



# FINAL REPORT

**Investigation of causes of an air accident  
of the Cessna 421B aircraft, ID mark OK-TKF,  
on 26 September 2017 approx. 1.5 km NE of Noviny pod Ralskem**

Prague  
January 2019

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This investigation was carried pursuant to Regulation (EU) of the European Parliament and of the Council No. 996/2010, Act No. 49/1997 Coll., on civil aviation, and Annex 13 to the Convention on International Civil Aviation. The sole and only objective of this report is the prevention of potential future accidents and incidents free of determining the guilt or responsibility. The final report, findings and conclusions stated therein pertaining to aircraft accidents and incidents, or possible system deficiencies endangering operational safety shall be solely of informative nature and cannot be used in any other form than advisory material for bringing about steps that would prevent further aircraft accidents and incidents with similar causes. The author of the present Final Report states explicitly that the said Final Report cannot be used as grounds for holding anybody liable or responsible as regards the causes of the air accident or incident or for filing insurance claims.

This report has been translated and published by the Air Accidents Investigation Institute to make its reading easier for English-speaking people. As accurate as the translation may be, the original text in Czech is the work of reference.

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## Glossary of Abbreviations Used in this Report

AAIL	Air Accidents Investigation Institute
AC	AltoCumulus
ACCID	Aircraft Accident
AGL	Above Ground Level
AMSL	Above Mean Sea Level
APP	Approach
ATS	Air Traffic Services
BECMG	Permanent Change Group (Gradual)
BKN	Broken
BR	Mist
C	Degree Celsius
CAA CZ	Civil Aviation Authority in the Czech Republic (Czech abbreviation: UCL)
CAI	Certificate of airworthiness inspection
CHMI	Czech Hydrometeorological Institute
CTR	Control Zone
CZ/CR	Czech Republic
ELT	Emergency Locator Transmitter
EPGD	Gdansk Airport, Poland
ERS	Emergency Rescue Service
FAA	Federal Aviation Administration, USA
FIC	Flight Information Centre
FL	Flight level
FPL	Flight plan
ft	Foot (unit of length – 0.3048 m)
GO	General Overhaul
h	Hour (unit of time)
hp	Horsepower (older physical unit of power)
hPa	Hectopascal (unit of atmospheric pressure)
FRS	Fire Rescue Service
IFR	Instrument Flight Rules
kg	Kilogram (unit of weight)
km	Kilometre
KT/kt	Knot (unit of speed – 1 nm.h <sup>-1</sup> )
kW	Kilowatt (unit of power)
lb	Libra (unit of weight)
L	Left
LH	Left-hand
LKPM	Příbram Airport
LT	Local time
M	Minus, in the CHMI report
m	Meter (unit of length)
MHz	Hertz (unit of frequency)
MIFM	Military Institute of Forensic Medicine
min	Minute (unit of time)
mph	Mile per hour (unit of speed)
NE	Northeast
nm	Nautical mile (unit of measurement, 1,852 m)
NOSIG	No significant change (in landing forecasts of TREND type)
NSC	No significant cloud
OVC	Overcast

PCR	Police of the Czech Republic
PIC	Pilot-in-command
PLB	Pilot Logbook
Q	Corresponds to QNH in the METAR report (Altimeter subscale setting to obtain elevation reading when on the ground)
QBA	Visibility
R	Right
RCC	Rescue Coordination Centre
RWY	Runway
sec	Second (unit of time)
s/n	Serial number
T	Temperature (°C)
T <sub>DP</sub>	Temperature of dew point [°C]
TAF	Terminal Aerodrome Forecast
TBO	Time Between Overhauls
TEMPO	Temporary or temporarily
TMA	Terminal Control Area
TSO	Time Since Overhaul
UCL	Czech abbreviation of the Civil Aviation Authority (CAA CZ)
UTC	Universal Time Coordinated
V	Variable, in the METAR report
V	Velocity, in tables (the report specifies velocity in km.h <sup>-1</sup> or m.sec <sup>-1</sup> )
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
WO	Work Order
Z	Universal Time Coordinated, in meteorological reports (ZULU)

## **A) Introduction**

Owner, operator: Legal entity  
Aircraft manufacturer: Cessna Aircraft Company, USA  
Aircraft model: Cessna 421B, Golden Eagle  
Serial number: 421B0931  
Identification mark: OK-TKF  
Call sign: OKTKF  
Location of incident: approx. 1.5 km NE of Noviny pod Ralskem  
Date, time: 26 September 2017

## **B) Synopsis**

On 26 September 2017, the AAI was notified by the RCC of an air accident of the aircraft with the said ID mark. When flying on the route from LKPM to EPGD, the pilot reported loss of control of both engines at the level of 14,100 ft, and the aircraft entered to fall a spin-stall near the said village. The spinning aircraft crashed into the forest trees and the ground in the hilly terrain. Having crashed against the ground, the aircraft caught fire.

The pilot and the passenger had sustained injuries to which they succumbed at the location of the air accident. The aircraft was destroyed by the impacting forces and subsequent fire.

The cause of the incident was investigated by the AAI Commission. The investigation team comprised of:

Investigator-in-charge: Ing. Josef Procházka  
Commission member: Pavel Mráček  
doc. MUDr. Miloš Sokol, Ph.D., MIFM  
Ing. Michael Seidl, Aerotaxi s.r.o.

The Final Report was issued by:  
AIR ACCIDENTS INVESTIGATION INSTITUTE  
Beranových 130  
199 01 PRAGUE 99  
on 22 January 2019

## **C) This Final Report consists of the following sections:**

1. Factual Information
2. Analyses
3. Conclusions
4. Safety Recommendations

## 1. Factual Information

Videofootage from LKPM camera system and the ANS FPL database records have been used for the description of circumstances preceding the ACCID. History of the flight has been documented on the basis of ATS radar records, radio-communication records between the said aircraft and ATS, and individual ATC stations. The short final flight stage has been captured on amateur video recording and described by witnesses.

### 1.1 The Event Flight

#### 1.1.1 Flight Plan

The pilot submitted a flight plan for the critical flight from LKPM to EPGD on 25 September 2017 at 17:15:13.

25 September 2017 17:15:13 LKAAZFZX

(FPL-OKTKF-ZG

-C421/L-SFGRWY/S -LKPM0515

-N0180F180 KOMUR/N0160F180 IFR Z39 ARTUP P733 AKAPI/N0180F250 P733 EBOGU/N0180F180 P733 IRLUN -EPGD0142 EPBY

-PBN/A1B2 NAV/SBAS DOF/170926 RVR/550 ORGN/KAUSZXBT RMK/IFPS REROUTE ACCEPTED CREW CONTACT 00420xxxxxxxxx FILED BY 00441273782130)

#### 1.1.2 Preparation for flight at LKPM on 26 September 2017

Camera footage covering hangar interior

- 07:33:30 Start of recording. The displayed times come from the setting of the camera system installed in the hangar.
- 07:34:41 Monitored presence of two persons in the hangar. Upon identification based on this camera footage, those two persons were identified, after ACCID, as the pilot and the passenger.
- 07:36:32 The pilot was preparing a tow bar for aircraft towing.
- 07:38:40 Tow bar attaching to the aircraft.
- 07:38:57 Beginning of aircraft towing.
- 07:40:51 The pilot returned a tow bar to the hangar.
- 07:41:49 End of activities in the hangar.
- 07:49:25 End of recording.

Footage from the camera located in the above-mentioned hangar, covering the space in front of the hangar

- 06:44:49 Start of recording. The said times come from the setting of the camera system installed on the hangar. The view of the area in front of the hangar was hindered by the closing hangar gate until the next sequence.
- 06:45:30 The aircraft with doors open was located in front of the hangar. The pilot and the passenger were moving close to the aircraft. The pilot was handswinging the propeller on the right engine and checking the smooth upward and downward motion of the right aileron. He was then checking smooth upward and downward motion of the elevator. The smooth motion of the rudder was checked by moving the directional trim tab to the right and to the left. Both persons boarded the aircraft.
- 06:47:20 The aircraft door was shut.
- 06:50:50 The right engine failed to start up.
- 06:51:20 The left engine was started up.
- 06:51:41 The right engine was started up.
- 06:52:22 Anti-collision flashing beacon was switched on.



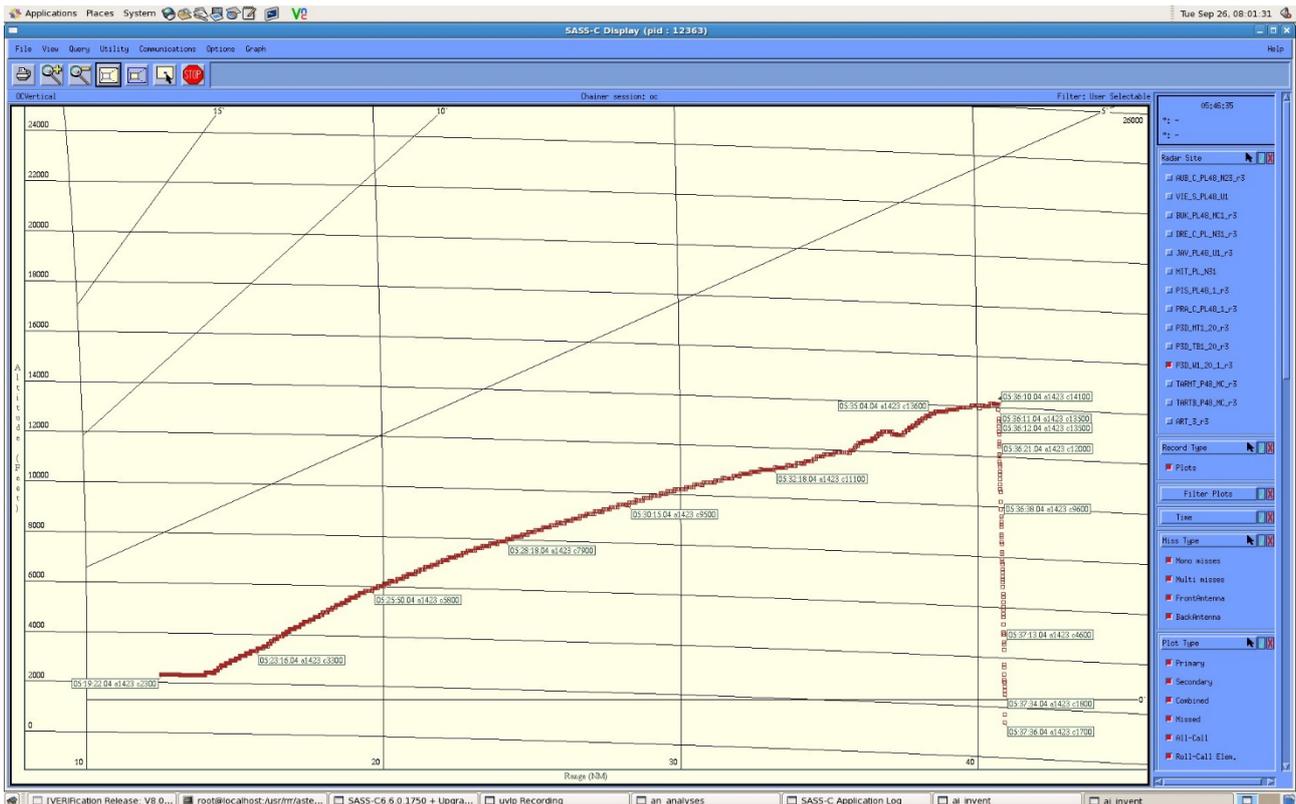


Fig. 3: Flight altitude profile

### 1.1.5 Communication time sequence

The first part of the transcript contains only communication between ATS and OK-TKF. The second part of the transcript contains time sequence of all the air traffic communication on the Prague Radar 127.825 MHz frequency, hereinafter only the “Radar”. (The numbers in red denote the critical interval.)

First part of the transcript

Time	Station	Content
04:57:57	PIC	He checked with FIC the planned FL and a request to SQUAWK by phone.
05:06:33	OK-TKF	Prague Info OKTKF Good morning.
	Prague Info	Good morning, go ahead.
	OK-TKF	Airborne 4 minutes from Přebíram. Request flight plan activation and continue to KOMUR, so far under TMA, and then request further climb.
05:09:09	Prague Info	Roger, regional 1020 and Ruzyně 1023, wait for IFR.
	OK-TKF	1023 and wait for IFR, OKTKF.
	Prague Info	OKTKF.
	OK-TKF	OKTKF.
	Prague Info	You have just trespassed TMA, you have 4,000 feet where TMA is 3,500. Please descend under Prague TMA, fly through or under Prague TMA, north of CTR, fly by and then change to APP, I will give you the frequency.
OK-TKF	Descending to 3,500 feet, and TMA reached. Do I really have to fly by CTR?	
Prague Info	I have been told that twice. Fly by CTR under Prague TMA and north of CTR Ruzyně, and report to the provided frequency.	

OK-TKF Roger, will fly by CTR left from east, pardon, west, and will report to Prague, OKTKF frequency.

05:10:04 Prague Info OKTKF, when north of CTR Ruzyně, change to 120.530.  
OK-TKF 120.530 OKTKF.  
Prague Info I have been warned: it really must be north of CTR.  
OK-TKF Roger, north of CTR.

05:19:20 OK-TKF Prague Radar OKTKF inquiry. Vodochody is active or can fly through?  
Prague Info Vodochody is not active.  
OK-TKF Thank you, will remain under 3,500 and continue via Vodochody. Remaining on your frequency.

05:21:00 OK-TKF Prague Information, OKTKF, north of CTR now, changing to 120.530. Correct?  
Prague Info Yes, Sir, hear from you soon.  
OK-TKF Hear from you soon, OKTKF.

05:21:20 OK-TKF Prague Radar, OKTKF, good morning. North bound from CTR Prague, 3500 feet and request climbing and ready for IFR.  
Radar OKTKF, Good morning, radar contact, climb to flight level 70 now.  
OK-TKF Climbing 70 OKTKF.

05:23:05 Radar OKTKF you IFR start now, time check 23 and continue now accordance flight plan route.  
OK-TKF IFR start, continue via flight plane route, OKTKF.

05:24:29 Radar OKTKF climb cruising level 100.  
OK-TKF Climbing 100 OKTKF.

05:27:11 Radar OKTKF climb cruising level 180, proceed direct to TOMTI.  
OK-TKF Direct TOMTI and climbing 180 OKTKF.

05:30:33 Radar OKTKF, contact Prague Radar 127.825, hear from you soon.  
OK-TKF 127,825, hear from you.

05:30:58 OK-TKF Prague Radar, OKTKF, Good morning, climbing FL180.  
Radar OKTKF, Good morning, radar contact.

Second part of the transcript

05:35:55 Radar  
05:36:01 Austrien175M

05:36:06 Lufthansa  
05:36:16 Radar

05:36:17 CSA718  
05:36:27 Radar

05:36:27 Radar  
05:36:38 CSA616  
05:36:34 may day, may day, ...engine, two engines both out of control.

Note: The final part of the preceding correspondence between the Radar and CSA616 and the start of OK-TKF emergency call were mutually interfering.

05:36:43 Radar Read back blocked.

05:36:43	Radar	
05:36:51		CSA616
05:36:51	Radar	Second station calling.
05:36:59	Radar	
05:37:14		ENTERAIR516
05:37:15	CSA6JK	
05:37:28		Radar
05:37:31	RyanAir	
05:37:43		Radar
05:37:47	Radar	
05:37:58		Austrien175M
05:38:39	Radar	
05:45:10		Repeated call of OK-TKF until the specified time.

### 1.1.6 Witnesses' Statements

The witnesses who saw the aircraft fall have stated that the aircraft had: *“heavy sound of high intensity, humming”, “fluctuating engine sound”, “pilot was trying to rev up engines, but they were misfiring”*. Engines then *“died away, stalled”*. The aircraft was then *“free-falling with nose down like spinning down”, “flying horizontally and in this position was turning counterclockwise”, “starting to turn horizontally around its axis and was descending fast”*. *“The aircraft was falling in whole”, “there was no smoke”, “nobody jumped out”*.

### 1.1.7 Videorecording

The beginning of videorecording shows steep aircraft descend at an angle of approx. 45° for some 2 sec. The aircraft then entered a left spin at a varying angle of 45–60°. When in spin, it turned twice by approx. 360°. The view of aircraft was then obscured by forest trees. Aircraft crash against the ground is not visible in the footage. Immediately after aircraft’s disappearing out of sight amidst forest trees, the recording featured a fiery flash followed by a column of heavy smoke. The entire videorecording takes 5–6 sec.

## 1.2 Injuries to Persons

Injury	Crew	Passengers	Other persons (inhabitants, etc.)
Fatal	1	1	0
Serious	0	0	0
Light/No injury	0/0	0/0	0/0

## 1.3 Damage to Aircraft

In air accident, the aircraft was destroyed by the crash against forest trees, ground and subsequent fire.

## 1.4 Other Damage

The aircraft has broken two pine trees with a diameter of approx. 10 cm. Fire affected another five pine trees of a similar size in the forest.

As a forest loader was extricating and transporting the aircraft wreckage from the location of the air accident, approx. 50-m-long belt of young pine trees has been damaged.

## 1.5 Pilot Information

Male – age:	46
Crew licence:	Issued with the qualification SEP land, MEP land/IR valid until 30 June 2018
Medical certificate:	Valid
General radio operator licence	
Air mobile services:	Valid
English level ICAO:	Valid, Level 5
Subsequent hours flown as specified in PLB:	First flight 20 July 2009, last flight 19 September 2017
Flying experience (hours):	675:29, last record
Flying experience as PIC:	440:29
IFR hours flown:	284:45
Day/night landing:	757/29
Flying Cessna 421B, transition training:	28 January 2016, 4 flights, 1 h 27 min
Hours flown on Cessna 421B	
Total:	47
As PIC hours/flights:	45:33/34
IFR hours flown:	36:26
IMC hours flown:	Not recorded
Last check:	30 June 2017

Year/Type	TB10	SR22	C172	PA28	PA46	C414	C421	Savage
2009	63:00	00:40						
2010	30:12	62:49						
2011	16:30	42:06	04:38	9:53				
2012	08:27	25:43	20:00	07:29				
2013	06:21		18:20	02:56				
2014		65:20	11:08	04:31				
2015		53:40			14:42	17:02		
2016		42:55			11:00		20:19	
2017	00:38	33:46					26:41	24:21
Total	125:08	326:59	54:06	24:49	25:42	17:02	47:00	24:21

Tab.1: Table in PLB

*Note: Tab.1 is included in PLB right at the beginning with further hours added in 2017. The sum of hours in the table differs from the last number of hours in PLB. Pilot's hours flown according to Tab. 1 on all types in total: 645:07.*

*The pilot had experience with flying abroad. Twin-engined aircraft piloted by him included C414 and C421B. His hours flown on them totalled 64:02 hours.*

*In his PLB, the pilot did not have any record of C421B in the Type qualification/licence certificate section.*

*In his PLB, the pilot had "C421B Transition" recorded with an instructor's signature and stamp in the Notes and Certificates column in the logged flight section.*

*He did not record transition to C421B in the Log section of his PLB.*

## 1.6 Aircraft Information



Fig. 4: Cessna 421B aircraft, illustrative photograph

### 1.6.1 Cessna 421B General Characteristics, Technical Data/Performance

The aircraft is a six- or seven-seater depending on the variant. All-metal low-wing monoplane with a retractable tricycle landing gear and a pressurised cabin. It is powered by two engines. The cabin is accessible from a door on the left-hand side.

Crew:	One or two (coupled controllers are located in front of both front seats)
Length:	36 ft 9 <sup>5</sup> / <sub>8</sub> in (11.09 m)
Wingspan:	41 ft 1 <sup>1</sup> / <sub>2</sub> in (12.53 m)
Height:	11 ft 5 <sup>3</sup> / <sub>8</sub> in (3.49 m)
Wing area:	215 ft <sup>2</sup> (19.97 m <sup>2</sup> )
Empty weight:	4.501 lb (2.041 kg)
MTOW:	7.450 lb (3.379 kg)
Engines:	Six-cylinder, air-cooled, horizontally opposed Continental GTSIO-520 engines incorporating fuel injection. They are fitted with a turbofan. They have power of 375 hp (280 kW) each.
V <sub>MAX</sub> :	256 knots (475 km.h <sup>-1</sup> , 295 mph) at 20.000 ft (6.100 m)
V <sub>CRUISING</sub> :	240 knots (444 km.h <sup>-1</sup> , 276 mph) at 25.000 ft (7.600 m)
V <sub>ASCENT</sub> :	115–140 knots (213–259 km.h <sup>-1</sup> )
Flying range:	1.487 nm (2.755 km, 1.712 miles)
Service ceiling:	30.200 ft (9.205 m)
V <sub>VERTICAL</sub> :	1.940 ft.min <sup>-1</sup> (9.9 m.s <sup>-1</sup> )

### 1.6.2 The Cessna 421B aircraft, ID mark OK-TKF, was a seven-seater.

Entry into the CAA Aircraft Registration Database:	25 October 2000
Manufacture date:	1975
Serial number:	0931
Hours flown/landings:	6.340/6.744 as at 5 April 2017
Hours flown/landings:	6.381:21/6.797 as at 26 September 2017

- CAI: Valid for the period from 5 April 2017 to 24 October 2017 with limitations:
- LH engine in the PRIVAT mode – only VFR operation due to expired 12-year deadline stipulated by the manufacturer's document Engine Model Time Between Overhaul, revision 2013/07/17
  - Non-functional DME – only VFR operation
  - Pressure gas bottle Scott p/n 81365-10, past expiration date, only for flights without use of oxygen

### 1.6.3 LH power unit

Data from Logbook No. 1/CZ, introduced by the issuing organisation in the Czech Republic with the first entry of annual inspection on 22 November 2012

Engine – type: GTSIO – 520 H (1)  
 Serial number: 817617 – R  
 Year of manufacture: Not found  
 Number of hours: 843:30, first data in the LH Engine Logbook  
 Date of last GO: 29 October 2001, in operation for 16 years at the time of AA

Deadline stipulated by the manufacturer: Expired deadline stipulated by the manufacturer in the document Engine Model Time Between Overhaul

Hours since manufacture/at the time of Logbook issuance: Unknown/843:30

Number of hours since GO: 893:05  
 Propeller – type: Mc Cauley, 3AF37C516/90LFB-0  
 Serial number: 030543  
 Year of manufacture: Not found  
 Hours in operation/at the time of Logbook issuance: Unknown/292:25  
 GO date: 3 February 2004, from LH Propeller Logbook  
 Date of last GO: 15 September 2011, data from the servicing organisation's WO, document not specified in the LH Propeller Logbook  
 Number of hours since last GO: 191:55 as at 5 April 2017, (annual inspection date)

### 1.6.4 RH power unit

Data from Logbook No. 1/CZ, introduced by the issuing organisation in the Czech Republic with the first entry of annual inspection on 22 November 2012

The first document in the RH Engine Logbook pertains to engine built-in after GO on 11 August 2009

Engine – type: GTSIO – 520 H (2B)  
 Serial number: 817543 – R  
 Year of manufacture: Not found  
 Date of last GO: 11 August 2009  
 Hours in operation/at the time of Logbook issuance: Unknown/0  
 Number of hours since GO: 192:45 as at 5 April 2017  
 Propeller – type: Mc Cauley, 3AF34C92-PR  
 Serial number: 814683  
 Year of manufacture: Not found  
 Date of last GO: 25 October 2015  
 Number of hours since last GO: 42:14 as at 5 April 2017, (annual inspection date)

### 1.6.5 Flight Manual

The specific Flight Manual for Cessna 421B, s/n 421B0931, ID mark OK-TKF was not available to the AAI CZ Commission. Therefore, a general Flight Manual for Cessna 421B s/n 421B0801–421B1100 was used for investigation. This Flight Manual was issued on 15 August 1974, reviewed by Revision 3 on 15 August 1996 and approved by FAA D6008- 3-13. It was also reviewed in the Emergency Procedures section on 16 November 2001 by FAA DF1635-13. Supplement D1625-1-13-CPS-2000-10/93 issued on 20 December 1988 and reviewed by Revision No.1 dated 10 February 1989 for all C421s from serial number 421-0001 to 421C1807 stipulates the FUEL FLOW check performance to prevent a non-operating engine. Should the fuel flow be insufficient, AUX pumps shall be switched to HIGH. It ensues from Emergency procedures Supplement D1635-13 that a single engine flight as such presents an issue. All tasks prescribed by the Emergency chapter of the Flight Manual presume a flight with a feathered propeller.

1.6.6 Additional information about the aircraft concerned

Engine injection system has been fitted with a hot air bypass autochangeover to engine intakes to prevent icing formation.

The critical power unit in case of power failure was the left one.

Propellers have not been provided with an automatic feathering system. Manual propeller feathering required revolutions not specified in the Flight Manual.

According to information from pilots and publicly available materials, the systems and controllers differed in each aircraft of the Cessna 421B range.

1.6.7 Weight and balance calculation

The total aircraft weight of 6,832 lb at take-off was below MTOW. (MTOW 7,200 lb). Balance, actual moment 1,066.955. When recorded in a diagram, the centre-of-gravity position is located close to the rear centre-of-gravity position. The centre-of-gravity position was standard and compliant.

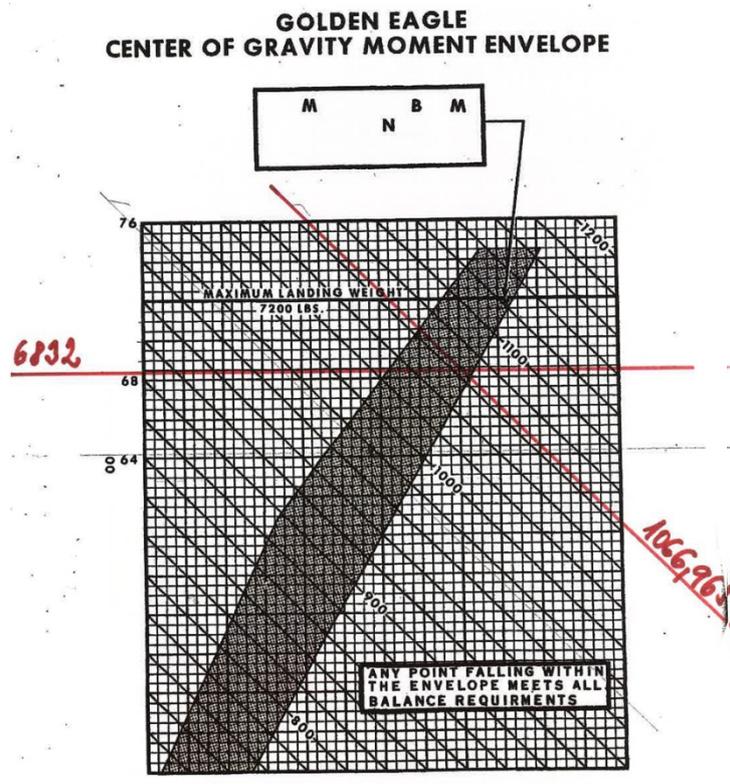


Fig. 5: Centre-of-gravity position diagram

#### 1.6.8 Service Information Letter SIL98-9C

The Service Information letter was issued by the engine manufacturer and approved by the FAA Technical Centre on 17 July 2013.

The Letter stipulates the TBO number of hours as 1,600, the TBO number of years as 12.

#### 1.6.9 Additional requirements for maintenance of transferred aircraft CAA-ST-092-5/07

On 22 May 2017, CAA (CZ) issued Additional requirements for maintenance and creation of aircraft maintenance programmes regarding aircraft whose type certificate has been transferred under EASA power in accordance with Regulation (EU) No. 216/2008 of the European Parliament and of the Council (transferred aircraft).

The said document reads:

a) Release of aircraft into operation is inadmissible if the operating time of an engine or a propeller (if installed) since manufacture of last general overhaul exceeded time between two general overhauls even if specified by the manufacturer as recommended time. If aircraft is not operated in return for payment, the provision regarding the recommended time since general overhaul shall not apply to the same unless in contradiction with the approved maintenance programme and aircraft being operated in the IFR category.

#### 1.6.10 Maintenance programme (approved by CAA CZ on 20 October 2015)

The maintenance programme specifies the manuals for performed inspections.

Under point 4:

Airframe: D817-15-13 Cessna Maintenance Manual  
Engine: GTSIO-520 series Engine Overhaul Manual (X30045)  
Propeller: McCauley Maintenance Manual CMM500-1

Under point 6:

The following servicing instructions shall be carried out on the aircraft in order to maintain airworthiness.

Binding instructions issued by the manufacturer(s) of aircraft, engine, propeller or other aircraft units.

Under point 7:

Time between maintenance conducted in accordance with servicing manuals and other documents specified below if maintenance is done:

On the annual basis and after 50, 100, 200 hours flown.

As regards inspections, the MM stipulates as follows:

Operating usage – TYPICAL usage environment.

Operating Environment – MILD/MODERATE Corrosio Environment.

Under point 8:

Aircraft units shall be replaced and maintained:

In accordance with fixed terms stipulated by manufacturer's documentation.

In accordance with recommended terms stipulated by manufacturer's documentation. *(In case of IFR operation, compliance with recommended terms is mandatory.)*

Under point 9:

The following special aircraft inspections shall be carried out:

Inspection of the static pressure system of each altimeter and each automatic altitude transmitter every 24 months.

Inspection of SSR airborne transponder every 24 months.

Inspection of functionality and sensitivity of radiocommunication and radionavigation systems (for IFR aircraft) every 24 months.  
 Compass compensation every 12 months.  
 VOR operational testing every 30 months.  
 Aircraft weighing every 72 months.

Under point 11:

Declarations of the operator/owner:

I hereby declare that the said aircraft shall be maintained in compliance with the proposed maintenance programme and relevant maintenance regulations.

Any changes in the maintenance programme may be made only in line with valid regulations. Any deviations from the maintenance programme, explanatory notes and approvals, changes in the method of use or method of aircraft operation necessitate an amendment to the maintenance programme and shall be approved by the CAA unless CAA decides otherwise.

#### 1.6.11 Maintenance Summary

Component	Job	Limit hrs	Limit flight	Completed Date	Next deadline Date
Left engine	GO	1,600	12	29/10/2001	10/2013
Right engine	GO	1,600	12	11/08/2009	08/2021
Left propeller	GO	2,000	6	15/09/2011	09/2017
Regulator	GO	1,800	5	05/04/2017	04/2022
Right propeller	GO	1,200	5	25/10/2015	10/2020
Regulator	GO	1,800	5	25/10/2015	10/2020

Tab. 2: Abstract of limits from the document of the authorised maintenance organisation

Provided Logbooks of both engines and propellers (first entry on 22 November 2012, last entry on 5 April 2017) lack any entries regarding performance of annual servicing inspections in 2013, 2014 and 2016.

Given the small number of hours flown by the aircraft, hour limits have not been exceeded. For this reason, they are not provided in the table.

### 1.6.12 Aircraft fuel system

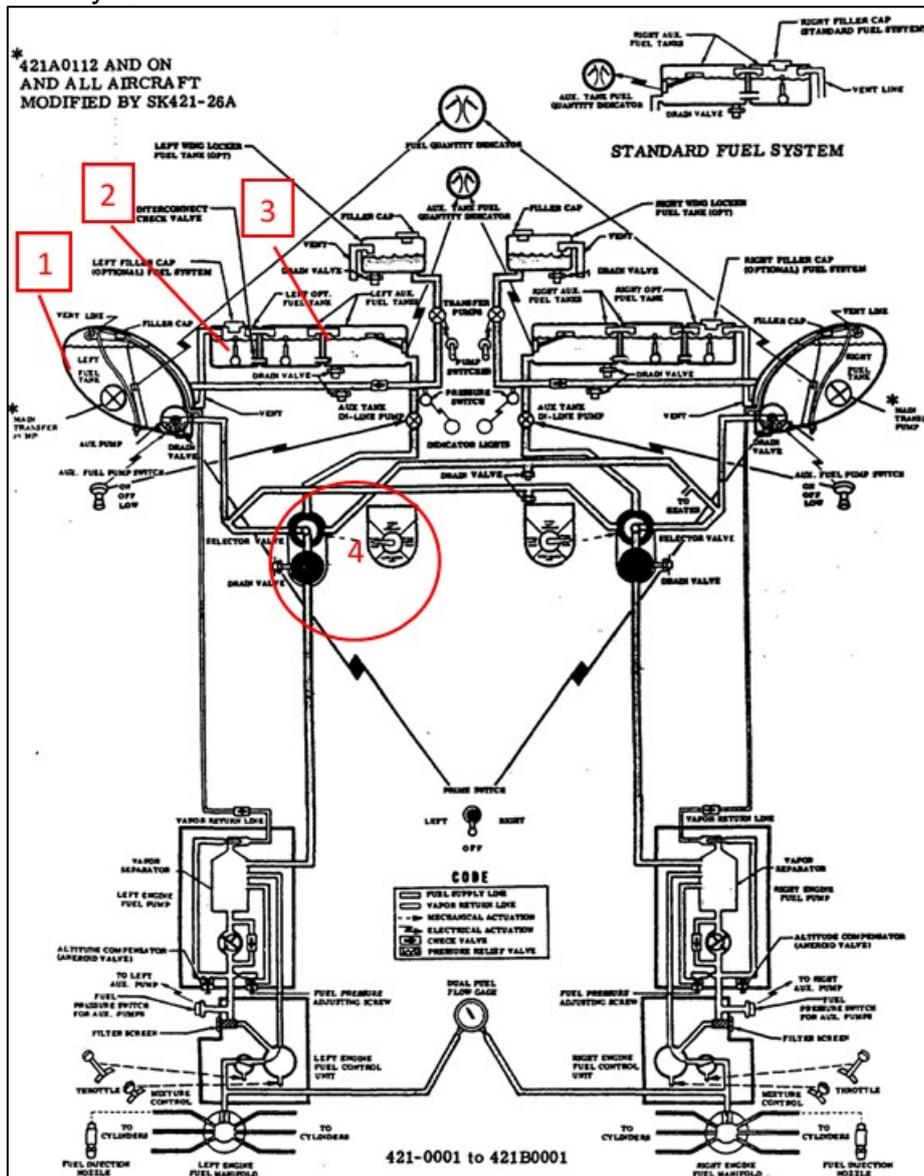


Fig. 6: Fuel system diagram

- Key: Position 1: Fuel tank, located at the wing end.
- Position 2: Optional fuel tank, located in the outer half of the wing.
- Position 3: Auxiliary fuel tank, located in the middle part of the wing.
- Position 4: Selector valve, located on the floor between pilot seats.

The left part and the right part of the fuel system were identical with an option to connect fuel feeding to the right engine from tanks in the left part of the fuel system and vice versa.

The aircraft in question had yet another, the seventh, fuel tank with capacity of 18.5 gallons mounted above the left engine.

The capacity of fuel tanks equalled 188.5 gallons (approx. 716 l). The aircraft had fuel tanks full of fuel for the planned flight prior to take-off.

#### Requirement for fuel during the event flight

The planned flight time from LKPM to EPGD with the use of the Bydgoszcz/EPBY reserve aerodrome has been calculated at 1 hour 42 minutes to the destination plus 5%, i.e. 5-minute contingency. The flight time to the reserve aerodrome is 25 minutes. Holding 45 minutes. The total is 177 minutes with an average consumption of 190 litres per hour (based

on experience). IFR flight performance required 560 litres. 716 litres of fuel have been tanked. The amount of fuel was sufficient for the intended flight according to the submitted flight plan.

During a standard flight, the fuel cocks should be switched to Fuel Tank and pumps to LOW for the first 90 minutes.

### 1.6.13 Documented history of the aircraft

#### 1.6.13.1 Foreign owner

Documentation records start on 19 December 1975 and detail aircraft putting into operation, regular maintenance, system checks and built-in navigation system. Records were kept until hand-over to the domestic owner.

#### 1.6.13.2 Overview of owners of OK-TKF in the Czech Republic

First owner:	25 October 2000, entry into the CAA CZ aircraft register
Second owner:	15/06/2004–13/03/2007
Third owner:	13/03/2007–27/12/2012
Fourth owner:	27/12/2012 – also on the AA day

#### 1.6.13.3 Overview of operators of OK-TKF in the Czech Republic

First operator:	25/10/2000–16/12/2002
Second operator:	16/12/2002–15/06/2004
Third operator:	15/06/2004–13/03/2007
Fourth operator:	13/03/2007–30/04/2010
Fifth operator:	30/04/2010–06/02/2012
Sixth operator:	06/02/2012–24/05/2012
Seventh operator:	24/05/2012–27/12/2012
Eighth operator:	27/12/2012 – also on the ACCID day

#### 1.6.13.4 Air accident at LKMT

The pilot, involved in this accident, stated that on 3 March 2004, the left main gear wheel of the aircraft concerned had got caught up in a patch of snow during a left-hand turn at LKMT. The left wheel was decelerated. The aircraft ran into deep snow. Having switched off engines, the pilot detected a bent propeller blade on the left engine upon visual inspection.

An authorised servicing centre repaired the propeller and the engine subjected to forced engine shutdown. The costs of repair work amounted to EUR 40,457.32.

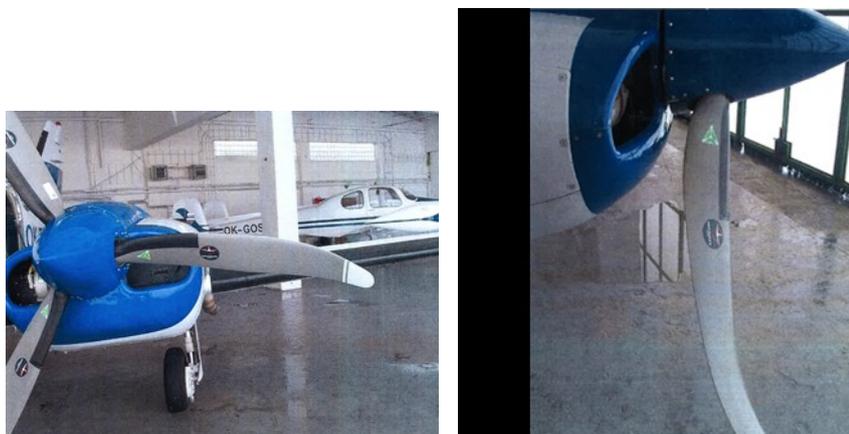


Fig. 7: Damaged propeller

The Logbook, namely the specific Section 1.6.3 lacks any record of work done or engine and/or propeller inspected following this event.

## 1.7 Meteorological Information

### 1.7.1 Analysis of the meteorological situation by CHMI, 05:45 UTC

Southwest edge of high-pressure area with a centre above Finland. Higher atmospheric levels affected by a high-altitude low-pressure area above Germany.

Location: approx. 5 km from the Ralsko hill and 3 km from Stráž pod Ralskem  
Ground wind: 090–150°/4–8 KT  
Upper wind and T: 2,000 FT MSL +11C 1,200/12 KT, 5,000 FT MSL +08C 1,300/12 KT, 10,000 FT MSL M03C 1,500/20 KT  
Visibility: more than 10 km  
Weather: broken – overcast, no precipitation  
Cloudiness: BKN/OVC LYR (Ac) 8–9,000 FT AGL, TOP 13,000 FT AGL  
Zero isotherm level: 7,500 FT AMSL  
Turbulence: NIL  
Ice: Weak to moderate in stratiform middle-level clouds FL080-130  
QNH pressure: 1,022–1,024 hPa, unaltered

Conclusion: The effect of high-altitude low-pressure area resulted in the occurrence of BKN/OVC stratiform middle-level clouds of AC type. The layer between 8,000 and 13,000 ft AMSL was very humid with high probability of weak to moderate icing occurrence.

### 1.7.2 CHMI radar image

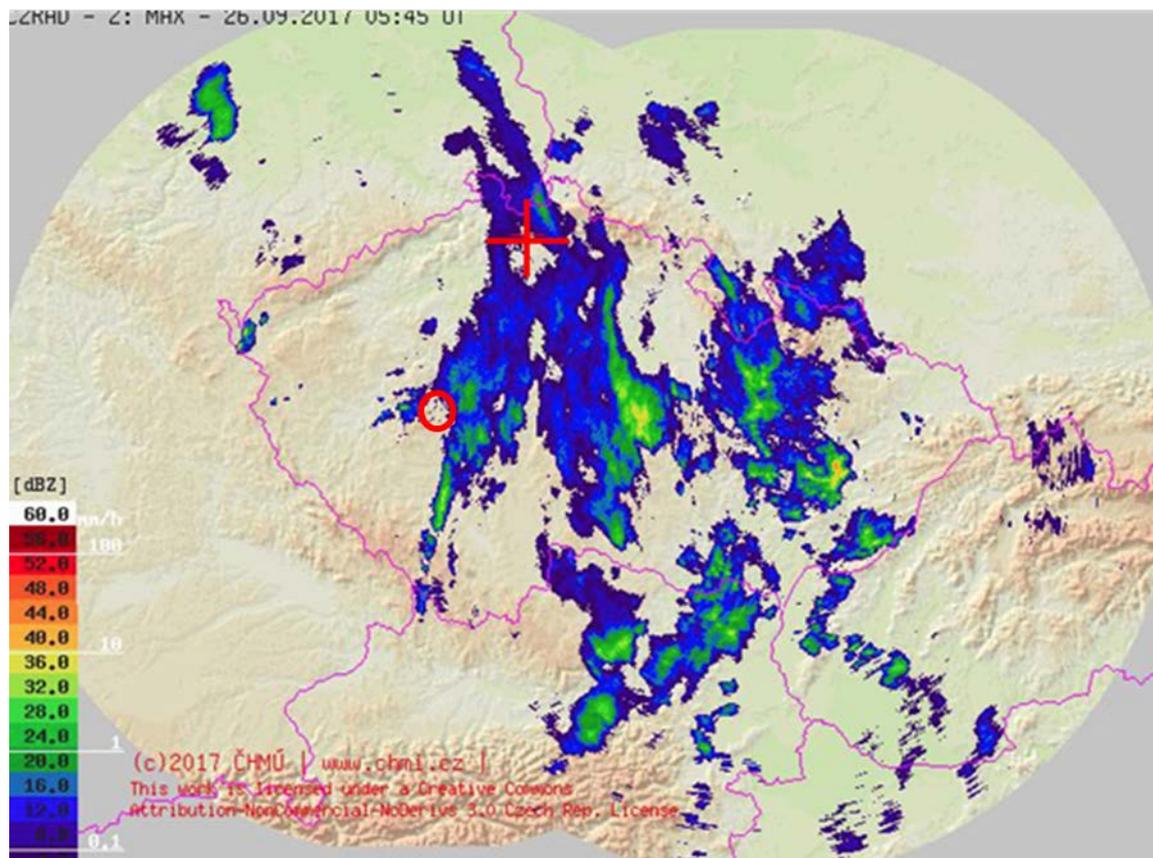


Fig. 8: CHMI radar image dated 26 September 2017 05:45 UTC. LKPM is marked with a red circle, the position of Stráž pod Ralskem is marked with a cross.

1.7.3 An extract from reports from the Liberec weather station:

UTC	Wind (kt)	QBA (km)	Cover	Cloud	Height (ft)	T	T <sub>RB</sub>
0500	160°/4	28	8		9,000	11,1	8,9
0600	150°/4	25	7	AC	9,000	12,1	8,5

1.7.4 METAR LKPR

260300Z 08005KT CAVOK 11/10 Q1023 NOSIG

260330Z 08006KT 8000 FEW004 11/10 Q1023 NOSIG

260400Z 08008KT SCT003 10/10 Q1023 TEMPO 5000 BR BKN003

260430Z 09007KT 6000 FEW003 10/10 Q1023 NOSIG

260500Z 090082KT 5000 BR FEW003 11/10 Q1023 NOSIG

260530Z 09009KT 5000 BR NSC 11/10 Q1023 NOSIG

260600Z 09007KT 6000 NSC 11/10 Q1023 NOSIG

260630Z 10007KT 9000 NSC 12/10 Q1024 NOSIG

260700Z 10008KT 9000 NSC 12/10 Q1024 NOSIG

1.7.5 TAF LKPR

260500Z 2606/2612 09008KT 7000 SCT023 TEMPO 2606/2608 4000BR BKN006 BECMG  
2608/2610 11008KT 9999 SCT030

1.7.6 METAR LKKB

260300Z 06006KT 7000 NSC 11/11 Q1023

260400Z 05005KT 5000 BR SCT004 BKN028 11/11 Q1023 260500Z 05007KT

260500Z 06007KT 5000 BR SCT033 BKN060 11/11 Q1024 NOSIG

260600Z 07007KT 5000 BR BKN033 OVC060 11/11 Q1024 NOSIG

1.7.7 TAF LKKB

260500Z 2606/2706 09006KT 4000 BR SCT004 BKN025 BECMG 2607/2609 10010KT  
9999 SCT025 BKN035

1.7.8 Weather according to the statements of witnesses:

*"It was overcast with a light wind blowing."*

1.7.9 Video recorded weather

Based on expert assessment of the final stage of the flight captured on a videorecording, the weather was estimated as broken with middle-level and high-level clouds, the low base of clouds being higher than approx. 500 m AGL and visibility exceeding 5 km.

## 1.8 Radio Navigational and Visual Aids

NIL

## 1.9 Communications

Communication took place on the Prague Info and Prague Radar frequencies. The operation at the Prague Radar station was assessed as medium during the ACCID.

## 1.10 Aerodrome Information

The Příbram aerodrome is a public domestic aerodrome. VFR day operation and parachute jumping.

ARP: 49° 43' 12" N, 14° 06' 01" E, 6 km NE Příbram, ELEV: 1,529 ft / 466 m.  
Opening hours 1 APR – 31 OCT, SAT, SUN, HOL 08:00–16:00, otherwise upon demand.  
The aerodrome had no impact on occurrence of the air accident.  
Gdansk/EPGD and Bydgoszcz/EPBY aerodromes were suitable for the planned flight. They had no impact on emergence of the air accident.

### **1.11 Flight Recorders and Other Means of Recording**

The aircraft has not been equipped with a flight recorder.

### **1.12 Wreckage and Impact Information**

The aircraft fell down on a NE slope in a hilly, forested and hardly accessible terrain. The place of the fall, with coordinates N50°41' and E014°46' and ASL 339 m, was located in a dense, 50-m wide young pine forest belt leading from NW to SE with trees of 3–5 m. This young forest belt was surrounded with pine trees of 10–12 m.

The aircraft fell down at an angle of approx. 45° in the course of approx. 300°. It was damaged by the crash against forest trees, ground and subsequent fire. The wing with engines, the front part of the fuselage and the torn-off rear part of the fuselage with tail surfaces have been scattered in the area not exceeding the geometric dimensions of the aircraft by more than 2 m. Smaller parts of aircraft wreckage and its equipment were scattered up to 5 m away from the place of fall. Greater dispersion has been prevented by the dense forest.

The right half of the wing was broken at the wing root. The flaps were retracted. The damage to metal nose cones protecting propeller hubs corresponded to the crash at the above-mentioned angle. The angle setting of both propellers was compliant with the flight mode. One blade of the right propeller was stuck nearly vertically in the soft forest soil. The remaining two blades have been neither bent nor considerably damaged. The left propeller had two of its blades stuck in the same soft soil. The third propeller blade, almost in vertical position, has been neither bent nor considerably damaged.

The bottom front part of the fuselage together with the wing centre section and the cockpit area have been heavily damaged due to the impact coming from the front bottom, and also by the subsequent fire. The cockpit was pierced by two pine trunks (approx. 10 cm in diameter) during the fall. The effect of flames and fire was devastating, namely in the front part of the cockpit and in the wing centre section. At the time of the AA site inspection, the top part of the cabin was non-existent. The interior equipment made of flammable materials was completely burnt. Parts made of light metals were melted down and together. The seat frames made of more fire-resistant material have been preserved. The mechanical and thermal damage to the wreckage considered, it was not feasible to ascertain and evaluate the functionality of controls and positions of controls of aircraft and engine systems. The fuselage rear part has been broken off together with the tailplanes at the point of contact of the vertical stabiliser leading edge with the fuselage. The control planes have been firmly attached and secured. The distance between both the fuselage parts from each other, up to 50 cm, was caused by the tilted position of back parts of the wreckage rearward. The tilt angle of the leading edge of the horizontal stabiliser was approx. + 60°. The longitudinal axis of the rear fuselage part wreckage was following through to the longitudinal axis of the front fuselage part wreckage. Except for the detached, broken off tailplanes the whole aircraft was affected by fire.

Charred Logbook and Pilot Logbook have been found in the back part of the cockpit.

In the broken off back part of the fuselage, an ELT accident compass locator has been found connected to the onboard power mains with the aerial connected. The switch was in the "ON" position. The beacon was not transmitting.

After the inspection of the AA site and the aircraft wreckage, and related documentation of the same by the Police of the Czech Republic and the AAI Commission, all parts of the wreckage have been transported to the AAI depository.

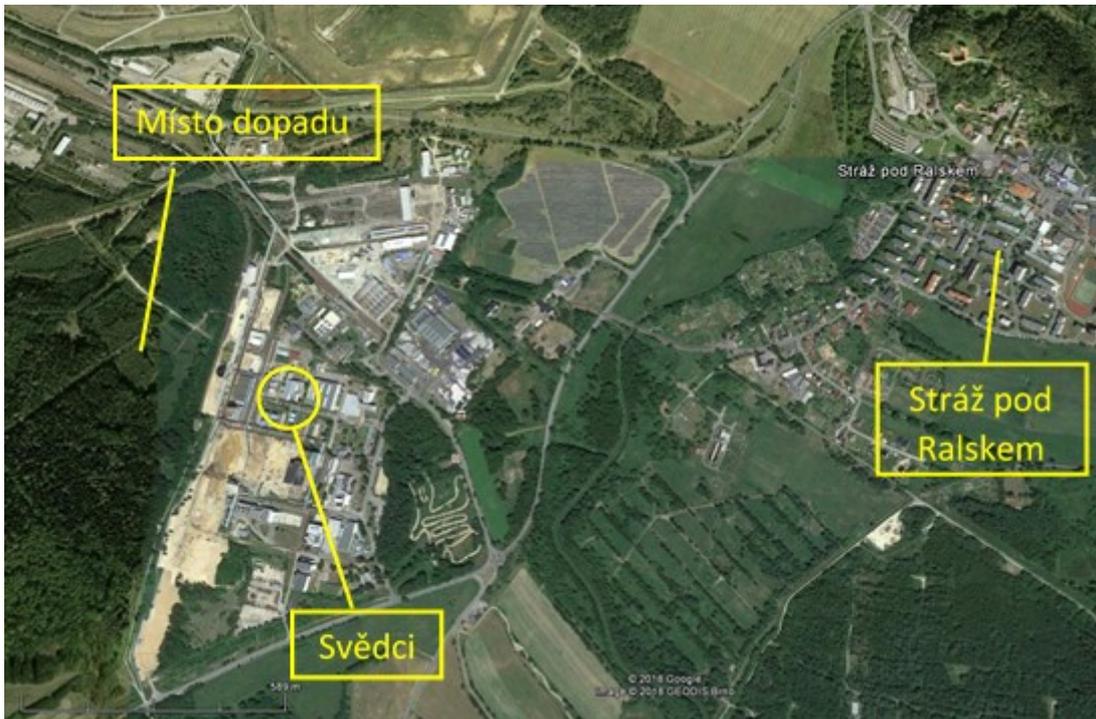


Fig. 9: Indicative aerial map of the air accident area

Místo dopadu – Impact Point, Svědci – Witnesses, Stráž pod Ralskem – Name of City

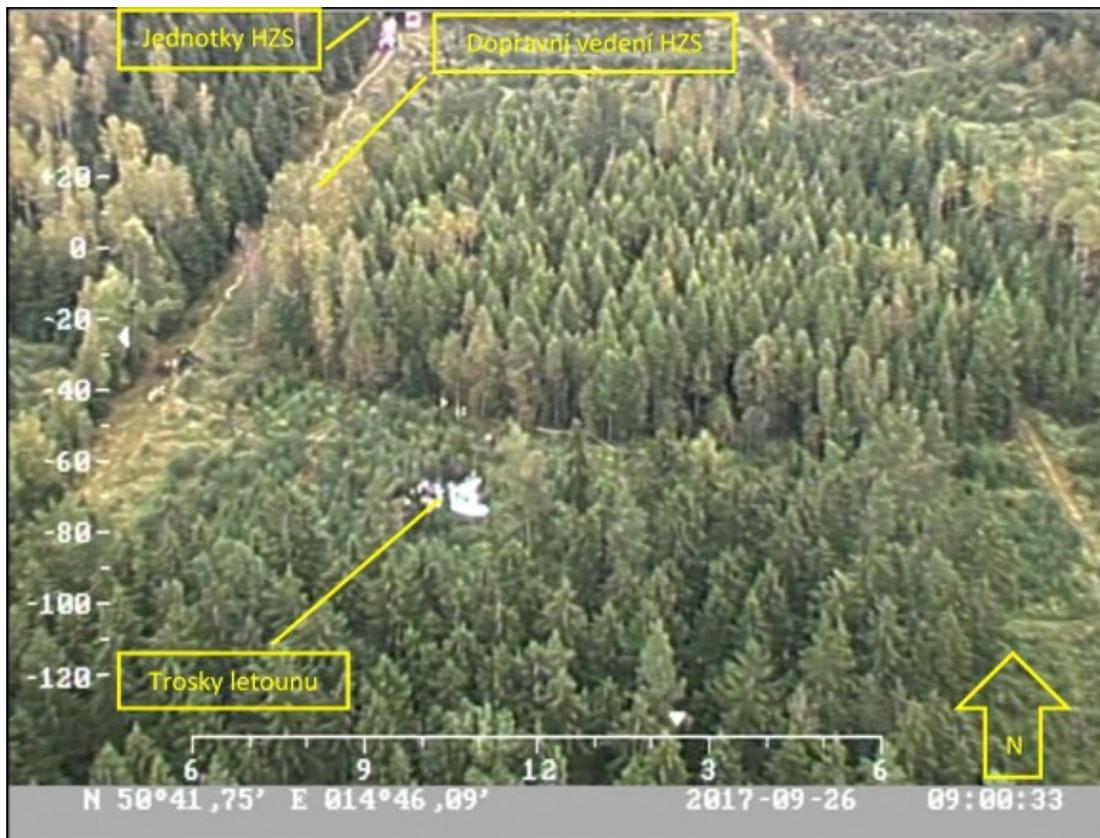


Fig. 10: Air accident site surroundings, Trosky letounu – Wrecks of ACFT  
 Jednotky HZS – FRS Units, Dopravní vedení HZS – Transport line of FRS



Fig. 11: Air accident location

### 1.13 Forensic Expert Opinion Conclusions

The immediate cause of death of both, the pilot and the passenger, was a polytrauma, multiple injuries to several organ systems leading to immediate death of both persons onboard. During the fire of the aircraft wreckage, the victims were no longer alive nor breathing.

From both, forensic medical as well as aviation medical perspectives, it can be stated that there was a blunt violent force of great intensity affecting the pilot's and passenger's body, with the vector of combined forces working from the front and below. The origin of injuries can be explained by the air accident mechanism – an impact of the descending aircraft into the ground in wooded landscape. The injuries of both persons were caused by the impact into the ground and by pressing of their bodies in the collapsing front part of the aircraft.

The bodies of the deceased have been significantly altered due to the thermal effects of the fire. For that reason, it was rather complicated to ascertain and evaluate the positions of the upper and lower limbs of the persons in regards to the controls. It can be deduced from the location of injuries on the body and upper limbs that the pilot had his left upper limb in front of his body; it could well be on the control (U-yoke). The right upper limb was stretched out, most likely into the central area between the right and left pilot seats. At the time of impact, the lower limbs were under the instrument board, most probably in the area of pedal controls.

No traumatic alterations substantiating the suspicion that at the time of impact the passenger had either upper or lower limbs in an active position on the controls have been found in the body of the passenger.

The autopsy has detected no traumatic alterations which could not have been explained by the mechanism of the said air accident, such as a projectile wound, an onboard explosion, etc.

The pilot's autopsy results have not disclosed any pathological changes that might have been involved in the causes of the accident, or that could have been considered as a causal link with the pilot's death.

Toxicological examination has not detected any alcohol in the blood stream of either person. During the flight, neither the pilot nor the passenger was under the influence of alcohol or any other substances prohibited for aviation duty (medicines or psychotropic drugs). No fumes from burning have been found in either person's airways.

Biochemical tests have been performed in the pilot in order to determine his somatopsychic condition. Based on the tested biochemical parameters and in the context of the other findings (AA site inspection, video footage from the flight, autopsy results, laboratory analyses, data collected by the investigation commission), after the statistical evaluation of the examination results, the conclusions may be interpreted as follows:

Mentally conditioned increase in performance took place in the pilot (constructive response), later developing into stress. Based on empirical knowledge it can be stated that the pilot's body response was sudden, about one minute prior to his death, with marks of an intensive mental strain and significant muscle tension. This response was later, approx. 20–30 seconds before death, overlaid by a negative emotion (stress). It can be stated with certainty that the significant biochemical response of the body to the surrounding events was only minutes long.

Conclusion: No traumatic alterations that could not have been explained by the air accident mechanism and no facts supporting any health-related cause of the investigated air accident have been found during the comprehensive forensic expert examination.

#### **1.14 Fire**

After an impact of the aircraft into the ground, fire broke out. Eight FRS units dealt with the fire in terrain with a complicated accessibility, deploying approx. 200 m long hose line.

#### **1.15 Survival Aspects**

No search and rescue procedures were organised. The AA was reported to the PCR by witnesses. ERS helicopter, ERS ambulances and two PCR helicopters operated at the AA site.

#### **1.16 Tests and Research**

Testing of the fuel selector state was performed at DSA a.s.; testing of both engines took place at EAA Tech, s.r.o. and at VTU Brno.

##### **1.16.7 Fuel selector test**

In order to determine the settings of fuel feeding, the right fuel selector was tested at the authorised servicing company due to the illegible indication of its gauge.

Test performance:

In accordance with the Cessna 421B Maintenance Manual D817, the fuel selectors are located in the aircraft wings. See Appendix 2, page 2. The overall control of the selector is described in Appendix 2, page 3. In order to determine the position of the selector control lever, the inlet and outlet pipes have been identified first. By applying compressed air, the throughput test was performed confirming that the submitted fuel selector was switched to the "Auxiliary Tanks" position, see Appendix 3. The remaining output pipeline branches were closed, which indicates the switched position of the selector. Whether the selector was switched to the "Auxiliary Tanks" position due to the impact to the ground cannot be determined; considering, however, the construction features of the selector, this option appears to be improbable. For this reason, it can be stated that the selector had been switched to the "Auxiliary Tanks" position most probably by the pilot. Nonetheless, the possibility of the selector being switched to the "Auxiliary Tanks" position due to unskilled handling during selector disassembling from the aircraft wing by the rescue services personnel cannot be ruled out.

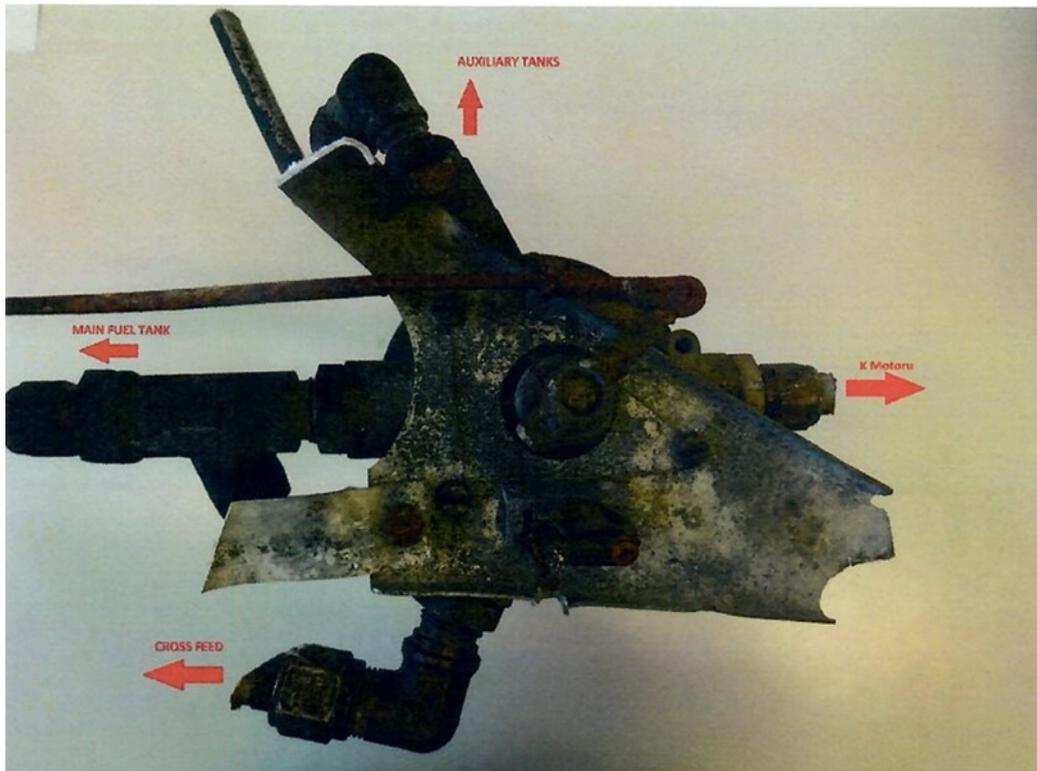


Fig. 12: Right fuel selector, outlets

Note: The Commission members were present during the dismounting of the said fuel selector from the aircraft frame. During the stated disassembly, neither intentional nor unintentional change of the position of the fuel selector control took place. The complete Technical Report issued by the reviewer of the fuel selector forms one of the Appendices hereto.

#### 1.16.8 Engine malfunction analysis report (performed by the authorised servicing company)

The figures in this section are numbered in accordance with the numbering used in the Engine malfunction analysis report. The complete Engine malfunction analysis report together with the photodocumentation form one of the Appendices hereto.

Targets of the analysis:

The target of the analyses was to determine the potential fatigue failure in the gears as one of the possible causes of malfunction. The gears from both, the right as well as the left engine have been provided for the analysis for potential comparison.

The requirement for the check was to verify:

- 1) The sameness of the material used (left engine vs right engine) – chemical composition, all gears
- 2) The sameness of heat treatment – hardness, all gears
- 3) Analyses of the fracture of gears L1, L2, L3 + determination of the pitting resistance, focusing on the L1A area.

Description of the state:

The gears from the left engine SN 817617-R were submitted for the analysis, WO: E34/2017 See Fig. 3.2 In order to ensure unambiguous identification of the gears, they were marked in accordance with the picture as follows:

- L1 – crankshaft drive gear
- L2 – camshaft driven gear
- L3 – starter pinion

In the like manner for the right engine SN 817543-R, WO E34/2017 (see Fig. 3.3) markings R1 – crankshaft drive gear, R2 – camshaft driven gear, R3 – starter pinion were used.

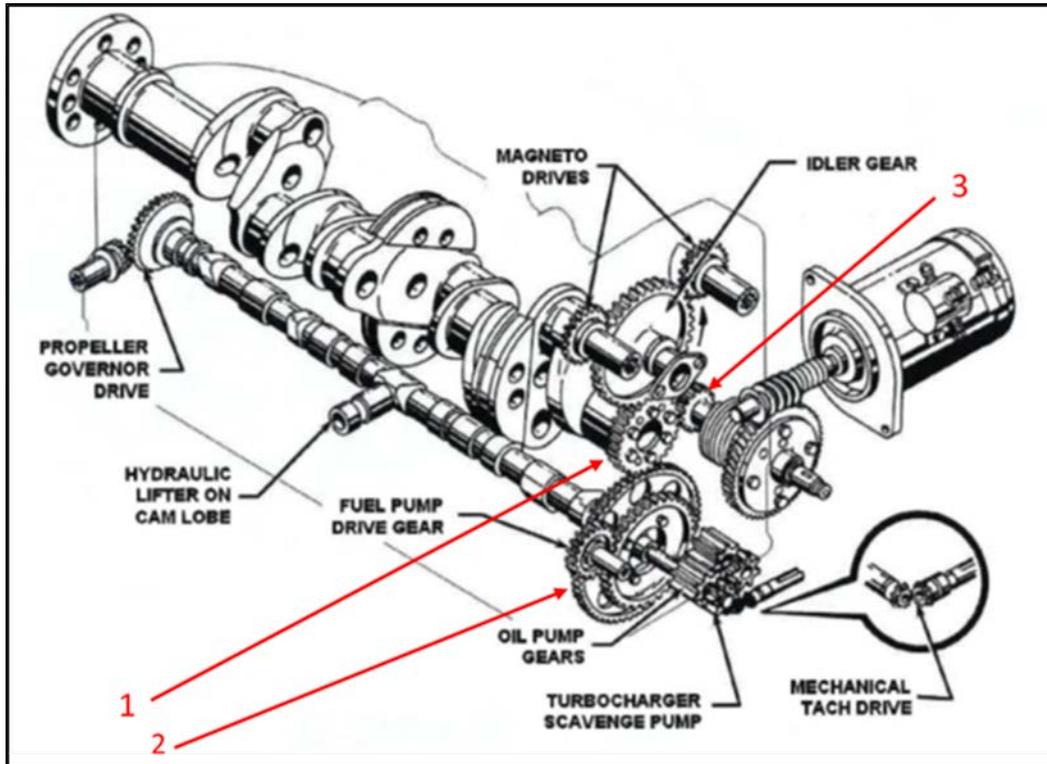


Fig. 3.1: Diagram of engine train of gears

For the purposes of description and potential hypotheses of failure, the areas of failure on L1 drive gear were marked (see Fig. 3.4 and Fig. 3.5). As obvious from the photographs, L1 drive gear is damaged in two areas – L12 and L13 – corresponding in the angle to the gears in the engine. As evident from the submitted photodocumentation (see Fig. 3.5), there is indenting of teeth of L2 driven gear into the teeth of L1 drive gear. Given the engine rotation direction, these imprints are located in front of the location of the broken off teeth.

The teeth of the left engine driven gear are damaged in one area only, see Fig. 3.6. L3 gear pinion teeth are completely damaged.



Fig. 3.2: Left engine teeth



Fig. 3.3: Right engine teeth

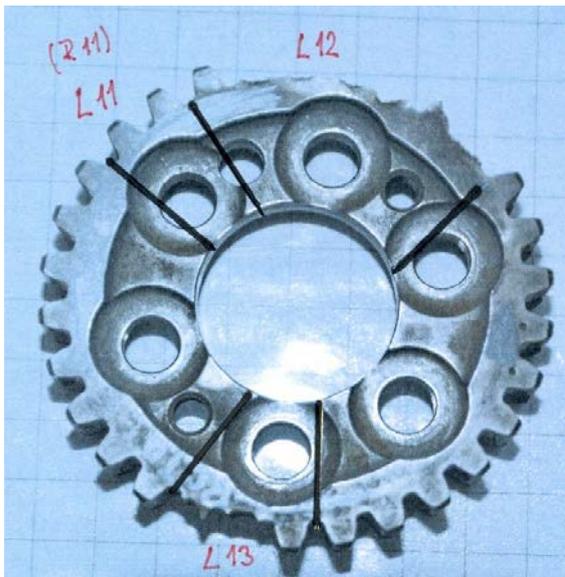


Fig. 3.4: L1 drive gear of the left engine



Fig. 3.5: Detail of L12 area damage with the areas of damage

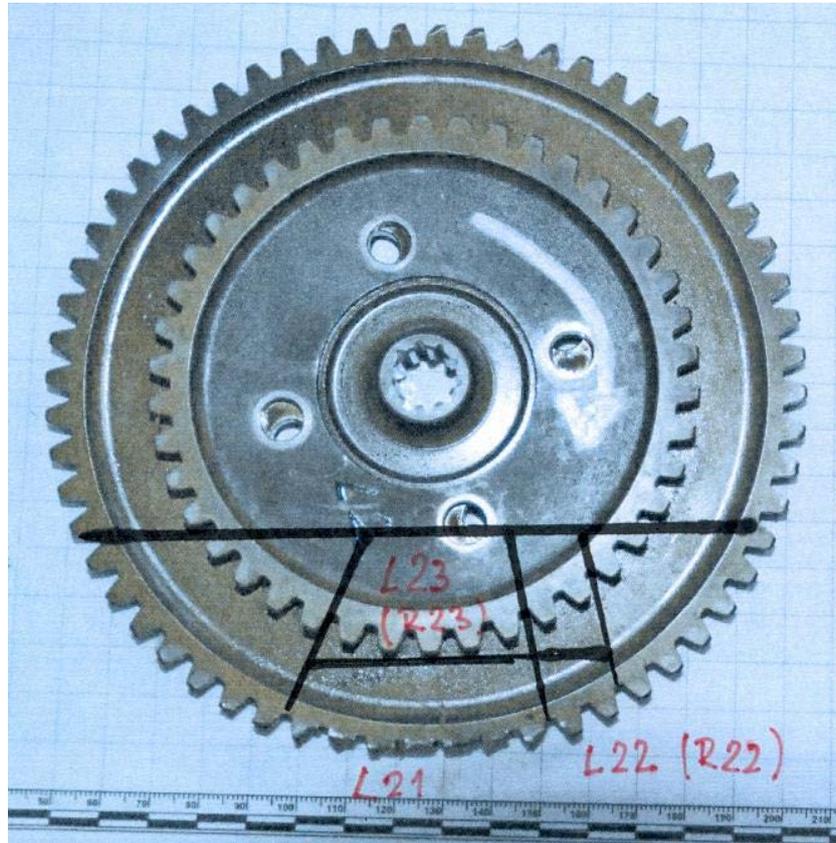


Fig. 3.6: L2 driven gear with the area of damage

#### Damage process hypothesis

Based on the state of the teeth, the possibility of wear damage can be admitted in case of the teeth of L2 driving gear; such condition, however, does not correspond with the damage occurred in the area in front of the broken off teeth location and thus cannot be considered as the primary cause of malfunction.

Based on the debate ensuing from inspection of L1 and L2 gears, traces of impressions as well as gradually disappearing damage of the apexes of L1 teeth, repeated on specific teeth, have been detected (see Fig. 6.1).



Fig. 6.1: Damaged faces of teeth on L2 gear

Furthermore, presence of a groove on L1 driving gear (see Fig. 3.4) ahead of the broken off teeth area (corresponding with the rotation direction) confirms a different mechanism of the defect origin.

For this reason, it is assumed that a regular "slight breaking" of the camshaft in a certain position was taking place, causing the teeth of L2 driven gear to hit the approaching corresponding teeth of the driving gear. This mechanism had been in operation for a

sufficiently long period of time in order to cause gradual damage to L1 driving gear (groove across several teeth) and pressing down of teeth on the driven gear. Once a certain degree of wear has been reached, substantial and major wear damage has occurred so that the teeth on L1 were broken off and pressed down and tore off teeth on L2 resulting in an immediate stall of the engine.

Resultant breaking off of two teeth on L1 driving gear and of all teeth on pinion L3 can be ascribed to the subsequent efforts of the pilot to start the engine up when the fixed worm gear was able to transmit the load onto the pinion which was thus damaged. The great strain on the starting mechanism is corroborated also by breaking off of the starter electromotor in the upward direction, i.e. the teeth of the worm and the gear were moved further apart from each other.

Through analysis of the damage to the L2 teeth, cams on the shaft were identified and also their respective corresponding active lifting tappets. Through their inspection it has been confirmed that two cams and tappets bear the marks of corrosion and of insufficient turning in lead and the third tappet has been jammed completely. All three tappets bear signs of significant wear on their faces caused by an increased pressure exerted by the cam. It is not possible to assess the true causes of corrosion and of the jamming as they might have also been partly caused by the fire and the subsequent extinguishing process.

In order to make the analyses complete it has to be noted that on 3 March 2004, the aircraft ran into a snowdrift at LKMT resulting in damage to the left propeller (bent blades) at total airframe hours 5,865, the left engine at 561 hours since general overhaul.

#### Resulting statement

The left engine of Cessna 421B, SN 421B-0931, identification mark OK-TKF was stalled as a consequence of gradual “slight breaking” of the camshaft and subsequent wear of the gears resulting in jamming of the teeth with an abrupt violent stall.

The possibility of a fatigue-caused breaking off of some of the teeth from the gears as a jointly influencing cause cannot be dismissed.

Signs of damage caused by an impact into the ground have been found on the right engine. No cause of its potential spontaneous shut-down in flight has been ascertained. The investigation of the cause of the failed propeller feathering on this engine has not been successful.

### **1.17 Organisational and Management Information**

The aircraft was a property of a legal entity. The same entity was also the operator. The aircraft was supposed to be operated under the PRIVATE mode and VFR only.

### **1.18 Supplementary information**

#### 1.18.7 Event flight analysis

For the purposes of performing the analysis, the Commission has used the following sources:

- Footage from LKPM cameras,
- ANS radar flight records,
- ANS–ATC communication records,
- PCR helicopter borne camera footage from the AA location,
- Amateur video footage from the final phase of the flight,
- Witnesses’ statements,
- Conclusions of the aircraft wreckage inspection at the AA location and in the AAll depository,
- Conclusions of expert evaluation of engines, propellers, and fuel selector,
- Pilot’s documentation,
- Collected documentation relating to the aircraft,

- Consultations with employees of airline companies and with pilots about their experience with operation and flying of this aircraft type and on this specific aircraft,
- Information available on social media.

#### 1.18.8 Radar flight record analysis

The incident occurred during the ascent at FL 14,100 ft in 31st min of the flight.

Time	FL <sub>(ft x 100)</sub>	H <sub>m</sub>	Δft	Δm	Δt <sub>sec</sub>	V <sub>y</sub> ft sec <sup>-1</sup>	V <sub>v</sub> m.sec <sup>-1</sup>
05:36:10	141	4,297					
05:36:11	135	4,115	600	182	1	600	182
05:36:12	135	4,430	0	0	1	0	0
05:36:21	120	3,658	1,500	457	9	166	51
05:36:38	96	2,926	2,400	732	17	141	43
05:37:13	50	1,524	4,000	1,219	35	114	35
05:37:34	18	549	3,200	975	21	152	46
05:37:36	17	518	100	30	2	50	15

Tab. 3: Flight altitude profile analysis based on Chart 1 evaluation

Legend:

- Time: UTC
- FL: in hectafeet
- H: in meters
- Δft: The difference from the previous stated FL in ft
- Δm: The difference from the previous stated FL in m
- Δtsec: Time from the flight through the previous stated FL
- V<sub>y</sub>: Average descent velocity from the previous stated FL
- Conversion: The units are rounded to the integer

#### 1.18.9 Aircraft wreckage inspection performed at the AAll depository

The aircraft wreckage has been inspected at the stated premises repeatedly.

##### Fuselage

The bottom front part of the fuselage was heavily damaged due to the impact coming from the front bottom. The subsequent fire caused extensive destruction of the front part of the cockpit and its equipment. The upper part of the cockpit literally “evaporated”. It was not possible to determine the level of functionality of controls and systems due to the mechanical and thermal damage. For the same reason it was not possible to determine the positions of gas control levers. The instrument board was heavily damaged both by mechanical forces as well as by fire. No values could be read on instruments.

Based on the ascertained position of the controls of fuel distribution from the fuel tanks it was found out that the left engine was switched to fuel distribution from the left main. On the left, also mechanically and thermally damaged board with switches, the switch control of the fuel pump was in the “LOW” position.

The rear broken off fuselage part with tailplanes was bearing marks of mechanical damage. It has not been affected by the fire significantly. The connection of moving rudder planes with their corresponding rods was found intact.

##### Wing

Both halves of the wing have been damaged by the crash against forest trees, ground and subsequent fire. The right half of the wing was broken off at the wing root. The connection of ailerons with their rods was found intact.

## Power units

The structures and installations of power units have not been damaged. Installations were compact. In both engines, the injector fuel flaps were set to the position nearing the maximum value. The engines were fitted with three-blade adjustable metal propellers. The hubs were protected by metal nose cones. Both the cones were damaged by a non-frontal impact. The setting angle of both the propellers corresponded with the operating mode. Due to the mechanical and pyrogenic damage it was not possible to ascertain whether the propeller feathering system had been activated by the pilot manually.

The left fuel cock was switched to the right Fuel Tank position.

## Conclusion

It has been verified through the technical inspection that the damage found during the inspection certainly corresponds to the mechanism of the aircraft impact into the ground. The said impact affected namely the front and bottom part of the aircraft structure by force.

Expert inspection has been performed on both the power units by an authorised company. Analysis of the left engine malfunction has been carried out. A test has been performed on the right selector valve to ascertain the settings of the fuel flow.

### 1.18.10 Aircraft documentation (airframe, engines, propellers)

The Commission had the foreign operator's documentation at its disposal.

The documentation of the domestic operators was not complete and it was not possible to trace all of its parts. Not all records of individual tasks performed by servicing organisations have been entered in the Logbook and had to be gradually searched out at these organisations.

The Commission was unable to trace the complete technical documentation of the aircraft operation and maintenance history in the Czech Republic.

### 1.18.11 Experience with the aircraft type

The statements of the pilots who have flown and the organisations that have operated this specific type of aircraft:

- Demanding in terms of simultaneous piloting and attending to engine, fuel, navigation and radiocommunication systems, and autopilot control in IMC when single-pilot operated.
- Experience essential.
- Organisations preferred flights with a two-pilot crew for IFR or IMC flights.
- No case of icing formation in engine air intakes, or, in other words, no engine stalling due to icing formation.
- Pilot – instructor with extensive experience – with both, the transition training of pilots for this type as well as individual flights with customers affirms the difficulty of a single-engine flight with an unfeathered propeller. His experience: *“If the engine is stalled due to the aggregate drives malfunction and it does not manage to feather in time during inertial running down, the flight will continue with the running engine, albeit working at nominal levels, with the consequence in decrease in speed of horizontal flight nearing very much the stall speed. In case of a slightly descending flight with descent values at 300 to 500 ft/min a stabilised flight can be maintained during the slight descent. The consequence, however, is inability to hold the flight level during the slight descent. If the power output of the operating engine is not 100%, the descent is considerably bigger. In numerous transition training sessions for this type as well as for C 414, there have been falls and prevention of falls into spin demonstrated. The aircraft has always behaved well and whenever it began rotating it was necessary to perform one complete turn in order to recover from the spin due to a greater mass of the aircraft.”*

- In Pilot Safety and Warning Supplements D5139-13 issued by the manufacturer on 2 OCT 1985, revised edition on 1 JUN 1998 No. D5139-13, the procedure for recovering from spin in clouds is described. The said procedure is not described in the Flight Manual.
- [www.cessnaflyer.org](http://www.cessnaflyer.org), Cessna Flyers Association „The 421B model’s fuel system is complicated and an operational and maintenance problem.“

#### 1.18.12 Flight Manual, engine failure during flight

In this case during ascent, i.e. at lower speed (see Section 1.6.1).

- Determining the engine with no power.
- Immediate reducing of rotations of a running engine to idle run.
- Push-down, recovering of the flight speed.
- Setting the operating engine to the maximum possible power regarding ensuring of the further flight.

#### Securing the non-operating engine

- Gas control lever, shut off.
- Propeller feathering.
- Mixture idle – Cut-off.
- Fuel valve closing.
- Fuel pump shutting off.

#### 1.18.13 Recovering from a spin

Recovering from a spin, according to the Flight Manual, does follow the general procedure for recovering.

### 1.19 Useful or Effective Investigation Techniques

Air accident investigation was carried out in compliance with ICAO Annex 13.

## 2. Analyses

When determining the causes of the air accident, the Commission based its deliberations on the footage of the LKPM camera system, ANS radar and audio records, amateur videofootage, and statements of witnesses. It further used the known information about the pilot’s expert and medical qualification and eligibility, general characteristics of the aircraft obtained from the public domain sources, from organisations and pilots who have experience with flying on this aircraft type. The Commission further performed a detailed thorough inspection of the aircraft wreckage at the AA location as well as at the AAll depository. The technical condition of engines has been evaluated. Analysis of the left engine malfunction has been carried out. A test has been performed on the right selector valve to ascertain the settings of the fuel flow.

### 2.1 Pilot

- He held a valid airworthiness certificate with the qualifications SEP land and MEP land/IR, valid until 30 June 2018.
- He held a valid medical certificate.
- According to the records in the Pilot Logbook, he had flown 675:29 hours in the past 8 years of which 284:45 h IFR.
- The transition training for Cessna 421B was recorded in the Pilot Logbook only in the flight log.
- He had flown Cessna 421B as his second twin-engined aircraft recorded in his Pilot Logbook.

- According to the records in the Pilot Logbook, he had flown altogether 47:00 h on Cessna 421B from 28 January 2016 when he started his practical transition training until the date of the AA.
- The total number of hours flown IMC and hours flown IMC on Cessna 421B cannot be evidenced from the Pilot Logbook records.
- He very likely did not possess comprehensive knowledge of the technical condition of this particular aircraft and hence its unairworthiness for any type of flight.
- He submitted his FPL for a flight with an unairworthy aircraft and for IFR not declared in the maintenance programme.
- He performed the event flight.
- After a forced stall of the left engine, he was unable – from a technical point of view – to carry out the left propeller feathering.
- It was not possible to establish the cause of the right engine shutdown, nor whether the pilot performed the operation of the right engine feathering during shutdown.

## **2.2 Aircraft**

- The aircraft had a valid Certificate of airworthiness inspection with limitations listed in Section 1.6.2.
- Based on the limits stated in SIL 98-9C, in accordance with Directive CAA-ST-092-5/07 and the maintenance programme, it was not airworthy for any type of flight.
- In the provided Logbooks with the first entry in 2012, there was not any record of servicing inspections performed in 2013, 2014, and 2016.
- The Commission was unable to trace the complete information on performed servicing as well as other activities during its operation under domestic operators.
- Its insurance coverage was current.
- It had full fuel tanks at the time of take-off from LKPM.

## **2.3 Critical day**

### **2.3.1 Activities of the pilot preceding the event flight**

- He submitted the FPL for a IFR flight one day before, with an unairworthy aircraft under flight rules for which the aircraft has not been declared.
- The pilot performed aircraft haul-out at LKPM on the day of the air accident.
- Performing of a complete preflight aircraft inspection is not verifiable, only in part.

### **2.3.2 Critical Flight**

- The pilot performed a start-up and heating up of engines outside the hangar.
- The pilot took off VFR at the stated time in accordance with the ATS instructions and changed to IFR.
- The flight route and level were recorded by the ANS system.
- The pilot trespassed TMA II Prague during its underflying.
- North of CTR Ruzyně, the pilot changed to IFR and during ascent entered IMC.
- The pilot reached the highest level at 14,100 ft at 05:36:10.
- The origin of the critical situation and the subsequent movement of the aircraft can be detected from the radar record.
- Pilot sent the distress call MAY DAY, MAY DAY at approx. FL100 at 05:36:34.
- The last radar record comes from level 1,700 ft at 05:37:36.
- The final phase of the flight, a stall and a spin, has been captured on an amateur videofootage and described by witnesses.
- The actual fall of the aircraft has not been recorded on video, nor witnessed by any person.

- The pilot and the passenger were killed in the ACCID.
- The aircraft was destroyed in the ACCID by the impact and subsequent fire.
- The flight duration was approx. 31 min.

### 2.3.3 Weather

- It can be stated beyond any doubt that the pilot with regard to his flight experience was aware of the weather conditions at the location of take-off, on route, and at the location of landing.
- Even if the aircraft was technically airworthy, it would not be suitable for the planned flight given its operating limitation only for VFR flights.
- Emergence of the critical situation most probably took place in IMC.
- The above stated meteorological conditions influenced the pilot's spatial orientation ability at the onset as well as during the negotiation of the given situation.
- Given the possibility of automatic switch of supply of preheated air into engine intakes, and after consultations with the operators and pilots flying this type of aircraft, the Commission did not assume icing formation inside engine intakes as the cause of their simultaneous failure. This hypothesis, based on further findings, was proven not to explain the cause of the event.

## 3. Commission's Conclusions

### 3.1 Pilot

- The pilot was a valid flight crew licence holder with valid corresponding qualification and a valid medical certificate holder.
- He had transition training for this type recorded in the PLB as described under 1.5 Note.
- According to the records in the PLB, he had experience in the air operation in IFR conditions, and also with flights abroad.
- The major part of his flying experience was on single-engined aircraft.
- The Commission had no opportunity to evaluate his experience with flying in IMC.
- He planned the flight with an unairworthy aircraft.
- It was the opinion of the Commission members and of the pilots flying on this type of aircraft that the pilot's experience on the given type was insufficient for performing the intended flight under the specific actual conditions.
- The pilot was attempting to deal with the emerged situation by starting up the left engine with the starter.
- Due to the stated inner defect of the engine, this attempt/these attempts could not have been successful and the feathering of the left propeller, from the technical point of view, could not have taken place.
- The Commission did not succeed in providing an exact reason for the right engine stall. It can only be assumed that the pilot shut the right engine down in an effort to lower the pitching moment of this engine in the spin.
- The Commission did not succeed in proving whether the pilot attempted at manual feathering of the right engine.
- When solving the situation, in summary of all the stated facts, under given meteorological conditions and with his level of experience on the given aircraft type he had a very small chance for its successful solution.

## 3.2 Aircraft

- It had a valid CAI with permit to perform VFR flights.
- The prescribed maintenance deadline was not met on the left engine, or more precisely, was not entered into the Logbook.
- On the basis of SIL98-9C, it should not have been operated after expired TSO, in accordance with the Additional requirements for maintenance CAA-ST-092-5/07 and the maintenance programme approved by the CAA on 20 October 2015.
- In its documentation, during its operation under domestic operators, there were no records made, nor was the documentation regarding all the performed and regular works prescribed in the maintenance programme found.
- In the provided Logbooks, there was not any record of servicing inspections performed in 2013, 2014, and 2016.
- Considering the inner damage of the left engine, it can be decisively stated that it was stalled by force in-flight due to the stated inner mechanical damage.
- This stall was a consequence of a long-term eroding process in the engine train of gears.
- In corroboration with the findings on both the engines it can be stated that the engines were not operating at the moment of the impact into the ground.
- Based on the set angle and damage on both propellers it can be decisively asserted that at the moment of impact into the ground both the propellers were set to an operating angle.
- Due to the mechanical defect on the engine and because it was not feathered, the left propeller was not turning.
- The right propeller was not turning at the moment of impact, or more precisely, it could have been rotating at very low revolutions. Neither the right propeller was feathered.
- The Commission did not succeed in explaining the unusual manner of switching of the fuel feeding to the engines at this stage of flight, that is from the right hand fuel tank system into the left engine, and into the right engine, in a non-standard manner, from the right AUXILIARY TANK. It can only be assumed that the pilot, upon the left engine stall, evaluated the situation as fuel insufficiency of this engine and switched the fuel supply into it from the right side of the fuel tank system.
- The Commission performed inspections of the aircraft on site in the AA location and subsequently also in the depository where the wreckage was stored.
- Analysis of the engine malfunction was carried out with the following conclusion. See Section 1.16.2

### 3.2.1 Power units

- The left engine TSO was over the stipulated limit of 12 years. (The last general overhaul was performed on 29 October 2001.)
- The right engine was within the stipulated TSO.
- The left propeller was within the stipulated TSO.
- The right propeller was within the stipulated TSO.

## 3.3 Weather

- It had no impact on the event origin.
- The weather had an impact on the pilot's spatial orientation when solving the event.

### **3.4 Aircraft Accident Causes**

The cause of the ACCID was an inner mechanical defect in the left engine past its stipulated TSO. The defect caused a forced stall of the engine. For this reason, the propeller on this engine could not be feathered.

During the shutdown of the right engine, the feathering of the propeller on this engine did not take place.

The aircraft entered to the fall and a stall-spin in which it fell to the ground.

## **4. Safety Recommendations**

In regard of the safety, not only of the air traffic participants, the AAll recommends to the CAA CZ to approve CAIs in compliance with the expiration dates and hourly TSO limits of aircraft components and systems prescribed by the manufacturer.