

FINAL REPORT

on

investigation of an aviation occurrence with An-2 aircraft, registered LZ – 1178, operated by air operator „Kapoli Air”, occurred on 11.04.2006 during a flight for aerial works in the Kozlovets village area, Municipality of Svishtov



The materials about the aviation occurrence have been classified under state file number 03/11.04.2006 in the archives of the Aircraft Accident Investigation Unit (AAIU).

Air Operator (AO): Kapoli Air with main office in the town of Byala, 5 General Arnoldi Str. and Air Operator Certificate (AOC) No BG 413, issued by Civil Aviation Authority (CAA) on 07.03.2001 and valid until 07.09.2006.

Aircraft Manufacturer: MAP, USSR

National and Registration Marks: LZ-1178, according Certificate for Registration No 1634, issued on 15.01.2002 by the Civil Aviation Authority.

Place and Date of Aviation Occurrence: The aviation occurrence occurred during the twelfth flight of the day for aerial works on 11.04.2006 at 15:55.

The aircraft hit the ground during a turn and was destroyed, and a fire emerged. As result of the fire, the fore part of the aircraft was destroyed. The commander and a person onboard died. A child being in the cockpit was seriously injured and was hospitalized in a hospital in Pleven.

Notified: Aircraft Accident Investigation Unit (AAIU) at the Ministry of Transport of Republic of Bulgaria, Civil Aviation Authority (CAA) and International Civil Aviation Organization (ICAO).

In accordance with Para.3, p.2 letter (a) of Additional Provisions to Civil Aviation Act and Para.3, p.1 letter (a) of Additional Provisions to Regulation No 13 of the Ministry of Transport of 27.01.1999 about the aircraft accident investigation and on the base of Article 9 of the same Regulation, the aviation occurrence was classified as an accident.

A commission for investigation of the aviation occurrence was appointed with an order RD-08-172/13.04.2006 of the Minister of Transport.

1. Factual Information

1.1 History of Flight

An-2 aircraft, reg. LZ-1178, was ferried from the Air Operator's airfield in Byala to temporary airstrip at village of Kozlovets, from which the aerial works started on 09.04.2006 for agricultural fields in the village of Tsarevets area and village of Kozlovets, Municipality of Svishtov.

On 10.04.2006 An-2 aircraft reg. LZ-1178 was located on the airstrip at village Kozlovets, Municipality of Svishtov, from which the aero-chemical flights (ACF) should be performed for the needs of local cooperative farming. General view of the aircraft before the accident is shown on Figure 1 of Enclosure No 1.

1.1.1 Flight Number: Aviation accident occurred during the twelfth flight for ACF for the day on 11.04.2006.

1.1.2 Preparation and description of the flight:

On 11.04.2006 the aircraft commander came at the airstrip at village of Kozlovets at about 09:00 and accepted the aircraft from the aircraft technician, refueled with 400 l gasoline

(according the record in monthly book) and after that moved the aircraft to the chemical charge stand, where the aircraft was loaded with 1350 l of chemical (herbicide).

According the technician's information, the first flight started at 09:15. The crew was incomplete. There was no copilot onboard.

After the fourth (at 11:00) and after the tenth flight (at 13:30) the aircraft was refueled with 200 l of gasoline.

At the airstrip after the 11th flight for AW two outsiders climbed on board with aircraft commander's permission, who were not crew members and the twelfth flight was performed with them.

One person, 11-year schoolboy, took the right-hand seat in the cockpit and the other person stayed upright between the two pilot seats.

The aircraft took-off from the temporary airstrip and headed for treatment of an agricultural field, situated behind a height relatively to the place of the temporary airstrip.

After the end of spraying of the first plot during the left-hand turn at very low altitude the aircraft collided with the ground in a heading of 310°.

As a result of the collision the construction was destroyed, the aircraft turned around the left-hand wing to 180° from the flight direction, a spilling of fuel and oil emerged and a fire blow up, which destroyed the fore part of aircraft fuselage.

The commander and the person standing between the pilot seats received fatal injuries and the child in the right-hand pilot seat was seriously injured and was hospitalized in the town of Pleven.

1.1.3 Location of the Aviation Occurrence

The aviation occurrence occurred in an agricultural field in the area of village of Kozlovets, Municipality of Svishtov at a place with coordinates: N43°28'49" and E025°18'59". Elevation of the accident place is 193 m.

A general view of the location of the accident, the place of accident and the location of the temporary airstrip are shown on scheme No 1 and scheme No 2 of Enclosure No 2.

1.2 Injures to Persons

1.3

Injures	Crew	Passengers	Others
fatal	1	1	0
serious	0	1	0
minor/none	0	0	0

1.3 Damage to Aircraft

On the place of accident the commission established the following destructions of the aircraft:

- a) On the aircraft structure:

- lower left-hand wing was destroyed into two parts with visible signs of warp and scorch of the stiffening ribs of the wing structure and entirely burnt wing skin on the part of the lower wing, which was in the fire area.
- upper left-hand wing was destroyed and in result of the collision in the ground it was divided into two parts with totally burnt wing skin. All stiffening ribs of the wing structure had visible signs of warp and scorch. Some of the stiffening ribs were destroyed by the hit and fire;
- outer part of the leading edge of the upper left-hand half-wing was deformed and with traces of burn. The fore and aft spars of the outer part of the wing were intact;
- there was a deformation by an impact at the end of the slat of the upper left-hand half-wing;
- the second half (inner one) of the upper left-hand wing was destroyed by the impact and fire. Part of fore spar and parts of load-bearing ribs of the wing structure were entirely destroyed. Part of the aft spar was heavily burned;
- aircraft fuselage was divided by the impact into two parts;
- the cockpit and the fore part of the aircraft, where the tank of spraying system was installed, were fully destroyed by the impact and the subsequent fire emerged;
- the aft part of the fuselage retained its structural integrity. In its fore part a part of the lower left-hand half-wing was found with heavy deformations and traces of scorch on the load-bearing ribs. The skin on the upper surface of the lower left-hand half-wing was relatively extant, but with deformation by the impact. The skin of the lower surface was fully destroyed by the fire;
- the right-hand half of the horizontal stabilizer was detached from the fixing assembly and destroyed by the impact and the fall of the aft part of the fuselage;
- the left-hand half of the horizontal stabilizer together with the strut retained their structural integrity;
- the fin retained its structural integrity;
- the lower right-hand wing was fully destroyed by the impact and the following fire, excluding a small section in the strut area connecting upper and lower right-hand wing. This part was with heavily deformed load-bearing ribs and scorched by the fire;
- the skin of the two surfaces of the upper right-hand half-wing was fully burnt by the fire;
- the load-bearing ribs of the vertical strut area, connecting the lower and upper right-hand -wing to the wingtip didn't lost their stability;
- in the wing root section area at the vertical strut, connecting the lower and upper right-hand wing, the two wing spars were destroyed and the slat and flap were also destroyed;
- main landing gears were detached from the fixing assemblies. The tire of the left-hand main gear was burnt.

The general view of the destroyed aircraft is shown on Figure 1 and Figure 2 of Enclosure 1.

b) on the aircraft powerplant

- the engine mount was destroyed and the engine mount was detached from the fixing assemblies of the airframe;
- the blades of the propeller were deformed by the impact into the earth;

The wrecks of the powerplant are shown on Figure 4 of Enclosure 1.

The aircraft was completely destroyed.

1.4 Other Damages

There was a spillage of chemical solution, fuel and oil around the accident site. There were no other damages as a result of the aviation occurrence.

1.5 Personnel Information

1.5.1 Commander – male, aged 41, holding a valid license and medical certificate.

1.6. Aircraft information

1.6.1. Airworthiness information

An-2 airplane, serial number 117417, reg. LZ-1178 was manufactured in 1962 by MAP-USSR, it has Certificate for Registration No 1634, issued by CAA on 15.01.2002 and it has Certificate of Airworthiness No 1634, issued by CAA on 05.02.2002, revalidated on 30.03.2006 and valid till 29.03.2007.

The aircraft has accumulated till 10.04.2006 9798:33 hrs and 49726 cycles since new. The last (sixth) aircraft overhaul was certified on 06.12.2001. After it the aircraft has flown 265:04 hrs. In accordance with the approved by CAA Maintenance Program of Kapoli Air Air Operator, Part III, Life-limiting Instructions, the life of the aircraft airframe was 16000 hrs and the time between overhauls after the sixth overhaul was 1600 hrs. As of the moment of the aviation occurrence the remaining general life of the aircraft was 620:26 hrs and the life between overhauls was 1334:54 hrs.

An engine Ash-62IR of 16th series, serial number K1611895, produced on 02.06.1978, was installed on the aircraft. As on 10.04.2006 the engine has accumulated 4851:51 with total life of 6200 hrs, without limitation of the calendar time of operation. The engine has accumulated 639:14 hrs since overhaul with time between overhauls of 1000 hrs. The last engine overhaul was certified on 06.05.1991. As of the moment of the aviation occurrence the remaining life of the engine was 1348:09 hrs and the life between overhauls was 360:49 hrs.

A propeller AV-2, 2nd series, serial No N056190264 was installed on the aircraft. As on 10.04.2006 the propeller has accumulated 6770:19 hrs since new with total life of the propeller 8000 hrs. The propeller has accumulated 270:19 hrs since overhaul and the time between overhauls is 1500 hrs. The last overhaul of the propeller was certified on 06.12.2001. As of the moment of the aviation occurrence the remaining life of the propeller was 1229:41hrs and the remaining time to the next overhaul was 1229:41 hrs.

From the abovementioned, the conclusion might be done that the airframe, engine and propeller of the An-2 airplane, registered LZ-1178 had the necessary life for flights.

The line maintenance of the aircraft was performed by Maintenance Organization of AO and the base maintenance was performed by Aircraft Overhaul Plant EOOD in the town of Montana on the base of a contract, enclosed to the Air Operator Maintenance Program. The last maintenance was certified in the aircraft technical log on 27.03.2006 and it included: F 180; F 360 and PSSO (preparation for Spring & Summer Operation). There is a Certificate of Release to Service No 04/27.03.2006. The check was performed at aircraft base in Byala by the plant's representatives.

A preflight check was performed before the flights on 11.04.2006 and it was registered in the monthly logbook. There were no failures registered during the check. There were no written notes and defect recorded between flights. No such works were established also during the

post-flight check, performed on 10.04.2006. Two refueling with 200 liters each and an oil refill with 10 liters of oil were performed on 11.04.2006.

On the base of aforementioned, the conclusion might be done that the aircraft was airworthy and prepared for the flight before the twelfth flight.

A replacement of 1st, 9th and 4th cylinders was registered in the monthly log book for preflight and post-flight checks on 08.04.2005, 24.04.2005 and 11.05.2005 respectively. These replacements weren't registered into the Engine Logbook. The reason for replacements also wasn't written. The installation of a plug into the carburetor altitude corrector according p.3.00.3 of An-2 aircraft Airplane Maintenance Manual during the PSSE wasn't registered in the Engine Logbook.

1.6.2. Aircraft performance

According the Certificate of Airworthiness of the aircraft No 1634 the maximum take-off weight is 5250 kg. Aircraft empty weight is 3460 kg.

Two outside persons stepped in the aircraft for the twelfth flight and the weight of people on board was about 240 kg. There was about 200 l of fuel and about 900 l of herbicides, what meant a take-off weight of the aircraft about 4520 kg and the center of gravity was within the operational limits.

Some of most important flight data of An-2 airplane in agricultural variant:

- maximum speed at low altitude – 220 km/h;
- operational speed 150...160 km/h;
- maximum allowable bank during the turn – no more than 30° and during turns over forest and ravines – no more than 20°.

1.6.3. Fuel

According the aircraft's Monthly Logbook, on 11.04.2006 the technician refueled 400 l aviation gasoline type 91.

Consequently, the aircraft was refuelled after the fourth and after the tenth flight with 200 l aviation gasoline type 91 in each case.

As result of the impact, structural destruction and the fire emerged, the commission wasn't able to take fuel samples for examination from the aircraft.

The fuel sample from aircraft pre-flight check and fuel from the barrel for aircraft refuelling were taken for examination.

Chemical Laboratory for Fuels and Lubricants at Sofia Airport examined the two samples of fuel.

According the Examination Report No 283, enclosed to the file materials, the sample taken by the Commission for the investigation of the accident from the refueling barrel didn't correspond to the requirements of ASTM 910-2004 standard on "end boiling point" index.

According the Examination Report No 284, enclosed to the deed materials, the sample of fuel sediment taken during the preflight check didn't correspond to the requirements of ASTM

910-2004 standard on “end boiling point” index, there was a raised content of tetraethyl lead and there were mechanical impurities.

However, the sample taken met the requirements of GOST-1012-72 standard. This type of fuel with parameters corresponding to the requirements of GOST-1012-72 is recommended by the powerplant manufacturer.

1.7. Meteorological information

According the analyses prepared by local meteorological station of Air Traffic Control State Enterprise as at 15:00 on 11.04.2006 the weather in Svishtov area was as follows: temperature +19°C, calm (no wind), visibility 20 km, cloudiness 8/8, cloud base 2500 m, QNH=1008.2 hPa.

According the Commission estimation, the weather was not relevant to the aviation accident.

1.8. Aids to navigation

Standard navigation aids for An-2 aircraft. No ground navigation facilities were used during the AW flight.

1.9. Communications

During the work the pilot didn't maintain two-way radio communication with Air Traffic Control.

The pilot maintained mobile telephone communication with the Flight Information Service Centre, to which he reported for the start of AW.

In a message about an aviation incident, received in the day before the aviation occurrence, received by Air Traffic Control State Enterprise, there was a registration about LZ-1178, whose commander didn't report about the end of work.

1.10. Airport

The AW flight for the agricultural cooperative farming in Kozlovets village was performed from temporary landing strip in the Kozlovets village area, which was a smooth meadow with a length of about 580 m.

The aviation accident emerged by an impact into the ground out of the temporary landing strip at Kozlovets village.

1.11. Flight data recorders

N/A

1.12. Wreckage and impact information

On the place of aviation occurrence, the investigation commission established the presence of two parallel traces from the first touch of the aircraft to the ground by the spraying system stem and upper left wing of the aircraft with a distance between them of 2.80 m. The traces were at a distance of 60 m from the main impact of the aircraft on the ground in a heading of 310°.

At a distance of 15 from the place of first touch the commission discovered Pitot tube from the left wing, embedded into the ground and torn out from its attachment point, which was on the strut, connecting the lower and upper left wing.

At a distance of 19 m from the place of first touch to the ground, the commission located a hole obviously left by the left-hand landing gear.

At a distance of 23 m from the place of first touch, the commission detected a pit with specific traces from the engine work and many fragments from the engine cowling.

The general layout of the traces along the aircraft flight direction after the first touch to the ground is shown on Figure 5.

The aircraft stopped at heading of 130°, at a distance of 60 m from the place of first touch to the terrain and the tail unit was lied down on the starboard. The distance between the first touch to the terrain to the cockpit burnt was 49 m.

Along the whole length of the traces the commission established the presence of many fragments from the landing lights glazing of the lower left wing and pieces of spraying system stem nozzles.

At the right-hand side from the aft part of aircraft fuselage (looking along the aircraft flight path, which coincided with the inspection direction) the upper left wing was found out, and it was split into two parts and the skin was burnt entirely and the ribs had traces of warps as a result of stress or were destroyed.

The right-hand half of the horizontal stabilizer together with its strut was destroyed by the impact and it was under the aircraft fuselage. The vertical stabilizer and the left-hand half of the horizontal stabilizer, together with the strut, were preserved.

On the left-hand side of the aircraft fuselage (looking along the aircraft flight direction, which coincided with the inspection direction) the upper right-hand of the aircraft wing was found, turned to 90° against its structural position in the aircraft assembling. The skin of the two surfaces of the wing was burnt entirely. The commission established destruction of the fore and aft spars, slat and flap in the wing root section area, at the strut, connecting the lower and upper right wing. The load-caring ribs in the area from the strut to the wingtip didn't lose their stability, but they were heavily burnt. The general view of the upper right-hand half-wing is shown on Figure 6.

The aircraft engine was found just afore the right wing at a distance of 3.60 m of it and a distance of 45.4 m from the first touch on the terrain. As result of the ground impact the engine mount was destroyed and the engine was detached from the aircraft structure and came to rest on the propeller under it, the hub embedded into the ground, what was an evidence that the propeller kept on rotate after the engine detachment from aircraft construction and came to a rest at the position, in which the commission found it.

The four blades of the propeller were deformed with traces of soil on them. Traces of oil spill and burning of the aft part, which was affected by the fire, emerged after the ground impact, were found on the engine.

Immediately between the engine and the upper right-hand half-wing the commission found out parts of the cockpit glazing, which were blown out by the impact and didn't burnt in the fire.

The cockpit and the aircraft fore part were totally destroyed by the impact and the fire emerged.

The commission found out some gauges in the seat of fire, including a compass (showing heading of 248°) and the indicator of directional gyroscope. All other instrumentation was totally burnt and it was impossible to take the readings. A photo of the compass is shown on Figure 7.

The commission found out also a digital photo-camera in the cockpit area, which was visibly safe and it was taken by the investigators in order to recover the information on it. The commission established that the camera was of the child, occupying the right-hand seat in the cockpit.

The nature of the traces on the terrain, the inspection made and the analyses of the wreckage and their placement on the place of the aviation occurrence permitted the commission to make the conclusion, that there was no reason to assume in-flight destruction of the aircraft. The first touch of the aircraft on the ground occurred with the left-hand part of the spraying system stem and the upper left-hand half-wing, during a left turn with left bank. The touch of the left-hand part of the spraying system stem and the upper left wing caused a rotation of the aircraft around the vertical axis. As a result of this rotation of the aircraft during the **left turn** the left-hand landing gear met the ground and the aircraft nosed-over. As a result of the impact and the aircraft speed and due to the falling of the all aircraft weight on the engine, the engine mount was destroyed at the attachment points and the engine was separated from the aircraft.

After the engine separation the aircraft met the ground with the right wings, which fixing assemblies to the fuselage were destroyed by the impact, after that the tail unit met the ground and the fore part of the fuselage and right-hand half of the horizontal stabilizer were destroyed. The aft part of the fuselage stopped on its starboard in heading of 130°.

The wreckage of the aircraft is described in Para.1.3.

In result of the tearing of the tanks in the wings and the fuel lines destruction a fire occurred, which was localized in the fore part of the aircraft and resulted in total destruction of the cockpit and the fore part of the aircraft.

1.13. Medical and pathological information

According to the forensic medical examination made in the hospital in the town of Svishtov on order of District Investigation Service of the town of Veliko Tarnovo and certified by a protocol, the death of the aircraft commander was a result of heavy complex blunt brain, pectoral and abdominal trauma, led to injuries of internal organs, incompatible with life.

A copy of the protocol of the forensic medical examination performed is enclosed to the file materials.

The blood analysis didn't show a presence of alcohol or intoxicants.

According to the forensic medical examination made in the hospital in the town of Svishtov on order of District Investigation Service of the town Veliko Tarnovo and certified by a protocol, the death of the passenger was a result of heavy complex blunt pectoral and

abdominal trauma, led to fractures of ribs and rupture of the left-hand half of the lung and blood pouring into the thorax.

A copy of the protocol of the forensic medical examination performed is enclosed to the file materials.

During the examination of the bodies a heavy ruptures at the left-hand side were established, confirming the hypothesis that the first impact came from the left-hand side of the flight direction.

1.14. Fire

As a consequence of the impact of the aircraft into the ground a rupture of fuel tanks, fuel lines and oil lines emerged and a fire originated from it.

The presence of highly inflammable fluids in the aircraft wings and fuselage area, as well the nature of the aircraft impact into the ground described (Para.1.12) assumed that the fluids should splash the cockpit.

The commission established at the accident site, that the fire started in the fore part of the aircraft, where the fuel and oil had burnt.

The fire resulted into a total destruction of the cockpit and aircraft structure elements, what was described in details in Para1.3.

According the explanations of the witnesses of the accident, for fire extinguishing in the cockpit area was used a car extinguisher (foam based), which wasn't effective because of presence of highly inflammable fluids.

The commission didn't establish use of on-board extinguishers.

The fire lasted about 40 min and finished before the arrival of firefighting vehicle from the town of Svishtov. After the fire vehicle arrival no extinguishing means were used.

1.15. Survival aspects

According to the witnesses' explanations, the first persons arrived on the place of the aviation accident were there about 10-15 min after the occurrence, when the aircraft was burning intensively.

The child, who was seated in the right-hand seat in the cockpit according his and witnesses explanation, was thrown out by the impact out of the fire area and had received serious injures. He was removed by a witness to a safe distance from the fire.

At a distance of about 1 m from the aircraft engine the heavily burnt body of the aircraft commander was found and in the cabin door area – the body of the second person.

About 10-15 minutes later a car with four persons in it arrived and the car extinguisher was taken from this car and an unsuccessful attempt for extinguishing of the body of the second passenger was made.

The car driver called a fire vehicle about 10-15 minutes after the accident.

The distance between the town of Svishtov and the accident site (15 km), as well the relatively complex terrain for the fire vehicle to access the accident site influenced negatively the time of arriving of the fire vehicle, which arrived about 40 min after the accident according the witnesses information, when the cockpit area was burnt entirely and when the use of extinguishing substances wasn't necessary.

An ambulance arrived about 20 minutes after the accident and it transported the child, who suffered serious injures, to the hospital in the town of Svishtov.

It was impossible for the commission to determine whether the aircraft commander had fastened the safety belts because of the full incineration of the cockpit.

The child in the right-hand pilot's seat didn't use safety belts according to his explanations.

1.16. Tests and research

For the purposes of technical investigation the commission preformed the following:

- inspection of the accident site – examination and photographing of the traces on the accident site; examination and photographing of the aircraft wreckagees and their layout on the place of air accident;
- taking explanation from the child survived the accident;
- taking explanation from the witnesses of the accident;
- taking explanation from the AO manager, AO chief pilot and the engineer, responsible for aircraft maintenance at the airstrip near the village of Kozlovets;
- investigation of the AO documentation related with the operation and maintenance of the aircraft;
- examination of fuel sample, taken during the pre-flight check of the aircraft for conformity with the standard requirements;
- examination of the fuel samples, taken from the refuelling barrel at the airstrip near Kozlovets;
- examination of the airstrip near Kozlovets, where the pre-flight check was fulfilled;
- examination and measuring of the characteristic dimensions of an aircraft of the same type;
- examination of the photo and video materials from the card of Canon A400 camera.

2. Analysis

The facts available, the results of the examinations and studies, as well the explanation of the persons having any relations to the aviation accident were the base for the following analysis:

2.1 On flight organization

The flights for herbicide spraying of ure agricultural fields of the cooperative farming in the village of Kozlovets, municipality of Svishtov, were organized on the base of verbal agreement between the manager of Kapoli Air Air Operator (AO) and the chairman and the agronomist of the “Zemedelets 93” Agricultural Cooperative Farming. During the negotiation the fields to be sprayed, the time and the payment were agreed.

On the 09.04.2006 in fulfillment of the agreement on the base of verbal order of the AO manager An-2 airplane, reg. LZ-1178 with a crew consisting of the aircraft commander and mechanic was positioned on the temporary airstrip at the North-East end of the village of Kozlovets.

In accordance with order No RD-08-361/27.11.1987 of the Minister of Transport, issued on the ground of Article 38 of Civil Aviation Act, Flight Operation Manual and in order to enhance the flight safety, for fulfillment of this flight mission for aerial works (AW) - herbicide spraying – the aircraft crew should include two pilots in one of the variants, included in the order.

During the inspection of the flight organization and AO documentation the commission established that the air operator has no copilot in his staff list and there was no labor contract with a copilot appointed as a second member of the crew, what created real conditions for violation of the abovementioned order and the safe conditions for flight execution.

2.2 On preliminary and pre-flight preparation

It was clarified from the aircraft Monthly Logbook, that on 03.04.2006 a pre-flight check was performed and during it oil filters were cleaned and the aircraft was refueled with 200 l air gasoline. During the post-flight check of the aircraft and the engine oil hoses were replaced, and the hose to the fuel system sensor was also replaced.

On the same day the aircraft commander, involved in the accident, fulfilled preliminary and pre-flight preparation for flights in order to restore the flying skills after lay-off and to check the flight proficiency.

The total flight time was 02:43hrs with 7 cycles.

The flight proficiency check was fulfilled with a rating “passed”.

On 04.04.2006 the commander has passed a training on a simulator on Task No 5.

On 05.04.2006 the validity of his license as a commander of An-2 airplane and agro-pilot 1st class was extended by an application No –1213/05.04.2007.

On 09.04 and 10.04.2006 the commander fulfilled flights for spraying with herbicides of the fields in the village of Tsarevets area, municipality of Svishtov, and he flew the aircraft alone, with incomplete crew.

On 10.04.2006, the aircraft commander fulfilled several flights for herbicide spraying from the airstrip at Kozlovets and he flew the aircraft alone, without copilot.

On 11.04.2006 at 08:00, the mechanic started pre-flight preparation of the aircraft for AW during the flying day.

The preliminary and pre-flight preparation of the pilot for the flights on 9.04, 10.04 and 11.04.2006 wasn't documented in the aircraft logbook, there were no records and sketches for the flights fulfilled, what was a violation of Article 47, Para.1, p.1 of Regulation No 6 of the Ministry of Transport and Communications of 14.06.2001.

No records for failures on the aircraft systems or deviations of the engine parameters were found from the previous day.

The mechanic checked the oil quantity (82 l) and refilled the aircraft with fuel – 200 l aviation gasoline type B91. The total fuel quantity in the aircraft was 500 l.

At 08:45 the mechanic started and checked the engine in various regimes according the regulations. The engine parameters were within limits and the engine worked without any remarks.

At 09:00 the aircraft commander accepted the aircraft and certified its running order and engine running order by a signature in the Monthly logbook.

2.3 On the flight execution

On 11.04.2006 at 09:15 the aircraft was filled up with 1350 l of herbicide solution.

At 09:15 the aircraft commander took-off in solo flight, with incomplete crew, without copilot, and executed four successive flights without any remarks to the aircraft and engine.

After the 4th flight at 11:00 the mechanic refueled the aircraft with 200 l air gasoline, the commander executed 6 flights more.

After the 10th flight, at 13:30, the mechanic checked the oil and refueled the aircraft with 200 l of gasoline.

The eleventh flight was executed by the pilot without any remarks on the aircraft and engine.

For the 12th flight for the day the aircraft commander permitted two outside persons to board the aircraft: a 22 years old man and 11 years old child.

The commission established that the child was seated and sat during the flight till the aviation accident emerging in the right-hand pilot's seat.

During the take-off and the flight the child wasn't fastened with the safety belts.

The young man was standing behind between the two seats.

At 15:05 according the information of immediate witness, An-2 airplane, registered LZ-1178, executing a left turn with a considerable bank at an altitude of 5-10 m according the witness assessment, hit the ground with the left wing and crashed, a fire emerged.

The commander and the young man died.

At the impact the child was thrown out from the cockpit with serious injuries.

At 22:20 the Aircraft Accident Investigation Unit in accordance with Article 10, Para.2 of Regulation No 13 of the Ministry of Transport about aviation accident investigation started a detailed inspection and facts establishing on the accident site. The traces from the different parts of aircraft left on the ground were fixed and analyzed in their sequence, the traces, the consequences and the remains of the fire, the components and aircraft structure elements were collected and examined.

Discussions were conducted and written explanation were taken from the AO manager, witnesses and eyewitnesses of the accident.

During the inspection the commission found out in the remains of the destroyed and burnt cockpit slightly burnt digital photo-camera Canon A400, owned by the child, who occupied the right-hand pilot seat.

After conducting of the necessary actions in the specialized laboratory it was established that the memory card of the camera has saved ten (10) pictures and six (6) video-clips, made before and during the flight.

An inspection was made about the presence and the actuality of the AO documents about the organization and execution of the flight and production activities and technical servicing.

A laboratory examination of the fuel, which was refueled in the aircraft, was performed.

On the base of the facts and circumstances of the aviation accident and the results of investigation and analysis and after rejecting the endmost and the least possible versions, the commission adopted as a possible four (4) main versions for establishing of the causes for the aviation accident:

- aircraft control system failure;
- engine failure;
- inadvertent intervention in aircraft control;
- human factor influence and violation of the flight rules.

On the first hypothesis:

The commission established, that as to the moment of the aviation accident the aircraft, aircraft systems, engine and propeller were airworthy and with the necessary life for the execution of the flight.

There were no records in the aircraft documentation and the Monthly Logbook, reflecting any problems concerning the aircraft control at any stage of the flight.

The examination of the aircraft flight path before the first touch to the ground by the commission didn't revealed any elements of the aircraft control system, which may evidence for disruption of the structural integrity and sudden emerging of a problem.

Relatively intact middle part of the fuselage and tail unit of the aircraft permitted the commission to make an inspection and to check the condition of the control cable of horizontal and vertical control surfaces (elevator and rudder). The cable was saved and it conveyed the movements through the connection lines to the control surfaces of the aircraft elevator and rudder, what presupposed the possibility for aircraft control along the longitudinal (lateral axis Zi) and yaw (vertical axis Yi) control channels.

The fore part of the aircraft and the two wings were heavily burnt and there was no possibility to trace the rigid coupling to the ailerons and to check the bank control (horizontal axis Xi) channel.

The commission established from the testimony of the child on the right-hand pilot seat that before the hit into the ground there were no signs in the cockpit or conversations of the pilot, which might give a hint for control problems.

The abovementioned facts give the commission grounds to assess as unlikely the hypothesis considered about a failure of aircraft controls.

On the second hypothesis:

The commission established in the aircraft Monthly logbook for the period between January – December 2005, that on 09.04.2005 the first cylinder was replaced, on 24.04.2005 the ninth cylinder was replaced, and on 11.05.2005 was replaced fourth cylinder. From the last date till the day of the accident there was no records in the Monthly logbooks about emerged and repaired failures in the engine operation.

The witness spoke that the aircraft engine was working before the aircraft hit into the ground. For the commission the cutting traces left by the propeller on ground surface immediately after the wing impact were an evidence that the engine was working and the propeller rotated with operational frequency. This contestation was supported by the direction and the magnitude of bending of the propeller blades, Figure 4 of Enclosure No 1.

The laboratory examination of the fuel sample from the aircraft and the fuel from the barrel for refueling showed that the fuel used was aviation gasoline type B91, prescribed by the manufacturer for operation of Ash-60IR engine of An-2 aircraft.

As to the moment of the occurrence the remaining life of the engine was 1348:09 hrs and the remaining time between overhauls was 360:49 hrs.

During the inspection of the place of aviation accident the commission made the conclusion, that in case of suddenly emerged problem with the engine, the terrain allowed the commander to make forced landing which was a trained emergency procedure.

During the analysis of the video-clips recorded some minutes before the aircraft impact into the ground the commission established problem-free operation of the engine.

The stated facts and circumstances gave grounds to the commission to conclude that in-flight engine failure was improbable as a reason for the air accident.

On the third hypothesis

The analysis of the character of the flight at the final stage and taking into account there were no conditions for creating of acceleration with sharp change of direction and sign (plus - minus) and accepting the explanation of the child occupying the right-hand pilot seat during the flight, there were no conditions and there were no actions until the aircraft impact into the ground, which might suppose unintended interference in the aircraft control.

The commission considered this hypothesis as a improbable and as a result of the analysis made it didn't find any evidences, to confirm or to permit the assumption that this should be possible a possible cause for the aviation accident.

On the fourth hypothesis:

The minimum crew for AW is defined in An-2 airplane Aircraft Operation Manual (AOM), Chapter 1 – aircraft commander and co-pilot.

By a note the AOM gives the possibility to the Ministry of Transport to specify the crew for different types of ACW.

The Minister of Transport by its order No RD-08-36/27.11.1987 defined the minimum crew of An-2 airplane for all types of AW, except AW for fertilization: crew of two pilots.

The abovementioned compulsory requirements are connected with the distribution of functions and obligations of the particular crew members during the flight and the necessary level of safety should be realized.

During the inspection performed the commission established that AO has no labor contract with a licensed co-pilot, who should perform the functions given in the An-2 Aircraft Operation Manual (AOM), Chapter 7.

Non-complying with these mandatory requirements by AO and degraded control created conditions for violation of the flight rules, led to the possibility to execute flights by the aircraft commander for herbicides spraying in shortened crew, what was a violation of the abovementioned requirements, respectively violation of the safe flight conditions.

In Chapter 5 of Aerial Works Instruction, p.5.5 - Rules for Execution of Flights, it is said that “the flight altitude should be determined in accordance with the technology of execution of the type of works”, which is between 2 and 5 m for herbicides spraying.

In An-2 airplane AOM , Chapter 7, “Peculiarities of airplane operation in agricultural variant”, p.3, it is written: “The impairment of aerodynamic characteristics of the airplane, equipped with agricultural gear, and also the low altitude flights and execution of large number of evolutions at these conditions require by the flight crews raised attention to the piloting and perfect execution of each element of the flight. The airplane is considerably more inert in this variant, especially with liquid chemicals and for preserving of the specific flight regimes (speed, altitude and bank) the timely and more vigorous actions”.

The citation above explains the necessity of a co-pilot in the crew and his obligations and functions are defined exactly in An-2 airplane AOM.

The commander’s decision for execution of flights with shortened crew created additional conditions for degradation of flight safety level and led to complicated flight conditions, which the aircraft commander routinely recognized as normal ones.

Just before the take-off for the 12th flight the aircraft commander permitted boarding and entrance into the cockpit of two outside persons - 22-years man and 11-years child, and there presence on-board during the working flight was a considerable violation of Chapter 5, p.5.5 of Aerial Works Instruction in already existing complicated situation.

From the explanation of the child survived the accident it was clarified, that during the take-off and the flight he was sitting on right-hand pilot’s seat, he wasn’t fastened with safety belts and he made photos and video-clips with a digital camera.

During the detailed inspection of the accident site and aircraft wreckagees the commission found out a relatively intact digital camera. It was established that it was digital camera Canon A400. The camera was partially burnt and at the moment of the impact into the ground it was in working mode. The memory card of the camera, Integral make, with capacity of 64 MB and serial number EN0516095Ch0519Pa, was unaffected by the fire. The files available were

recovered by a specialized laboratory and the commission identified the date and time of the records, as well the content of the respective file.

Six photos with numbers from IMG_0353.JPG to IMG_0356.JPG including were made on 10.04.2006 during the period between 16:48 till 18:05.

Four photos number IMG_0359.JPG and from IMG_0396.JPG to IMG_0398.JPG were made on 11.04.2006, as three photos (from IMG_0396.JPG to IMG_0398.JPG) were made between 14:44 and 14:56 from the aircraft and photo with number IMG_259.JPG was made at 12:22 in child's school.

Six (6) video-clips were recorded also on the memory card and two of them with respective numbers MVI_0390AVI and MVI_0391AVI were recorded at 13:54 on 11.04.2006, before the child boarded the aircraft. Three video-clips with respective numbers MVI_0392AVI to MVI_0394AVI including were recorded from the aircraft on 11.04.2006 at 14:51.

The first video with number MVI_0392AVI showed the stage of aircraft take-off for the 12th flight and it gave the possibility to define the exact time of take-off – 14:50 on 11.04.2006.

The fourth video with number MVI_0395AVI was made at 14:54 on 11.04.2006 and it was the last record, contained in the memory card of the camera.

The video with the longest duration of 01:44 min, MVI_0394AVI, permitted to analyze the character of the flight before the start of spraying: the flight was very dynamic and during this short period of time were 6 to 8 small turns with banks between 30° to 50° and the pilot was turned his face to the right-hand seat and communicated with the child.

According child's explanation, the flight lasted about ten minutes for spraying from an altitude between 2 and 5 meters and after that “started a big turn (what means with a big bank)”, and he didn't remember anything after that.

The character of the flight, the elements performed and the pilot's behavior were in sharp contradiction with the rules for flights for herbicides spraying, given in Chapter 5, p. 5.7, p.5.9 and p.5.11 of Aerial Works Instruction.

Analyzing the personal peculiarities, the behavior and the decisions taken by the commander of the aircraft, the commission acquainted itself with the flight reference from the personal file of the pilot, where the following was written: “In relation with his self-assessment as a person there was a small overestimation. There were some more to be required regarding his self-criticism, purposefulness, self-discipline and excessive self-confidence. As a recommendation it was necessary to work on the discipline and self-discipline both before the flight and during the flight”.

It was clarified by the commission from pilot's colleagues, that the aircraft commander possessed enhanced high self-assessment, liked to fly the aircraft at critical regimes and didn't show any inclination to listen the remarks, made to him in this relation.

During the inspection of the traces left after the first touch with the ground the commission established the aircraft met the ground with the end of the left-hand spraying stem and lower

left wing and almost at the same time with the wingtip of the upper left-hand half-wing. It was confirmed by the explanations of an immediate witness of the aviation accident.

In order to determine the aircraft attitude position at the moment of the contact of the spraying stem and the upper left wing with the ground, the commission made calculations on the base of the following measured distances on the ground and aircraft geometric adjectives:

- distance between the traces of the spraying stem and upper left-hand half-wing on the ground = 2.80 m;
- length of the upper wing = 8.425 m;
- length of the left-hand half of the spraying stem = 5.83 m;
- distance between the upper half-wing and spraying stem = 2.2 m.

During the computation the commission admitted the following assumptions:

- the turn was performed without slipping (what is unlikely in presence of liquid chemical and additionally might worsen the conditions for turn performing);
- simultaneous touch of the spraying stem and upper left-hand half-wing on the ground;
- flat terrain, without slope, what was the real situation at the moment of the aviation accident.

These assumptions permitted to define the aircraft bank and the flight altitude just in the moment, when the spraying stem and upper left wing touched the ground.

On the base of the abovementioned the angle of aircraft bank in the moment of simultaneous touch of the spraying stem and upper left-hand half-wing on the ground was:

$$\sin \gamma = 2.2/2.8, \text{ from where } \gamma = \arcsin 2.2/2.8 \approx 51^\circ.$$

From the angle computed it is possible to define the flight altitude at the moment of the touch of the spraying stem and upper left-hand half-wing on the ground:

$$H = 5.83 \times \sin \gamma \approx 4,3 \text{ m.}$$

These computations are based on the above stated assumptions and reflect the aircraft momentary attitude positions at the moment of simultaneous touch of the spraying stem and upper left-hand half-wing.

On the ground it was established that the aircraft touched at first the ground with the spraying stem and at 2.20 m further the left wing touched the ground. Hence the angle of bank was less than the computed one. But the commission was unable to define exactly its value because of lack of any data concerning the flight altitude, but it was possible to assume with a reason and authenticity that the bank was between $\gamma = 40 - 50^\circ$.

The aforesaid was a violation of the rules for AW flights, defined in Chapter 5, p.5.11 of Aerial Works Instruction, where it was said, that the turns during the AW should be performed in horizontal plane at an altitude no less than 50 meters above the obstacles in the plain and no less than 100 m over cross-county.

The maximum allowable bank during the turns of An-2 and An-2M aircraft is no more than 30° and over forests and ravines no more than 20° .

The touch of the left-hand spraying stem and the left wing to the ground during a left-hand turn with a speed of $V= 150-160$ km/h created powerful momentum, which rotated the aircraft around its yaw and rotation axes and it led to subsequent touch of the propeller to the ground, what was confirmed by the discovered cutting traces.

As a result of the yawing and pitching moments followed by a hit of the massive elements of the aircraft end engine construction into the ground the aircraft rotated at 180° from the previous flight direction and was destroyed.

Taking into account the distance between the main aircraft impact into the ground till its full stop, what was about 23 m at a speed of $V=150$ km/h to $V=0$ km/h, the average negative acceleration was about 3.5 units.

Because of the existing fuel in the six wing fuel tanks and the existing oil in the oil tank and engine immediately after the dynamic impact of the aircraft into the ground an intensive fire blew up.

The aircraft commander and the young man being between the left-hand and the right-hand pilot seats died due to the traumas as result of the impact and the fire developed.

The child, sitting without fastened safety belts in the right-hand pilot seat was thrown out because of the created acceleration at about 10 m from the main point of impact and fireplace with serious injuries.

3. Conclusions

The facts available, the sequence and the character of the traces on the accident site, witnesses explanations and the analyzes performed gave a ground to the commission to make the conclusion that the accident was in result of the following

MAIN CAUSE:

Demonstrated self-sufficiency and lack of self-discipline by the aircraft commander, led to violation of the flight rules during AW, defined in Aerial Works Instruction, due to which the complicated flight conditions became dangerous and in the specific circumstances the situation created developed to a catastrophic one.

IMMEDIATE CAUSE:

Collision with the terrain.

The commission considered that for the occurrence contributed the following **contributory factors:**

1. Negligence of the requirements for available regular flying staff by AO for the established by AOM flight conditions for minimum crew during AW.
2. Degraded level of control by AO on the activities, character and quality of the aerial work performed.
3. Lack of in-depth analysis of the personal and professional abilities of the flight personnel of the AO and passivity displayed in cases directly influencing the safe performing of the flights.

During the process of the cause about the accident the commission disclosed also the following deficiencies:

1. Formal attitude of the inspector during the fulfillment of the control list of the aircraft commander for the flight proficiency and navigation check.
2. Lack of record in the aircraft engine technical book for installation of a plug No 105975 into the altitude corrector during the technical measures for PSSE.
3. The reason for replacement of the cylinder No 1, 4 and 9 wasn't registered in the technical documentation.

The commission for air accident investigation proposed **for immediate execution the following safety measures:**

1. The managers of Air Operators for aerial works (AW) to declare in written to the CAA the aircraft readiness for operation in spring and summer conditions.
2. The recommended procedures for AW, prescribed in Aerial Works Instruction should be strictly executed.
3. CAA to send letters to all AW air operators to prohibit categorically the boarding during the flight of the persons, which are not crew members.
4. Air operators operating An-2 airplanes to perform an engine check at all operational regimes and to record the parameters in the technical log book.
5. The managers of air operators and the directors of operations to draw attention of the all staff on the matters of discipline during the flight execution and the strict fulfillment of procedures, included in the legislation.

During the investigation the following immediate safety measures were recommended to the CAA by a letter reg. No 10-01-64/05.05.2006. The execution of the recommended measures is certified by a letter No of the Chief Director of CAA.

On the ground of the ascertainments and a conclusion made **the commission proposed also the following safety measures to be executed:**

1. CAA should organize working meeting with the flight crews of the AW air operators to discuss the flight safety level and the readiness of the crews for work in spring and summer conditions.

Time: February 2007. Person in charge: Chief Director of CAA

2. CAA should perform an inspection of the staffing of AW air operators crews.

Time: 01.08.2006. Person in charge: Chief Director of CAA

3. During the active season of AW, CAA should perform an extra inspection of the planning, performing, account and control of the flight and production activities of AW air operators.

Time: permanently. Person in charge: Chief Director of CAA

4. AO on the grounds of the Final Report of the commission and in accordance with p.18 of Flight Operation Manual should prepare and submit in CAA a written analysis about the human factor influence on the AW flight safety and about the planned activities of the airline management for improvement of the safety level during organisation, planning and execution of flight and production activities.

Time: 20.08.2006. Person in charge: AO manager.