by hydraulic compression from right to left (towards inside).

The damage/deformation of the right cargo door upward fittings was in accordance with the load direction (towards inside).
The left cargo door was intact and fitted correctly to the structure.

After recovering the wreckage it was noticed that all the upper cowlings of the engine and of the main gear box-MGB were in place, except the right cowling of the MGB. They were dismantled for the examination.

The fixed part of the right main gear box cowling exhibited a large deformation with a part of the canopy roof still connected.

In these conditions the mobile cowling part has been disconnected from its fixed part due to the cockpit deformation during crash.

The fixed part of the left main gear box cowling exhibited lighter deformations than the right one probably due to its contact with the main rotor.
The secondary drive shaft cowlings after dismantling exhibited visible damages on the inner side (not visible outside due to thermal protection) due to interference with the first segment of the engine drive shaft which has been disconnected from the splined shaft and moved freely.
c) Seats

All the seats of the helicopter are anti-crash type seats. All the seats were still correctly fitted on the mechanical floor. No seat presented records showing that the anti-crash system was activated.

No seat was damaged/deformed except the front middle seat which exhibited a slightly right-lateral and forward deformation.

On the front middle seat, the right sliding device between the mobile component of the seat (seat pan/back) and its fixed component (seat support) exhibited a displacement (nothing on the left sliding device).
This sliding device is used to guide the seat pan/back in case of crash when the vertical acceleration is high.

In case of vertical crash, the lower fixed structure fitted on the seat pan deforms and the seat pan/back moves controlled downward in order to limit the acceleration on the seat occupant.

The sliding is generally asymmetrical because the acceleration is never purely vertical and/or the occupant’s weight is never strictly positioned on the middle of the seat.

In this case the damages of the aircraft were not compatible with a vertical acceleration able to activate this device (except if the occupant of this seat was very fat compared with the pilot and others occupants).

The activation of this device can also appear when a load is applied laterally from the seat back. This can happen if an occupant is on the seat with the belts on, or if a rear passenger hits the front seat in the case of a frontal/lateral impact of the aircraft.
1.3.2 Dynamic component examination

a) Main rotor blades

Schematic diagram of the main rotor blades

General condition of the main rotor blades

The blue blade has not been recovered.

The blades exhibited damage/failure compatible with contact with a soft surface (failure of the trailing edges by compression and low deformation of the blades).
b) Main rotor head assembly

Schematic diagram of the main rotor head

The main rotor provides the lift of the helicopter and powers its forward flight. The main rotor comprises:

1. Main rotor mast (1)
2. Main rotor hub (2)
3. Main rotor blades (3)

The main rotor mast is secured to the MCG. It drives the main rotor hub and transmits the rotor lift to the airframe. The hub is attached to the rotor shaft and supports the blades. It is located at the center of the resultant lift of the blades and it absorbs the forces induced by the motion (centrifugal forces, whipping and drag (loading) loads).

The blades convert the mechanical engine power into aerodynamic forces (17).

**Some figures:**
- \( N \approx 300 \text{ rpm (speed governed in steady flight)} \)

All the rotor hub parts are either perfectly symmetrical or foot-proofed:

NO ERROR IS POSSIBLE IN DISASSEMBLY/REASSEMBLY.
General condition of the main rotor head

The three star arms of the blades were broken.

The red and yellow arms exhibited failure mainly by stretching compatible with blade contact and with rotor rotation.
The blue arm exhibited a significant flapping failure with downward deformation of fibers compatible with an aircraft roll over.

The end arms were missing except for the red one where it was still fitted by few fibers.

The elastomeric bearing bolt of the yellow arm was sheared, a sign of the blade contact with water and the bolts of the red and blue arms were fixed in their places.

The frequency adaptor of the blue arm has not been recovered.

The frequency adapters of the red and yellow arms were disconnected from its sleeves with a displacement compatible with blades impact while they were activated.
The red and yellow sleeves exhibited a hard delamination.
The blue sleeve was completely destroyed and half of it was missing.

The drop restraining ring exhibited no abnormal damage.  
For the blue blade where the star arm was exhibiting flapping failure, this evidence is compatible with an aircraft roll over.

The swashplates, pitch rods, pitch arms, scissor are undistorted and correctly linked together.

**c) Main Gear Box**

Schematic diagram of the main gear box
General condition of the main gear box

The main gear box didn’t exhibit any damage/deformation/failure. No metallic particle was found on the magnetic plug.

d) Suspension system of the main gear box
Schematic diagram of the system
General condition of the system

The left front and rear bars of the main gear box exhibited deformations by bending (compression).
The front right bar exhibited high deformation by bending.
The fittings were intact and still fitted to the longitudinal structural beams.
The longitudinal structural beams were broken and deformed downward for the front left fitting and upward for the rear right one.
The findings were compatible with a high displacement of the main gear box to the front and behind on the left and on the right.

This high displacement of the main gear box was compatible with:
• high unbalancing load due to blades failure;
• sudden blades brake;
• roll over.
But this high displacement of the gear box was not compatible with a high acceleration of the helicopter during impact due to the findings on the structure.

The findings were compatible with a blade water impact, with unbalancing generating by the blade damages, with roll over but were not compatible with high acceleration of the helicopter during impact due to the findings on the structure.

e) **Engine coupling assembly - Main Gear Box - MGB**

Schematic diagram of the main gear box coupling assembly – MGB
General condition of the main gear box coupling assembly

The engine was still connected to the main gear box.

However the cadran ring of the coupling tube belonging to the drive shaft exhibited an overload crack in the area of a fitting pin.

The coupling tube of the drive shaft exhibited interference traces with the coupling flange of the drive shaft (MGB input).

The engine output and the flexible coupling of the drive shaft exhibited damages compatible with a compression of the drive shaft.
The flexible coupling of the drive shaft in MGB input was completely destroyed by overtorque.

The drive shaft flange in MGB input exhibited deformation in compression (drive shaft compression) and deformation of holes on the flexible coupling area compatible with an overtorque.

The screws of the fitting flange between the drive shaft and the elastic coupling were missing probably due to their shearing.

The flexible coupling was completely destroyed.

1.3.3 Engine

Schematic diagram of engine controls

The engine control system inside the cockpit

Both rotating levers of the pitch lever were in FLIGHT position. This is their normal position during flight.
The engine on button was in ON position and secured in this position (fig. no. 42). This is its normal position during flight.

The fuel shut off valve for emergency situations was found activated (the red handle).
a) Engine examination
   Visual examination

The engine was removed from the wreckage for further examination. It was complete and it had all equipment fitted on it. It was covered with a dusting which came from the muddy water of the lake where the engine was submerged after the accident.
Constructively, the engine is divided into five modules as follows:
- Module M01: Drive shaft and accessories gearbox;
- Module M02: Axial compressor;
- Module M03: Gas generator (high pressure side);
- Module M04: Power turbine (free turbine);
- Module M05: Reduction gearbox.

Accessories gear box and link tube (M01)

There were no specific findings regarding the accessories gear box M01. The accessories gear box and the coupling tube were in good conditions and functionable because the starter could rotate along with the gas generator, thus confirming the operational condition of the the kinematic chain of the accessories gear box;

The engine coupling tube exhibited friction longitudinal traces at the level of rear bearing supports, thus indication movement of the engine in direction front-back, with respect to the rear support. Such engine movements are compatible with other damages of the helicopter (the firewall in front of the engine compartment, the transmission to tail rotor, the main reduction gear, etc.).
Axial Compressor Module (MO2)

There were no specific findings to be noticed regarding the Axial Compressor module.

Gas Generator Module (MO3)

The manual rotation of the gas generator rotor is rough. Even like that, the investigation crew confirmed that it rotated when the aircraft was recovered from the lake. It is assumed that corrosion appeared on bearings due to water entering the engine during the accident. There were no other specific findings regarding the gas generator module.

The borosquope inspection of the combustion chamber did not reveal any discrepancies. Some blades of the high pressure turbine were partially covered with sediments, as a consequence of the time spent by the engine in the water after the accident.

Power Turbine Module (MO4)

All power turbine blades were present and in good condition.

The disc of the power turbine could not be manually rotated. Similarly as the gas generator it is assumed that it blocked due to corrosion that appeared on bearings as a consequence of the water entered into engine during the accident.

There were no other specific findings regarding the free turbine module.
Speed Reduction Module (MO5)

The reduction module was separated from the power turbine module in order to discover the engaging splined nut from the drive shaft. This nut transfers the torque given by the free turbine through the coupling sleeve of the drive shaft belonging to the reduction gear box.

The coupling sleeve was removed in order to analyze the position of the engaging splined nut from the drive shaft. The examination revealed that the nut rotated on its shaft almost 3 mm.

There were no other specific findings regarding the speed reduction module.

There were also checked the following:
- Magnetic collectors

No particles were found on the magnetic collectors of MO1 and of the „general return” (oil return in the oil tank).
An unimportant amount of small particles was found on the magnetic collector MO5. Such unimportant particles do not represent an advanced state of deterioration.
- **Output drive shaft and free wheel**
  The coupling tube was removed in order to discover the free wheel assembly.
  The free wheel could be manually rotated. Its rotation could have been blocked or unblocked by rotating the output drive shaft in opposite directions, thus confirming the normal operation of the free wheel function.

- **Equipment**
  There were no other specific findings regarding the engine equipment (HMU, release valve, valve assembly, sensors, etc.).

- **Coating**
  The exhaust nozzle exhibited 2 superficial recesses on the left that seemed to be consequences of the accident.
  There were no other specific findings regarding the engine coating (pipes, harnesses, supports, etc).

**1.3.4 Fuel supply circuit**
Schematic diagram of fuel supply circuit

There were no findings of failures before the crash.
After the inspection it was noticed that the helicopter fuel tank was in good conditions.

The fuel shut off valve for emergency situations was found partially activated. Most likely, the complete destruction of the cockpit is the cause the partial activation of the fuel shut off valve for emergency situations.

### 1.3.5 Tail Rotor Drive Shaft - TRD

![Schematic diagram of drive shaft](image)

Fig. no. 52
General conditions of the tail rotor drive shaft

From the tail gear box to bearing N° 5, the tail rotor drive shaft did not exhibit failure/deformities/malfunctions or abnormal conditions.

The engine output flange, the flexible coupling and the flange of the front steel drive shaft exhibited a high deformation in traction.

The splined coupling between the front steel drive shaft and the splined drive shaft was disconnected. Disconnecting the splined coupling is possible under the following conditions:
- Malfunction of the engine flexible coupling (not applicable);
- Large deformation of the helicopter rear beam structure (not applicable);
- High engine displacement forwards (abnormal in normal operation).

Thus, the disconnection of splined coupling is compatible with a high engine displacement forwards, which is in accordance with:
- Deformation in traction of the engine output coupling;
- Forwards deformation of engine support;
- Deformation in compression of engine/drive shaft MGB due to impact.

The front steel drive shaft exhibited traces of a circular friction which was compatible with a disconnection of the splined coupling and a rotation of the drive shaft during crash.

After disconnecting the splined coupling, the front steel drive shaft is connected only at the engine output and it is not guided in its rotation, generating interference with the structure, coupling, splined drive shaft (for the splined flange area) and with the firewall behind the engine (for the tube).

Without guidance or along with the front steel drive shaft, an unbalance load is generated, and the engine output flexible coupling would brake.

The engine output flexible coupling exhibited a deformation, but without any malfunction, which is compatible with a sudden stop of the engine, which in its turn is compatible with an overturn of the aircraft into the water.

### 1.3.6 Secondary Reducer Gear Box (TGB) and Tail Rotor (TR)

Schematic diagram of secondary reducer gear box and of tail rotor.
General condition of secondary reducer gear box and of tail rotor.

The secondary reducer gear box and the tail rotor did not exhibit damages, deformations or failure.

The secondary reducer gear box freely rotated and no particles were found on the magnetic top.

The secondary reducer gear box and the tail rotor were in good conditions.

There was no evidence of any malfunction before the crash.

1.3.7 Flight control

Kinematics of flight control – Schematic diagram
Components general condition

All kinematic components were in their place, in good conditions, correctly connected and freely activated. The following were noticed:

- Some rods were bent due to frontal impact;
- A rod under the mechanical floor broke by bending during impact, along with the bending of the floor longitudinal structure;
- The control cable of the tail rotor pitch was damaged due to disconnecting the tail rotor drive shaft, which entered in contact with the cable;
- The pilot’s stick bent from forward to backward.
1.3.8 Servo-Actuators/Hydraulic Circuit
Schematic diagram of servo-actuators/hydraulic circuit

- The pilot pitch lever stick broke at floor level.
General conditions
The servo-actuators were in their place, in good conditions, properly connected and they moved freely.

All components of the hydraulic circuit were in their place, in good conditions and properly connected.

The lower pump rotated freely, the belt was in its place and stretched, no metallic particles were found on the magnetic collector.

The mechanical indicator of the oil filter of the lower hydraulic unit was not activated.

The upper pump rotated freely, the magnetic collector was missing (probably due to the impact), but without any influence on the circuit operation (especially since the hydraulic fluid was present in the circuit).

The mechanical indicator of the oil filter of the upper hydraulic unit was not activated.

1.4 Other damage

No damages were produced to third parties.

1.5 Personnel information

<table>
<thead>
<tr>
<th>Pilot (Captain)</th>
<th>Male, 49 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>License</td>
<td>CPL(H), issued by AACR, valid until 04.04.2014</td>
</tr>
<tr>
<td>Medical certificate</td>
<td>Class 1, valid until 05.11.2013</td>
</tr>
<tr>
<td>Flight experience</td>
<td>Total of 1792 hours out of which:</td>
</tr>
<tr>
<td></td>
<td>IAR 316 B Allouete - 680 hours</td>
</tr>
<tr>
<td></td>
<td>IAR 330 Puma - 90 hours</td>
</tr>
<tr>
<td></td>
<td>EC 120B - 850 hours</td>
</tr>
<tr>
<td></td>
<td>EC 130 B4 - 172 hours</td>
</tr>
<tr>
<td>Last examination</td>
<td>21.03.2013</td>
</tr>
<tr>
<td>Work time</td>
<td>20 minutes</td>
</tr>
<tr>
<td>Rest time</td>
<td>over 16 hours</td>
</tr>
</tbody>
</table>

1.6 Aircraft information

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>EC 130 B4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft manufacturer</td>
<td>Eurocopter France</td>
</tr>
<tr>
<td>Manufacturing number (MSN)/ manufacturing year</td>
<td>SN 4542/2008</td>
</tr>
<tr>
<td>Registation state and marks</td>
<td>Romania, YR-BTM</td>
</tr>
</tbody>
</table>
The aircraft was bought by the owner in September 2009 having at that moment 9h and 24 minutes of flight.
Till the accident, the helicopter had all technical checks at date, all service bulletins and airworthiness directives applied.

The helicopter was maintained in conformity with the requirements of the maintenance schedule ref MIR-PI-02 edition 0/revision 0 January 2012, approved by AACR under the reference 1496/29.02.2012.

During the period flown since acquisition to the date of the accident there were performed 14 technical checks at 100 flight hours/6 months/1 year and 2 basic revisions at 600 flight hours or 2 years. The last technical check was performed at 1610 hours, on 24.05.2013 (revision at 6 months and additional works).

In this period there were also replaced all the components with limited resource that reached the maximum limits provided by the manufacturer.

For the engine all the modifications required and introduced through the issuance ASB/AD were applied by the representatives of Turbomeca (ex. TU 147 prin ASB 292.73.2836//AD 2010-0215 and TU 166 through ASB 292.73.3166B//AD 2012-0124 R1).

The service bulletins and airworthiness directives issued by EUROCOPTER and EASA, were applied according to the imposed requirements and deadlines.

During the operation there have not been reported and/or registered in the aircraft documents, deficiencies in its operation.

**Engine data:**

<table>
<thead>
<tr>
<th>Engine</th>
<th>TSN</th>
<th>TSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arriel 2B1-S/N46094</td>
<td>1120</td>
<td>N/A</td>
</tr>
<tr>
<td>Turbopropulsor manufactured by Safran Turbomeca, France,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modules</td>
<td>P/N</td>
<td>S/N</td>
</tr>
<tr>
<td>MO1-Accessories gear box and coupling tube</td>
<td>70 BM 012010</td>
<td>6264</td>
</tr>
<tr>
<td>MO2- Axial compressor</td>
<td>70 BM 022010</td>
<td>7468</td>
</tr>
<tr>
<td>MO3 – Gas generator</td>
<td>70 BM 032020</td>
<td>9667</td>
</tr>
<tr>
<td>MO4 – Power turbine</td>
<td>70 BM 041720</td>
<td>Not accesible</td>
</tr>
<tr>
<td>MO5 – Speed reducer</td>
<td>70 BM 052000</td>
<td>10367</td>
</tr>
<tr>
<td>Equipment</td>
<td>PN</td>
<td>S/N</td>
</tr>
<tr>
<td>DECU</td>
<td>70BMF 01020</td>
<td>7086</td>
</tr>
</tbody>
</table>

Arriel 2B1 engine is a free turbine engine, with an axial compressor stage, a centrifugal compressor stage, an annular combustion chamber, a high pressure...
turbine stage and a power turbine stage and a reduction gear box with a nominal output of 6000 rpm.

The engine power at take-off is rated at 746 shp (557kW), and the continuous maximum power at 728 shp (543 kW).

The engine dimensions are 1.14 m length, 0.491 m width and 0.616 m height. Its weight without fluids is 132 kg.

The ignition system is a low voltage one, high power and it includes a high power generator, two injectors and two spark plugs.

![Fig. no. 60](image)

### 1.7 Meteoorological information

The meteorological information estimated according to the data registered at the Airport nearby (LRCT), la ora 20.00 LT:

- Coverage =4/8
- Ceiling = 6000m
- Visibility over 10Km
- Temperature at 20.00= 25°C
- Wind direction = 260°
- Wind speed= 3-4 m/s

### 1.8 Aids to navigation

The helicopter was equipped with a Garmin GNS430 – VHF/VOR/LOC/GS/GPS equipment.

Additionally, the operator mounted a GPS Garmin equipment, GPSMAP695 model.
1.9 Communications

The communication aids functioned normally. The radio connection was used in order to obtain the permission to take-off when leaving from Elie Carafoli Aerodrome towards Tăureni. From Tăureni they obtained the flight approval by phone, following to connect b TWR Tg. Mureș after take-off.

1.10 Flight field data

The field from which the last take-off was performed is a grassy field, chosen from air by the pilot, situated in the vicinity of DJ-151 county road, at almost 1 km from the factory headquarters. On the direction chosen by the pilot for take-off the field presented a flat surface with slight curvature to the lake, without obstacles.

1.11 Flight recorders

This helicopter is not equipped with flight recorders of the type CVR and FDR. The device has equipment on board that is used only for maintenance (error messages and their associated parameters, at the time of their emergence as well as the reports of overcoming some functional limits which are not dated), thus:

DECU (Digital Engine Control Unit) is digital control unit with two channels which serves to control fuel dosage, to control the engine operating parameters and the registration of engine operation nonconformities. Each channel (module) has a non-volatile memory EEPROM of 32 kB in which there are registered the error messages.

VEMD (Vehicle and Engine Monitoring System) is a management and control system of the main aircraft and engine parameters which contains a multifunctional screen installed on the instrument panel, having the role of managing the essential and non-essential data of the helicopter and engine. VEMD is a system with two channels that in their turn, each channel (module) has a non-volatile memory EEPROM of 32 kB in which there are registered the error messages and the helicopter/engine operating parameters.

The data registered by VEMD relevant for the investigation are the following:
- flight reports;
- error messages and operating parameters in that moment
- reports of overcoming the functional limits.

1.12 Wreckage and impact information

The aircraft was destroyed at the impact with water. The wreckage was recovered from the lake in which it crushed.
1.13 Medical and pathological information

After the forensic autopsy reports of the deceased it was revealed that:

- the pilot died as a consequence of the mechanical asphyxiation by drowning, produced in conditions of multiple trauma with thoracic and cervical vertebrae fracture. The toxicological examination result was negative and zero blood alcohol content.

- the passengers died as a consequence of the traumatic injuries caused by impact with a rough object, with a sharp edge moving at high speed (possibly the blade of a main rotor) and/or hitting-compression of rough objects inside the helicopter.

1.14 Fire

N/A.

1.15 Survival information

After the accident occurrence a few locals jumped quickly into the water and managed to save a passenger who was transported immediately to the hospital where it was found that he had no lesions or injuries.

The ISU crews were alerted by phone, they intervened immediately and managed, at almost an hour from the accident occurrence to take out of the lake four deceased persons, the pilot and three passengers. The research of the fifth passenger continued till sunset when they were interrupted because of safety reasons for the divers.

The last victim of helicopter crash from Tăureni was found the second day around 8.10 LT, at almost 10 meters from the helicopter into the water.

1.16 Tests and research

Because this helicopter type is not provided with recording equipment of the flight parameters, during the investigation on site it was recovered, in order to identify some possible information, the avionic equipment provided with memory elements. In this concern, in the facilities of BEA, there were identified and analyzed the following components:

a) VEMD Thales, P/N: B19030MD05, S/N: 4545;

b) ECU Thales, P/N: 70BMF01020, S/N: 7086;

c) GNS430 Garmin, P/N: 011-00280-10, S/N: 97141799;

d) GPSMAP695 Garmin, S/N: 1H8000115 (additional equipment);

e) The gas-pitch lever, left pilotage position.
At decoding it resulted the following:

**VEMD**

The downloaded data were associated to the last flight, more exactly to the flight no. 1649. The recording duration is of 4 min. 10.0 s. The recording of data in VEMD starts when the engine NG (the gas generator turbine speed) increases over 60% and it stops when the NG decreases below 50%. There was no anomaly recorded of the engine / helicopter operating parameters.

**DECU**

The concludent data corresponding to the last flight are the ones associated to the flight no. 2430 for channel A and 2339 for channel B. The recording duration of the last flight is of 4 min. 43.0 s. The recording of data in DECU starts when it is powered with electricity and it stops with the interruption of the unit power supply.

**Conclusions:**

- The error message TEST_FADEC_4 which was registered in VEMD corresponds to a malfunction of the anticipating potentiometer collective pitch lever. This error was generated by DECU. In DECU, the same error was identified as PANNE_XPC_OUI. Based on these identical error messages identified by both units, they were able to be synchronized.
  
  This error message was generated when the potentiometer reaches the minimum limit position (5%) or the maximum one (95%), or when variation is higher than 350% in one second. The two limits, lower and upper, cannot be mechanically reached due to the design of the collective pitch system.

  Based on the experience of BEA, Eurocopter and Safran - Turbomeca, this is one of the first error messages registered from a sequence of errors generated by the system after an impact of the helicopter.

  Moreover, the two computers registered a large number of errors related to different systems within a very short period of time. All the error messages were a consequence of the helicopter impact with water.

**Gas-pitch lever** (left pilotage position)

Because the gas-pitch lever, left pilotage position, was found broken it was examined in the facilities of BEA in order to determine the causes, the breakage manner but also a possible influence on the accident occurrence.
The lever assembly is composed of the following elements, the collective pitch lever itself, the twist grip and the machined box. This box is manufactured through a mechanical machining process.

There were identified two breakage areas (fig. no. 61):
- An area at the box level where it occurred the detachment of pieces (the lever was found separated with a part of the box attached to it)-green color;
- An area at the level of the end of tubular rod of the lever. (visible only after disassembling the damaged assembly)-red color.

As a consequence of examining the breakage surface of the carcass it was highlighted that it was the case of a fragile breakage propagated from downwards to upwards, without the usual working position, without fatigue breakage marks or damages of the breakage surface.

The breakage surface of the manufactured piece is granular. It was noticed a breakage model in the shape of V whicj is oriented towards the breakage origin. The
breakage of the manufactured piece is a fragile one, propagated from downwards to upwards (see fig. 62, red arrows).
No pre-failure marks were detected on the breakage surface (e.g. corrosion, fatigue cracks, etc).
The drive tube (pilot) was bent (see fig. 64).

On the breakage surface of the tube there were noticed deformations caused by shear, characteristic to a ductile breakage (see fig. 65).

Moreover, deformations have the same orientation on either side of the green line, with neutral axis (see fig. 63 and 65). This is characteristic to bending loads. The deformations orientation and the neutral position of the fibers indicate a deformation by bending from downwards-left to upwards-right.

This is in accordance with the deformation of the drive tube (pilot) noticed in fig. 64.

With the electronic microscope there were noticed (SEM) recesses in the breakage surface (fig. 66). No marks before breakage were noticed (e.g. corrosion, fatigue cracks). This confirms the ductile breakage of the drive tube by overload.
In order to calculate the necessary force to break the lever in the area in which the breakage occurred during the accident it was performed a analytical calculation, based on the mechanical mechanism of the collective pitch, by applying a load of 1.5 x 445 N (in longitudinal plane and perpendicular to the lever). The resulted forces on different components or surfaces were compared with their final resistance and it was noticed that there are three areas with smaller limits namely: the fitting screws of the collective pitch lever assembly (Fig 67), the connection tube and the coupling of the connection tube (fig. 68).

Prinderea manetei și localizarea șuruburilor de prindere.

Mecanismul cinematic al manetei: tubul de legătură și cuplajului tubului de legătură.
From the technical report of BEA it results that the equivalent of the load that could have been applied by the pilot in order to produce the established damage of the lever has a significant value of 2945 N. Applying the load with one hand by the pilot is definitely impossible.

2 ANALYSIS

For this accident occurred on 29.07.2013 it shall be analyzed the helicopter trajectory on the last flight section, since take-off at 20:14 LT, from the grassy field situated in the vicinity of the county road DJ-151 (at almost 1 km from the furniture factory in Tăureni) towards Tg. Mureș, till the impact with the water surface.

After boarding the last 3 passengers, who came by car, the helicopter took-off on direction South-West, it reached a height of almost 35-45 m, it performed a turn on the left of approximately 90° in order to center on direction Tg Mureș, after which the helicopter followed a descent slope, that was continuous till the impact with the lake water (Fig. no. 69).

From the wreckage analysis and witness statements it turned out that the initial helicopter impact with the lake surface occurred with the blades of the main rotor on the left side from the flight trajectory.

After the impact, due to braking the rotation of the blade (in clockwise) the helicopter rotated to the left, around the gyration axis combined with a rotation around the longitudinal axis which led to a violent impact of the helicopter front right
part with the water, followed by a projection of the helicopter at approximately 40-50 m from the place of the first impact, roughly in its travel direction.

The helicopter projection as well as the deformation of the front right part (figures no. 9, 10 and 11) indicate that at the time of the impact it had a high speed of advance, with a dive angle, theoretically calculated of almost 14-16° and an inclination on the left exceeding 40°.

Because the investigation commission of this accident was unable to question the main witness namely the passenger who survived, there were analyzed the following factors that might have contributed to the accident occurrence:

a) Engine operation manner;
b) Bearing rotor and tail rotor operation;
c) Intention to perform a flight at low height (razmut);
d) Environmental factors influence;
e) Pilot's temporary physical incapacitation.

For the analyzed scenarios there were also taken into account the following aspects:
- the passengers on board of this helicopter did not use the safety belts system;
- the pilot used only the abdominal safety belt;
- the passenger who occupied the right pilotage position, according to the witnesses statements, was a person who did not feel comfortable when flying.

I. Analysis of engine operation manner

In order to determine the engine operation condition at the time of the accident the most important information could have been given after inspecting module 5. Thus they passed to its disassembly and inspection.

The most important element is the inspection of the splined drive nut mounted on the first drive axle of the speed reduction gearbox. For the inspection of this nut it was necessary to demount the muff coupling which connects the free turbine shaft and the first drive shaft. This nut transfers the torque delivered by the free turbine through the muff coupling, towards the rotation elements in the reducer.

![Diagram of engine components]

**Fig. no. 71**
Thus it was removed the muff coupling in order to find the splined drive nut from the drive shaft. A close examination revealed that the nut rotated on the shaft with almost 3 mm.

This indicated the appearance of an overload in the kinematic chain of the drive. Misalignment between the two signs appeared when the engine encountered a significant increase of the resistance at the torque produced by it. The resistance increase of the torque is most likely to have occurred when the main rotor hit the water, at the time of the accident.

The next step was inspecting the combustion chamber using a borescopes to search for evidence that could point to a malfunction burning.

The boroscopes inspection of the combustion chamber revealed no discrepancies. Some blades of the high pressure turbine were partially covered with sediments, as a consequence of the time spent by the engine into the water after the accident.

After analyzing the evidence, it was noticed that the engine stop happened at 1-3 seconds after the impact due to water ingestion, which was also confirmed by the recordings of parameters in VEMD.

After correlating the events registered by the two units (VEMD and DECU), it was determined the time of the helicopter impact with the water - T0.

<table>
<thead>
<tr>
<th>Time</th>
<th>NG (%)</th>
<th>ΔNG (%/s)</th>
<th>T4 (°C)</th>
<th>NTL (%)</th>
<th>ΔNTL (%/s)</th>
<th>TRQ (%)</th>
<th>XPC (%)</th>
<th>Mode</th>
<th>DECU Mode</th>
<th>Engine control</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>90.9</td>
<td>+6.3</td>
<td>729</td>
<td>94.7</td>
<td>-52.7</td>
<td>56.9</td>
<td>53.9</td>
<td>Flight</td>
<td>Auto</td>
<td>Proportional</td>
</tr>
<tr>
<td>T0+0.3</td>
<td>94.5</td>
<td>+11.5</td>
<td>773</td>
<td>97.5</td>
<td>+60.3</td>
<td>38.6</td>
<td>53</td>
<td>Flight</td>
<td>Manual</td>
<td>EBCAU</td>
</tr>
<tr>
<td>T0+0.9</td>
<td>85.3</td>
<td>-24.6</td>
<td>708</td>
<td>95.3</td>
<td>-2.7</td>
<td>0.03</td>
<td>51.1</td>
<td>Flight</td>
<td>Manual</td>
<td>EBCAU</td>
</tr>
<tr>
<td>T0+2.7</td>
<td>31.9</td>
<td>-10.2</td>
<td>163</td>
<td>95.3</td>
<td>0</td>
<td>0</td>
<td>45.8</td>
<td>Flight</td>
<td>Manual</td>
<td>EBCAU</td>
</tr>
</tbody>
</table>

It is noticed the temperature variation of the combustion gases when exiting the combustion chamber (T4), which took place during 2.7 seconds and it decreases from 729°C to 163°C.

Even though the fuel shut off valve for emergency situations was found activated (red lever), the experience showed that in such situations, when auctioning this control the engine stops for 5-6 seconds.
Thus, after the engine detailed examination it was concluded that the engine was rotating and provided power at the time of the accident according to the operation program selected by the pilot through the gas-pitch lever.

Thus, both rotating handles of the pitch lever were in FLIGHT position. This is their normal position during flight.

II. Bearing rotor and tail rotor operation

It was examined the kinematic chain of the drive for the engine rotations towards the bearing rotor but also towards the tail rotor.

Thus, after the detailed analysis of the the kinematic chain of the drive of the engine-bearing reducer, the way in which the drive shaft but also the coupling flanges were affected by the accident, lead to the conclusion that the kinematic chain was destroyed due to an overload emerged during the contact of the bearing rotor blades with water, causing a sudden braking of the blades movement and an accumulation of energy in the kinematic chain.
Also when examining the drive of the engine – tail rotor (see “Examination of dynamic components”, pag 29, point 1.3.2, letter e) it was noticed that the frontal drive shaft (1) was disconnected from the intermediate shaft (2) after the engine movement on direction forward-backward when impacting the water.
From operational point of view, the loss of power at the level of the bearing rotor would have determined the pilot to take the specific measures for an emergency landing under autorotational conditions, which would have led to:

- taking the helicopter out of turn and ensuring a trim to prevent the rough contact with the lake surface;
- choosing as much as possible a landing field, avoiding landing on water;
- reducing the speed of advance and amortization of contract by returning with the general pitch control.

In addition, according to statistics on aviation accident investigation in which there were involved helicopters, in an autorotational landing, in the case of a rough contact with ground/water, there would have occurred major deformations of the cockpit lower side and/or cutting off the tail beam, deformations that are not present in this accident.

**III Environmental factors influence**

From the analysis of tables with sunrise and sunset hours, (Annex no. 1), calculated according to the geographic coordinates on site of the accident, for 29.07.2013, it appears that the sun rose at 6:00 and the it has set at 20:58, at almost 38 minutes after the accident occurrence and the azimuth of the sun was of 298°. The incidence angle, calculated according to the sunrise, sunset hours and when the occurrence took place, it was of almost 8° (180°-172°).

The lake in which the helicopter crashed was surrounded by reed beds with the height between 1-2 m.

The meteorological situation, estimated according to the data registered at Airport nearby (LRTM), at 20.00 LT (20 minutes before the accident):

- Covering=4/8
- Ceiling = 6000m
- Visibility over 10Km
- Temperature at 20.00= 25°C
- Wind direction = 260°
Wind speed = 3-4 m/s

Taking into account that there were no abnormalities in the helicopter operation and that according to the operational provisions on flight over water surfaces which require reaching and/or maintaining a sufficiently large height, so that in the situation of a special case, even the engine stop, the pilot shall have time for an autorotational landing, after performing the centering turn the pilot should have kept the climbing slope at least till the minimum height of 150 m, accepted in VFR flight conditions.

In the specialized studies on human performance and limitations in aviation it is stated that for the flights above water surfaces, at low height with low intensity wind, towards zero, in the direction of the sun or with the sun behind, and in the absence of adequate visual reference, due to sun reflection it is possible that the pilot shall not appreciate correctly height above the water surface.

This is also due to the reflection phenomenon, which can make someone judge incorrectly the position of an object reflected into the water.

The take-off was performed on a direction of almost 230°-240°, direction maintained till the beginning of the turn, continuing then on a direction of almost 105°-115° which means that during climbing he had the sun on the right side (50°-60°), and on descent even from behind.

By the red line it is represented the projection on ground of the helicopter trajectory.

The helicopter descent slope was calculated by the investigation commission taking into account that from the estimated position of the vertical of the place where
the turn began and till the accident occurrence place it was a distance in horizontal plane of 300-310m, and the height was of 35-45 m, and it resulted a value of approximately 6-8°.

In the given conditions, but most of all in conjunction with a possible stress condition induced by the reopening of the criminal case file in which he was involved, this might have led to the diminishing of the pilot attention and the failure of observing the descent, especially because the slope was constant, inducing either the idea of choosing an inadequate reference for the last part of the flight, or an inability of reaction at the time.

IV. Intention to perform a flight at low height (razmut);

The pilot, on his own initiative or at the beneficiary’s request could have performed a controlled descent in order to control the speed necessary to perform a tight turn, on the left side aiming to pass the vertical of the place in which there were the persons that led them to the helicopter or even performing a flight at low height over the water.

In both situations, the undesired descent as a consequence of the influence given by the environmental factor or the undesired descent, completed by the fact that the passenger situated on the front middle seat, corresponding to the second pilotage position, was not tied with the safety belts, it is possible that when it approached the water surface and eventually when the helicopter inclined on the left (beginning of turn), for increasing the personal safety that he might have looked for support points which thus may have led to a temporary bloking of the general pitch control or even to its enabling downwards.

This in conjunction with the helicopter high speed of advance and with its position towards the water surface might have led to the impossibility of handling the helicopter by the pilot for a very short period of time, but enough to occur the impact with the water surface.
The investigation commission considers that the deformations of the right pilotage position stick (almost 15 degrees) are a consequence of the passenger (untied with the safety belt) projection forward, over it, at the time of the helicopter impact with the water.

V. Physical incapacity

From the witnesses’ statements it appears that the pilot, after being informed by the beneficiary that it was reopened the criminal investigation file in which the two were charged, he was very affected. Noticing the general stress condition caused by this information, the factory director offered to ensure the helicopter parking and the transport by vehicle of both the passengers but also of the pilot to Tg. Mureș. It was insisted on this proposal until the moment the beneficiary took the firm decision to turn back by helicopter.

Taking into account the fact that the pilot, as it results from the characterization made, was a very rigorous pilot in complying with the regulations, especially the company internal procedures, the mode of action described above shows that he was very concerned about other issues, probably personal. This would explain the rush of performing the mission without taking into account the boarding conditions of the passengers and especially imposing and checking the safety belt binding, but also of accepting a passenger on the second pilotage position.

Additional arguments concerning the way of performing the flight missions emerge also from flight analysis, based on the data contained on GPS, for the flight Tg. Mureș-Tăureni, in the same day, showing that the flight was performed maintaining an almost constant height, without deviation from the established trajectory.

This mental pressure on a possible sentencing might have led to diminishing the attention or even to a physical incapacity of the pilot’s reaction.
3 CONCLUSIONS

3.1 Findings

- the pilot was licensed and qualified for flight according to the regulations in force;
- at the time of the accident, the pilot’s medical certificate was valid;
- the pilot performed many flights from the flight field in Tăureni;
- according to the forensic report, the pilot did not use alcohol or prohibited substances;
- the records on maintenance reveal that the helicopter was equipped and maintained according to the regulations and procedures applicable for this aircraft type;
- the helicopter was not equipped with flight parameters recorders (FDR and CVR). The equipment with these recorder types is optional according to the regulations in force;
- the helicopter weight and balance were in the admitted limits;
- on board of the helicopter it was enough fuel to perform the flight mission;
- the weather conditions were optimal to perform the flight activity;
- it was no fire on board of the helicopter after he impact;
- the quality of the used fuel and oil correspond to the manufacturer’s provisions for Arriel 2B1 engine;
- there were no elements indicating a malfunction or an abnormal operation of the helicopter engine before the impact;
- there was no evidence on a structural failure or a malfunctioning of the helicopter systems/subsystems before the impact with the water surface;
- the control of the splined drive nut of the gearbox shaft MO5 revealed the fact that it rotated with almost 3 mm, thus indicating that the engine supplied power at the time of the accident. This is in accordance with the breakage of the drive shaft, which connects the engine with the main gearbox;
- the blades deformations are compatible with a strong impact of them with the water surface, with an uneven distribution of loads, followed by a helicopter roll into the water;
- the engine output flexible coupling presented a deformation, but without any malfunction, which is compatible with a sudden stop of the engine, which in its turn is compatible with an aircraft overturning into the water;
- the servo-actuators and the hydraulic circuit were in their place, in good conditions, correctly connected and freely moved;
- after the initial impact with the water surface the helicopter was projected at almost 50-60 m;
- both rotating handles of the pitch lever were in FLIGHT position;
- the engine turn on button was in „On” position (normal situation during flight);
- the fuel shut off valve (red lever) was enabled, but it is evidence that this was due to the accident or to the wreckage recovering.
- the pilot was informed on the reopening of an older corruption in which he was charged;
- except the pilot, none of the passengers wore the safety belts system;
- the pilot did not use the back safety belts, he had on only the abdominal belt;
- the descent towards the water was made on a continuous downward slope till the impact with the lake water;
- during descent to the lake mirror the sun was positioned behind the helicopter at an incidence angle that was close to the landing slope angle;
- the second pilotage position was occupied by a passenger;
- in MO of the operator it is specified that the second pilotage position shall remain free.

3.2 Causes of accident occurrence

The most likely cause of the accident occurrence is incorrect assessment of height from the water surface or the pilot's physical incapacity of reaction.

Favoring causes:
- a) stress condition, temporary physical incapacity;
- b) not using the safety belts systems that the helicopter seats were equipped with;
- c) twilight flight over the water.

4 RECOMMENDATIONS

The investigation commission doesn’t issue safety recommendations.