



**HELLENIC REPUBLIC
MINISTRY OF INFRASTRUCTURE AND TRANSPORT**

**AIR ACCIDENT INVESTIGATION AND AVIATION
SAFETY BOARD
(AAIASB)**



**INVESTIGATION REPORT
OF AIRCRAFT ACCIDENT 5B-CLB
ON OCTOBER 16th, 2016,
AT KALAVRYTA AREA**

07/ 2018

ACCIDENT INVESTIGATION REPORT
07 / 2018

AIRPLANE C 172P, Reg. Nbr 5B-CLB
ON OCTOBER 16th, 2016 AT KALAVRYTA AREA

The investigation of the accident accomplished, by the accident investigation and safety committee, according to:

- **ANNEX 13 of Chicago Convention**
- **Regulation (EU) 996/2010**
- **Law 2912/2001**

«According to the Annex 13 of Chicago Convention for the International Civil Aviation, the Regulation (EU) 996/2010 and the Law 2912/200, the sole objective of the investigation of an accident or incident, is not the purpose of this activity to apportion blame or liability. The sole objective of the investigation and the final report shall be the prevention of accidents incidents.

There for, the use of this final report for any other purpose except of the prevention of future accidents could drive in wrong ways».

The accident investigation and flight safety committee

The Chairman

Athanasios Bines

Aircraft Engineer (B1, C)

Members

Panagiotes Vasilopoulos

Lieutenant General HAF ret.

Akrivos Tsolakis

Lieutenant Colonel HAF ret.

Nikolaos Goutzouris

Lieutenant General HAF ret.

Ch. Tzonos-Komilis

Captain

Secretary: K.Katsoulakis

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ABBREVIATIONS

AD	: Airworthiness Directive
BKN	: Broken
CAMO	: Continuing Airworthiness Management Organisation
cm	: Centimetre
CPL(A)	: Commercial Pilot Licence
CRS	: Certificate of Release to Service
EASA	: European Aviation Safety Agency
ELT	: Emergency Locator Transmitter
FCL	: Flight Crew Licence
FI	: Flight Instructor
FIC	: Flight Information Centre
FIS	: Flight Information Service
fpm	: Feet per Minute
ft	: Feet
GPS	: Global Positioning System
h	: Hour
hPa	: Hectopascal
IR	: Instrument Rating
kt	: Knot
L	: Left
lbs	: Pounds (Weight)
lt	: Litter
MEL	: Minimum Equipment List
MEP	: Multi Engine Piston Airplanes
MHz	: Megahertz
ml	: Millilitre
NM	: Nautical Mile
POH	Pilot's Operating Handbook
RON	: Research Octane Number
s	: Second
SEP	: Single Engine Piston Airplanes
SMS	: Safety Management System
STC	: Supplemental Type Certificate
TJB	: Technical Journey Logbook
TMA	: Terminal Control Area
U/S	: Unserviceable
VFR	: Visual Flight Rules
ATO	: Approved Training Organisation

AAIASB	: Air Accident Investigation & Aviation Safety Board
AACC	: Athinaí Area Control Center
ACT	: Airodrome Control Tower
CAA	: Civil Aviation Authority

OPERATOR	: AEROCLUB OF WESTERN GREECE
OWNER	: AEROCLUB OF WESTERN GREECE
MANUFACTURER	: CESSNA AIRCRAFT COMPANY
MODEL	: C 172P
NATIONALITY	: CYPRIAN
REGISTRATION MARKS	: 5B-CLB
PLACE OF THE ACCIDENT	: KALAVRYTA
DATE & TIME	: 16/10/2016 & 17:26 h
NOTE	: The time is local (UTC = Local time - 3 h)

SUMMARY

On October 16th, 2016 at 16:25 h, a single engine airplane Cessna 172P, with registration marks 5B-CLB, owned by Aeroclub of West Greece, took off from Megara airport for a training flight. Destinating airport of the airplane was Megara airport as well. On board the airplane were the instructor and the trainee. According to the flight plan, the airplane was heading towards Kalavryta area.

After an hour of flight, at 17:26 h, the airplane crashed over the mountains of Kalavryta area at an elevation of 4,965 ft. The airplane was totally destroyed from impact and a postimpact fire. Both people on board were fatally injured.

On October 17th, 2016 the AAIASB was informed for the airplane accident, and by the same date an investigation team was appointed.

On October the 18th, 2016, the accident was officialy reported and at the same time the States of Registry, Manufacture and Design, the European Union, the European Aviation Safety Agency, the Hellenic Civil Aviation Authority as well as the Committee of Security Incident Report were notified.

The same day the State of Registry, State of Manufacture and State of Design, designated Accredited Representative.

1 FACTUAL INFORMATION

1.1 History of the flight

On October 16th, 2016, a single engine airplane Cessna 172P, with registration marks 5B-CLB, owned by Aeroclub of West Greece, took off from Megara airport for a training flight. On board were the instructor and the trainee. The above flight was the forth for the airplane for that day. A flight plan was filed, with Megara as the departure and destination airport, the ETD reported 16:00 h and the meteorological conditions met the criteria for VFR. The duration of the flight was reported as 02:30 h with a cruising speed of 90 kt and the airplane would pass from the following points: KORINTHOS – PIKAD – RIO – KALAVRITA – PIKAD -KORINTHOS (fig.1), the ETA was reported 18:30 h and as alternate destination was reported the Messologi landing field.



Fig. 1 Intended flight reported by the flight plan

Data from the communication between Megara Control Tower and the pilot, indicated that:

At about 16:10 h the pilot requested and received start up and taxing clearance. The tower cleared the airplane to taxi to the E(cho) intersection, RWY in use 26 L and the QNH 1018 hPa.

At about 16:23 h the pilot reported he was ready for departure and he was cleared for line up to RWY 26 L.

At 16:24 h the pilot received take off clearance from RWY 26L with wind from 220°/07 kt.

At 16:24 h the airplane took off from Megara Airport.

At 16:26 h the pilot reported to the TWR his position, 3 nm west of airport climbing to 2000 ft and that he would change frequency to Athens TMA on 124.025 MHz. The pilot was cleared to change to Athens TMA frequency.

At 16:49 h, the pilot reported to Flight Information Centre (FIC), he was approaching to PIKAD at 4500 ft with ETA over RIO and KALAVRITA about 17:15 h and 17:35 h respectively. He was instructed by the FIC to call again at RIO and informed FIC that he was in contact with Araxos on 125.250 MHz and on 121.125 the Andravida approach if no contact was established with the Araxos.

At 17:15 h the pilot reported to the ANDRAVIDA Approach his position at KALAVRYTA area and that he would leave the area at 17:35 h.

At 17:20 h at the point with coordinates 38° 10' 33.5'' N, 22° 12' 58.7'' E and between the areas TRAPEZA and DIAKOPTO the airplane turned southerly towards KALAVRYTA mountainous terrain at 4500 ft. (fig.2)

At 17:21 h the pilot reported to the FIC that he was in contact with ANDRAVIDA Approach.

At 17:21:29 h, the secondary radar recorded the last airplane trace at an altitude of about 4400 ft, at the point with coordinates 38° 8' 40.5'' N, 22° 12' 5.5'' E.

At 17:24 h, the airplane was at an altitude of about 4540 ft with indicated air speed of 90 kt, at the point with coordinates 38° 4' 42.17'' N, 22° 11' 8.49'' E.

At 17:26:27 h in daylight conditions, the airplane struck the terrain at an elevation of about 4965 ft, with 75 kt airspeed, 2000 ft rate of descent and 30° bank at the point with coordinates 38° 01' 46'' N, 22° 11' 52.4'' E. The terrain slope at the impact point was 40° and the airplane struck the ground with an angle of about 65°, while the angle between the airplane longitudinal axis and the horizontal level was 73°.

At 17:26:35 h, a postimpact fire broke out on the aircraft.

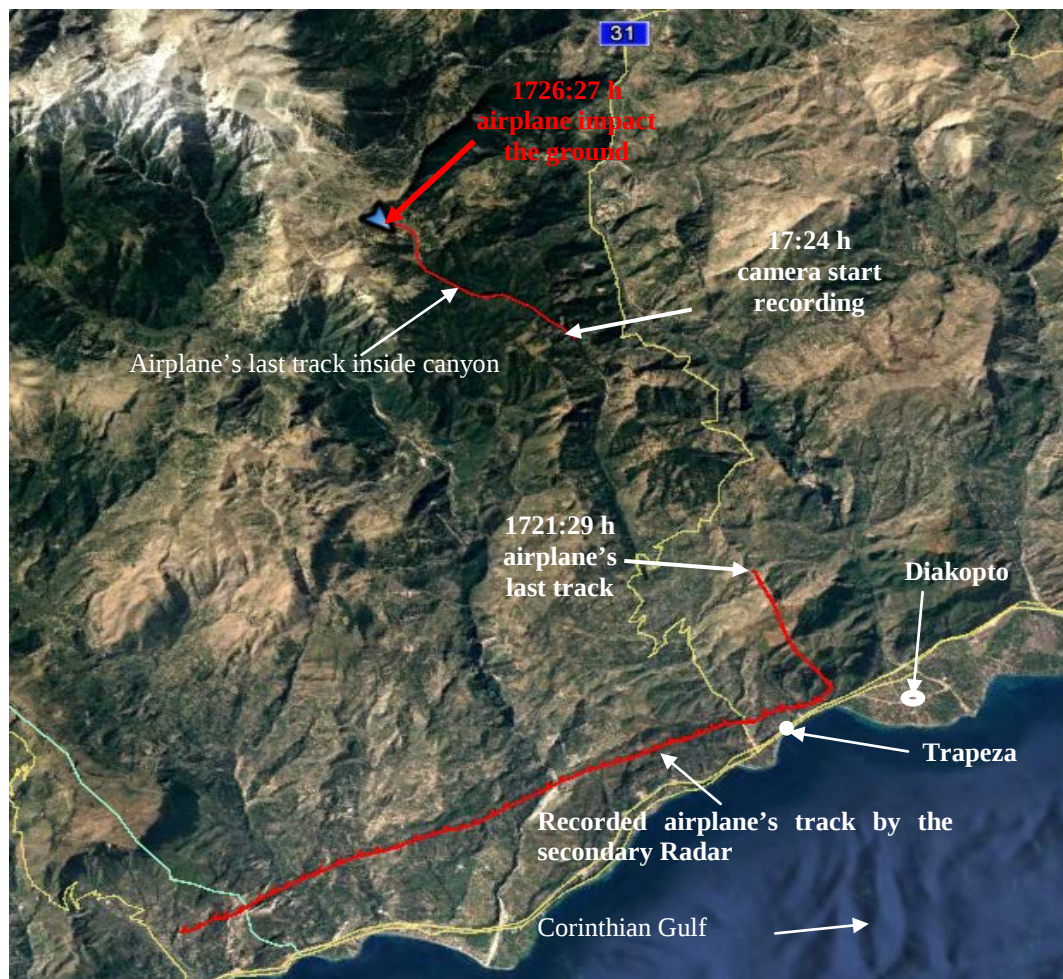


Fig 2. Airplane's track and the point of impact



Fig1. Airplane at the impact point (view looking from above)



Fig2. Airplane at the impact point (view looking from lower)

1.2 Injuries to persons

Injuries	Flight Crew	Passengers	Other
Fatal	2	0	0
Serious	0	0	0
Minor / None	0 / 0	0 / 0	0

1.3 Damage to aircraft

The airplane was totally destroyed by the impact and the following fire.

1.4 Other damage

A small area and some branches of trees were substantially damaged by the postimpact fire around the airplane.

Also a small crater of 55 cm deep was created by the impact forces.

1.5 Personnel information

1.5.1 Instructor

The instructor was male, age 31, Air Force Flight Officer. He held a valid CPL (A) pilot certificate, with initial date of issue September 9th 2011, for single engine airplane valid until October 30th, 2017 and multi engine airplane until April 30th, 2017.

He held flight instructor rating for airplane valid until November 30th 2017 and instrument airplanes valid until April 30th 2017.

The instructor had accumulated more than 4050 total flight hours, including 3000 hours in various single piston engine and jet powered aircraft and about 1850 hours as instructor and he had also attended aerobatic flight training.

The instructor also held a valid class 1, class 2 and LAPL medical certificate issued without limitation.

He held a level 5 English Language proficiency, valid until July 31st, 2022.

His total flight experience during the last 90 days, 7 days and 24 hours were as follows:

- 90 days: 27:55 h
- 7 days: 08:05 h
- 24 hours: 02:50 h

The total on duty time of the pilot during his last 48 h, was 04:45 h, with 38:50 h as crew rest time. The instructor was employed as an instructor by another aeroclub before joined the ATO of West Greece Aeroclub.

1.5.2 Trainee

The trainee, male age 53, was captain of Merchant Navy. On August 30th 2015, he joined as member the West Greece Airclub after he submitted an application on August 20th, 2015.

On October 5th, 2016 he received his familiarization flight and on October 7th, 2016 he received his first training flight. On October 8th, 2016 he received an Evaluation Certificate by the Training Manager and the Chief Flight Instructor.

On October 16th, 2016, the accident day, the trainee received his seventh flight training lesson.

1.6 Aircraft information

1.6.1 General information

The aircraft involved in the accident is an all metal, high-wing, four seats, single engine with tri cycle landing gear system (main and nose wheels) airplane originally designed and built as a general aviation airplane.

Airplane Manufacturer	: Cessna Aircraft Company
Model	: 172 P
Serial Number	: 17275551
Manufacturing Year	: 1982
Registration Marks	: 5B-CLB
Airplane's total flight hours	: 6265:55 h
Flight hours since last major inspection	: 254:15 h
Flight hours since last inspectio	: 08:45 h
Certificate of Registration	: Cyprian, June 01st, 2016

Certificate of Airworthiness : Valid. Issue May 31st ,2016
Expires May 31st,2017

Engine

Manufacturer : Lycoming
Type : O-320-D2J
Number : 1
Serial Number : RL-10413-39A
Total flight hours since manufacturing : 4401:05 h
Flight hours since last major inspection : 456:55 h
Flight hours since last inspection : 08:45 h

Propeller

Manufacturer : Mc Cauley
Type : 1C 160 DTM 7557M1
Number : 1
Serial Number : BI 176
Flight hours since last major inspection : 256:15 h
Flight hours since last inspection : 08:45 h

1.6.2 Global Positioning System (GPS)

A portable GPS had been installed on the airplane over the left control column and connected by two wires with the airplane structure. Examination of the airplane's technical log revealed that on December 21st, 1993 and January 05th, 1994 two modifications took place, the 1993-0525 and the 1994-0017 respectively, related with the antenna the first and with the supplying system the second. Dutch Civil Aviation Authority had issued the airplane's modification list where both modifications were reported. The above equipment was not in operation during the accident flight.

1.6.3 Maintenance

The airplane's airworthiness management was performed by the EL.MG.0050 continuous airworthiness management organization (CAMO), based on a contract between the CAMO and the West Greece Aeroclub.

Also by the same contract, organizations EL.MF.0006 and CY.145.005 were responsible for the airplane's maintenance procedures.

Cypriot Civil Aviation Authority had approved the airplane's maintenance program.

On October 14th, 2016 the last 50 h scheduled inspection had been performed by EL.MF.0006 maintenance organization.

On September 30th, 2016 the last inspections of 50h, 100h and 200h were performed by the EL.MF.0006 maintenance organization while on April 20th, 2016 the last annual inspection and the inspections of 100h and 200h were performed by the CY.145.005 maintenance organization.

1.6.4 Airplane's Fuel

According to the Pilot's Operating Handbook, the airplane was certified for 100LL/100 Aviation fuel.

According to the EASA.IM.A.S.01957 STC (Supplemental Type Certificate)¹ the accident airplane used MOGAS.

All the supplementary instructions of the EASA STC should have been included to the Pilot's Operational Handbook.

According to the available information it was revealed that the airplane's fuel tanks were filled by $\frac{3}{4}$ of their total capacity at the time of the accident.

An amount of 32 gal of fuel were equally divided between the two wings fuel tanks.

The maximum fuel capacity of the airplane was 43 gal.

1.6.5 Airplane Weight

According to the Pilot's Operating Handbook the maximum take off mass is 2400 lbs. The estimated corresponding weight of the airplane at the postimpact point was 2070 lbs.

¹ STC: Supplemental Type Certificate

1.7 Meteorological information

According to Megara Airport METAR, on October 16th, 2016, at about 16:00 h the surface wind was from 230° at 10 kt, the temperature was 23° C (Celsius), the dew point was 17 °C, the altimeter was 1018 hPa and the visibility was 9 km.

The prevailing meteorological conditions at the time of the accident on Kalavryta mountainous area, about 5000 ft, were wind from 270° (west-southwest direction) 15 kt -20 kt, the OAT was 19° C, and the dew point was -3° C, with few to scattered middle level clouds (FEW LOC SCT) and broken high level clouds (SCT LOC BKN).

1.8 Aids to navigation

Not applicable

1.9 Communications

The airplane was equipped with two VHF devices with frequencies between 117.975 - 137.00 MHz. No problem with the communication between the a/c and Megara Control Tower, Athinai FIC and Andravida Approach was reported.

Communications between the a/c and Megara Control Tower and between the a/c and Athinai FIC were recorded and the transcript was provided to AAIASB.

1.10 Airodrome information

Not applicable

1.11 Flight recorders

The flight track of the airplane after its departure from LGMG airport has been recorded from Air Force (primarily) and Athinai Area Control Center (AACC) Secondary Radar. Also a video camera was mounted inside the aircraft and in the top of the cockpit which recorded the aircraft's last 2 min and 27 sec. The above camera was found within the wreckage close to the starboard's wing leading edge. All damage to the camera protective cover and especially to the installation point is attributed to the postcrash fire while no damage was found to the camera's frame and memory chip.



Fig 3. The point where camera was found

1.11.1 Air Force Radar

Air Force Radar data indicate the accident airplane track at the points S1,S2,S3,S4 (fig 3) with coordinates as follows:

Point	Coordinates (N, E)	Time	Altitude (ft)	Course (Deg.)
S1	38° 1' 0'', 22° 42' 0''	16:52:10	4500	315
S2	38° 5' 0'', 22° 34' 60''	17:01:26	3000	270
S3	38° 7' 0'', 22° 18' 0''	17:14:06	3750	297
S4	Not available	17:25:00	---	---

There are no data available for the point S4, apart from the time that the point S4 was recorded and it is the last recorded position of the airplane from this radar. Airplane's estimated track according to the above radar data is shown in Fig 3.



Fig 3. Airplane's possible track according to the above radar data

1.11.2 AACC Radar

System PALAS data indicate the flight track of the airplane after its departure from LGMG airport, for its last 08:21 min, as fig 4 shows (from 17:13:08 h until 17:21:29 h where was the last recording)



Fig4. Airplane's possible track according to the above radar data

After 17:21:29 h we have not any further data from AACC Radar.

1.11.3 Action camera inside the airplane

A 04:48 min video has been recovered from the internal memory camera's chip, 02:27 min with the airplane still in flight and the rest 02:21 min after crash.

Data from video camera showed the flight from 17:24:00 h (time 00:00) until 17:26:27 h when the airplane crashed into terrain (time 02:27), the following:

- The airplane was flying inside a gorge and before its crash in a valley at a mountainous terrain of Kalavryta in a southerly course at low altitude above the ground even lower than the mountaintop. The video data show that the airplane altitude at video time 00:00 min until 02:20 min was between 1024 ft and 350 ft AGL.
- As we can see in Fig.5 of the appendix, the airplane had a shallow climbing course following the terrain masking inside the gorge. The airplane's indicated airspeed had a fluctuation of 10 kt.
- Except the last 3 s of the video flight time, the accident airplane was under the trainee pilot's control.

- During the flight in the gorge, the instructor was making the decision for the turning points
- The engine was running between 2100 rpm and 2350 rpm.
- The engine's oil pressure and temperature indications were in green sector.
- The fuel indications were in the $\frac{3}{4}$ of the total fuel capacity of each tank.
- The artificial horizon on the trainee pilot instrument panel was covered by an orange 7.5 cm x 7.5 cm dimensions paper, with the indication «U/S» underwritten
- On the trainee control column a portable GPS device was mounted, connected by two wires with the airplane.
- As we can see at the beginning of the video and few seconds before the airplane crashed into terrain, the pilot (instructor) applied left rudder pressure.
- The mixture lever was in the rich position. The carburetor lever was in forward position and the fuel selector on 'Both' position. The flaps were retracted.
- The outside air temperature was 15°C.
- In the radio communication unit the frequencies of Adravida Approach, Athinai FIC and Araxos TWR were selected and the navigation aids of LGEL VOR and Lemnos VOR were also selected.

In fig. 5, 6 and 7 the course of the airplane in the gorge is shown as follows:

- At 17:24:00 h, point A: The instructor turned on the camera and began recording. 38° 04' 42.17'' N and 022° 11' 8.49'' E were the airplane's Coordinates at that point, at an altitude of 4540 ft and with an indicated airspeed of 90 kt.
- At 17:24:22 h, point B: The instructor turned on and started taking pictures with his cellphone while the trainee pilot had the control of the airplane. The airplane was at an altitude of 4550 ft with an indicated airspeed of 80 kt.



Fig. 3 the airplane course inside the canyon

- At 17:25:57 h, point C: the instructor shows the exit point from the valley to the trainee pilot.
- At 17:25:59 h, point D: the engine's rpm was increased; the rate of climb and the altitude started progressively increasing while the indicated airspeed was decreasing. The airplane performed a 30° bank left turn into the valley. The indicated airspeed had a fluctuation of 10 kt.
- At 17:26:19 h, point E: The vertical speed indicator reached a maximum indication of 1000 fpm with an indicated airspeed of 65 kt at an altitude of about 5120 ft.
- At 17:26:20 h, point Z: The airplane reached a maximum altitude of about 5150 ft with an indicated airspeed of 65 kt and 800fpm rate of climb. The turn and slip indicator showed up the maximum lean toward right. The airplane started left banking.

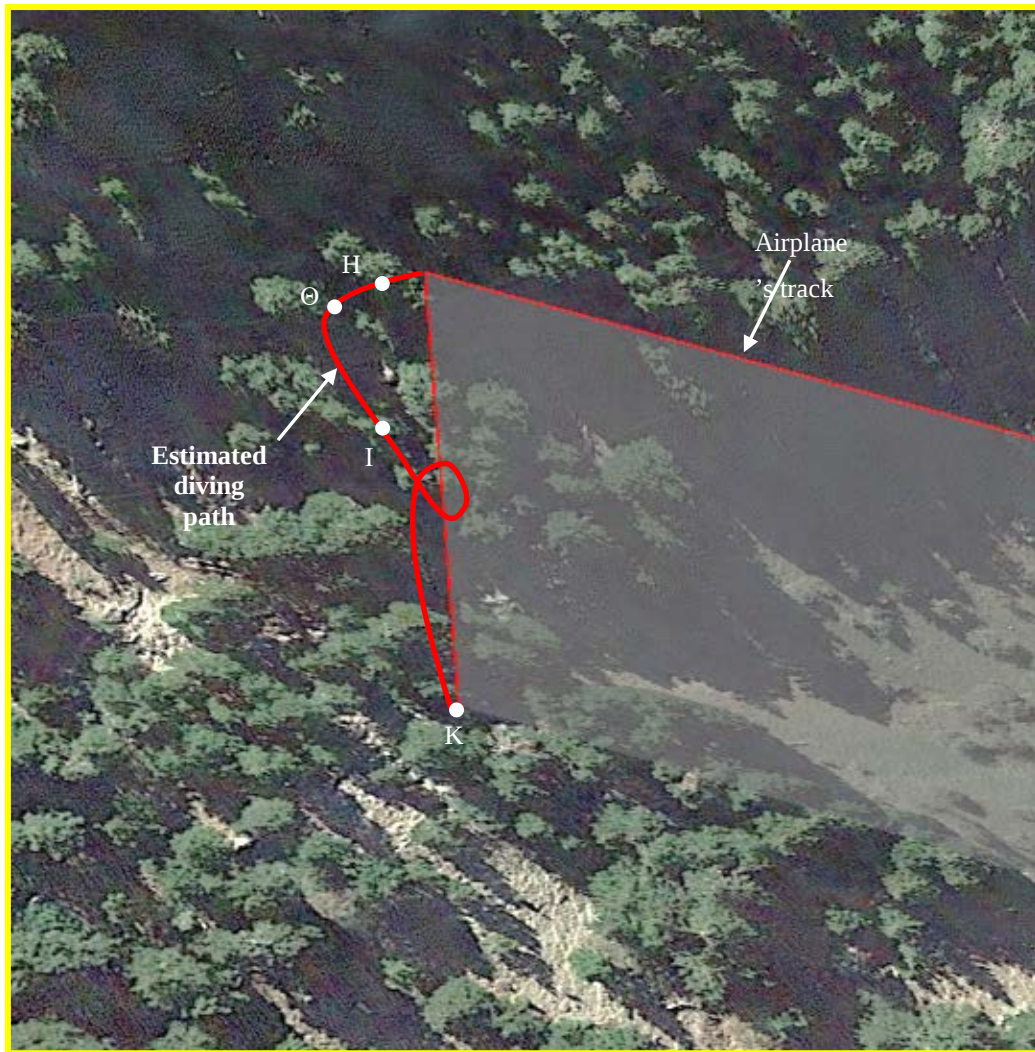


Fig.5 Detail B, estimated diving path at impact point

- At 17:26:24 h, point H: The airplane reached an altitude of about 5100 ft, the airplane reached its minimum airspeed of 50 kt and the rate of climb of about 100 fpm. The airplane reached an approximate 80° left-bank.
- At 16:26:25 h, point Θ: The airplane reached an altitude of about 5100ft, the airspeed was about 55 kt and the indication in the vertical speed indicator was 0 fpm. The airplane was in approximately 10° dive with about 85° left-bank. The controls were pulled all the way back and the left rudder was applied.
- At 17:26:26 h, point I: The airplane's left bank reached a value greater than 90°. The airspeed and the rate of descent were increasing.
- At 17:26:27 h, point K: The airplane crashed into the mountainous terrain. The airspeed was about 75 kt, the altitude was 4900 ft and the rate of descent was 2000 fpm. The power lever was in full open position (maximum power) and the fuel was

in rich position. The carburetor heat lever was in FWD position and the fuel control valve was on 'Both' position, while the flaps selector was found in up position.

The video camera inside the cockpit was detached from mounting point during the impact and ended up in front of the right wing leading edge after 5s.

- At 17:26:35 h: A postcrash fire broke out and was recorded by the video camera till the end of the recording.

1.12 Wreckage and impact information

1.12.1 Postaccident Description

The airplane collided with Aroania (Helmos) mountain at an elevation of 4965 ft, with coordinates 38° 01' 46,0'' N and 022° 11' 52,4''E. At the impact point the terrain slope is 40 deg. The impact point was located approximately 2.38 km North of Kalavryta ski resort.

The airplane impacted a mountainous tree-covered terrain surrounded by mountaintops of 5276 ft westerly, 5663 ft northerly and 5511 ft easterly of impact point. (fig. 8)

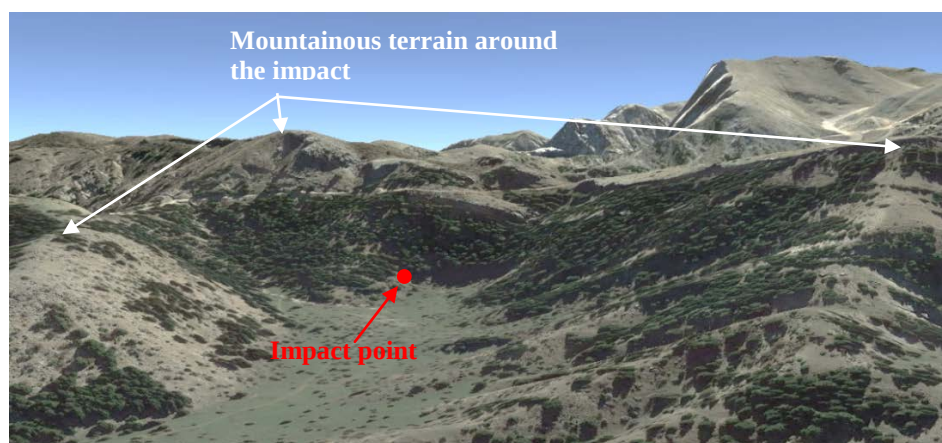


FIG 8 Airplane's accident area

1.12.2 Airplane Impact

The airplane impacted the terrain with a diving angle of 65 deg while the angle between its longitudinal axis and the horizontal level was 73 deg. The airplane's longitudinal axis direction was 170 deg.

Examination of the wreckage revealed that it was the engine that first impacted the terrain and then the left wing tip. Because of the postimpact forces the propeller was

found about 55 cm under the ground (fig. 4), while the leading edge of left wing tip was deformed (fig. 5). The empennage remained intact while some tree branches were damaged along the airplane's path.

The remainder of the wreckage was found concentrated after the impact.



**Fig.4 The accident airplane' wreckage were showed
The engine's position**



Fig. 5 The deformed airplane's left wing tip

1.12.3 Airplane Examination

From the postimpact airplane examination it was revealed that the airplane was whole during the impact without having any part of it separated.

1.12.3.1 Fuselage - Wings - Horizontal stabilizer and vertical fin

Examination of the accident airplane revealed that no damage were found to the rudder and elevator control surfaces and they were attached to the vertical and horizontal stabilizers. Also the trim tab was found attached to the elevator.

The rudder was displaced left, the two elevators were displaced up with symmetrical motion and the trim tab was in neutral position.

The vertical fin leading edge showed damage as a consequence of the fire.

Examination of the airframe revealed that it had been destroyed from impact forces and postimpact fire.

The Engine and Cockpit have been unified, while the nose wheel was found against the bottom of the fuselage between the main landing system.

The firewall and the cockpit were found totally deformed.

Examination of the airplane wings revealed that both ailerons and flaps were hinged in the trailing edge of the wings.

The half upper side of the left wing from the root revealed extensive damage from the postimpact fire. Its wing tip was compressed as the airplane crashed on the slope terrain. Examination of the accident airplane revealed extensive damage to the bottom of the left wing from wing root up to the end of the trailing edge flap. The remaining portion of the wing bottom was compressed from the postimpact forces.

Examination of the right wing revealed a whole length damage to the upper and lower part from the postimpact fire.

However, postaccident examination revealed extensive strong fuel smelling.

1.12.3.2 Engine

The airplane impacted the terrain and the propeller was found about 55 cm into the ground. The propeller blades exhibited bending, while the left hand blade exhibited twisting and sweeping back (fig.6).

The engine's shaft in relation to the propeller's shaft exhibited an angle of about 39° and two of the six propeller bolt connectors with engine were broken. The propeller blades surface exhibited scratching while the propeller blades leading edge were found with dents to the whole length.

The engine's body was fractured and an engine piston showed at the aft section of the engine.

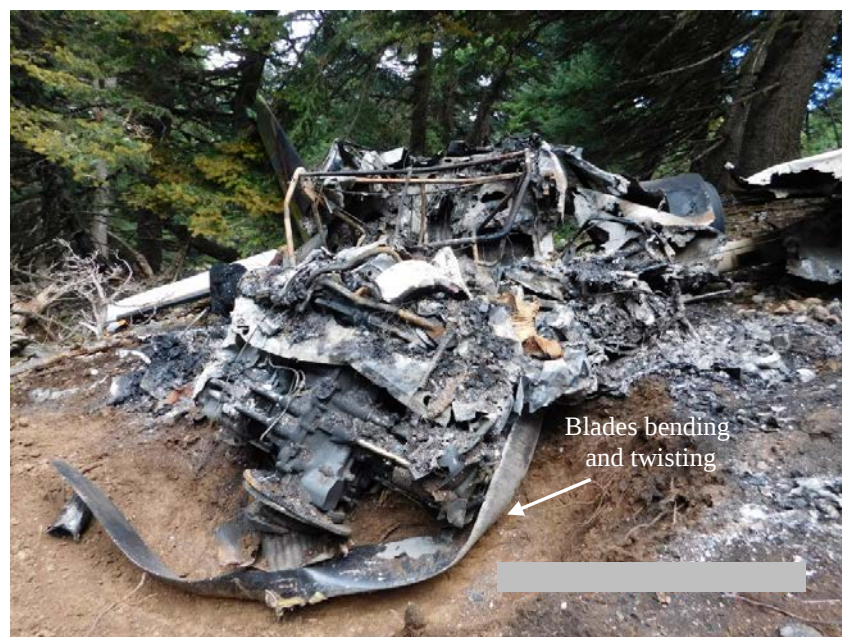


Fig.6 The airplane's engine

1.12.3.3 Instrument of Indicated Airspeed

The airplane's airspeed indicator, was found and recovered on the impact point, in front of the right wing's leading edge. At the recovery point, the airspeed indicator had an indication of 130 kt.



Fig.7 the recovered airspeed indicator

The instrument's outer case was deformed as a result of crash and postimpact fire, while the front glass cover part of the instrument was broken by half.

1.13 Medical and pathological information

From the post-mortem examination of the instructor and the trainee, there was no evidence that physiological factors and drugs affected the performance of the crew during flight. In addition, toxicology testing results of the instructor and trainee were negative for carbon monoxide, while for the trainee it was not feasible the performance of an alcohol blood test examination.

1.14 Fire

At 17:26:35 h, 8 s after impacting on the ground, the airplane video camera captured images of the airplane postimpact fire.

Exept the wing tip and trailing edge of the left wing, all the other airplane structure of the cockpit, the fuselage until the horizontal stabilizer and vertical fin were totally destroyed from the postcrash fire.

Also, postaccident examination revealed that some parts of both wings surfaces was found melted down.

1.15 Survival aspects

1.15.1 Search and Rescue operation after airplane communication loss

At 18:05 h, the Athinai Flight Control Center (ΚΕΠΙΑΘ) declared an uncertainty phase, because there was no contact with the a/c 30 min after the time that the a/c should have contacted Adravida Approach.

At about 18:30 h, Athinai Flight Control Center (AFCC), after subsequent attempts to establish communication with the airplane had failed, declared a distress phase.

At 13:56 h, on October 17th, 2016, the Athinai Flight Control Center (AFCC) canceled the distress phase with the completion of the Search and Rescue operation that led to discovering the airplane's wreckage.

1.15.2 Emergency Locator Transmitter (ELT)

The airplane was equipped with Kannad 406 AF-Compact Emergency Locator Transmitter with product number S1840501-01 and serial number 2620025- 0234. At May 16th, 2016 the battery of the ELT had been replaced because of its life time limits had expired. An operational radio control test was performed after battery replacement. No emergency signal from the accident airplane was received by the Search and Rescue Service Center after the airplane's impact.

Evidence of the airplane's ELT was not found on the wreckage side.

1.16 Tests and research

1.16.1 Fuel Test

The examination of accident airplane found no quantity of fuel or oil that could have been taken as a sample for testing. A quantity of 500 ml of fuel sample was taken from the fuel tank from which the airplane had been refueled at Megara Airport the day of the accident. The fuel sample was sent to an accredited laboratory for quality control examination purposes.

Testing of the accident airplane's fuel revealed that all measurable factors of 95 octane fuel was within normal limits, except RON and sulphur.

1.16.2 Examination of Airspeed Indicator

After the recovery of the airspeed indicator an examination and disassembly performed by specialists. The examination of the ASI revealed that the instrument was in very good condition and there was no evidence that any component was absent while the indicated airspeed of 130 kt was corresponding to the position of the internal mechanism components.

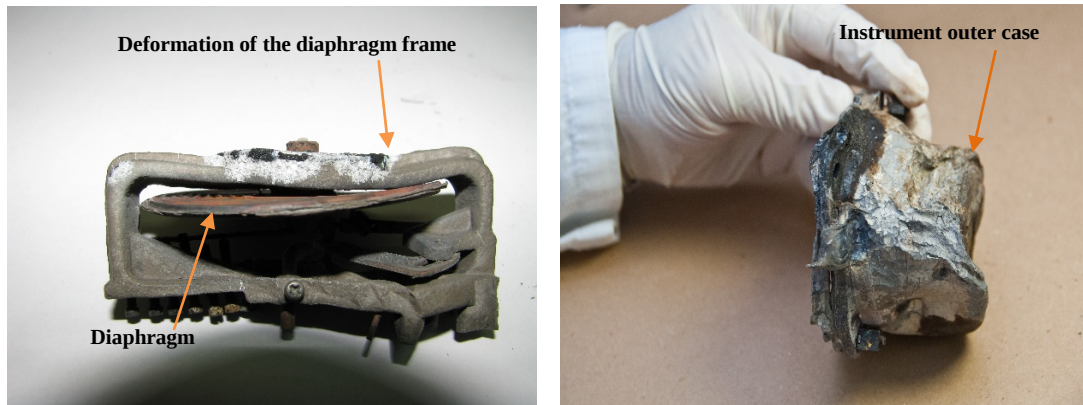


Fig. 1 The deformed ASI from postimpact forces

Also after the above instrument examination, the airspeed pointer and the indicator display were sent to a specific laboratory for macroscopic and stereomacroscopic examination for identification of any mark over the indicator display from the airspeed pointer.

According to the above examination results, no useful conclusion could be reached due to the condition of the indicator display.

1.17 Organizational and management information

1.17.1 West Greece Aeroclub Approved Training Organization

The Aeroclub West Greece training organization held a valid Greek CAA's operating certificate issued according to the regulations with certificate number GR-ATO-128 based in Arta's Hanopoulo.

On July 06th, 2015, the West Greece Aeroclub submitted an application to HCAA to be certified as an approved training organization and on October 21st, 2015, HCAA provided the initial certification.

With the initial certification the training organization was capable of performing flight training for private pilot's licence.

Arahtos ‘Captain Anastasios Balatsukas’ airfield was chosen as the location for ground and flight training while Megara and Preveza’s Aktio airports were appointed as locations for flight training only.

One Cessna 172 P airplane registered 5B-CLB and one Cessna 172M registered SX-ACO were used for flight training by the training organization.

The administrative structure of the Organization was composed of the Accountable Manager, the Head of Training, the Chief Flight Instructor, the Compliance Monitoring Manager, the Safety Manager and the Chief Theoretical Knowledge Instructor. All the above members were approved by HCAA.

The roles of the Safety Manager (SM) and the Compliance Monitoring Manager (CMM) were satisfied by a single person, also the roles of Chief Flight Instructor (CFI) and Head of Training (HoT) were met by a single person as well.

The Head of Training, the Compliance Monitoring Manager and the Safety Manager were responsible to the Accountable Manager. The Chief Flight Instructor and the Chief Theoretical Knowledge Instructor were responsible to the Head of Training.

In the Organization Management Manual the procedures of the organization’s compliance monitoring system are described. For that purpose, the Compliance Monitoring Manager was performing scheduled audits according to existing checklists. On January and February the annual audits were programmed according to the described audit program.

The structure and operation of the Organization, the implementation of training and the description of the safety system were described on the CAA approved manuals. The organization submits to the CAA any revised manuals for approval.

In the Organization’s Operation Manual, part B Technical in paragraph 5 ‘allowable deficiencies’ the procedures are described, that take place should the airplane’s minimum equipment list (MEL) has been issued (if applicable) by the operator. At the above mentioned Manual, it is referred: *‘Air club West Greece has developed MELs with the intention of improving aircraft utilization and thereby provides more convenient and economic training or hire’*. The above MEL list was not issued.

1.17.1.1 Accountable Manager Responsibilities

Among other duties, according to the organization's manuals, the accountable Manager is accountable for:

- . The overall responsibility of the safety management system.
- . Setting the Safety policy of the Organisation.
- . Ensuring that all training activities can be financed and carried out in accordance with the approved procedures.
- . Organises the 'safety review panel' meetings once a year.
- . Ensuring the implementation and the effectiveness of the Safety Management Policy and procedures
- . Advising the Post Holders and other key safety personnel of the effectiveness of the Organisation's Safety Policy
- . Being responsible for all financial activities with students and employers of the Organization while maintaining an effective working relationship with the local authorities.

1.17.1.2 Head of Training and Chief Flight Instructor's Responsibilities

Among other duties, according to the organization's manuals the Head of Training and Chief Flight Instructor have the following responsibilities:

- . Ensure that the implemented training is in compliance with Part- FCL.
- . Have the overall responsibility to ensure that the training is in compliance with the appropriate requirements.
- . Are responsible for supervision of flights and standardisation for the flight training.
- . Supervise the instructors and staff and assist them in the identification of hazards and risks and provide the necessary guidance and support to mitigate any risk.
- . Supervise the progress of each student individually.

1.17.1.3 Safety Manager Responsibilities

Among other duties, according to the Organization's Manuals the Safety Manager is responsible for:

- . The management of the organization's safety management system regarding its monitoring and the corrective actions that are taken.
- . The implementation of the Safety Management System (SMS) under the supervision of Accountable manager.
- . Executing the strategy and objectives as delegated by the Accountable Manager.

1.17.1.4 Compliance Monitoring Manager's Responsibilities

Among other duties, according to the Organization's Manuals the CMM is responsible for:

- . Monitors the implementation and controls the Safety Management System. Has a direct reporting line to the AM.
- . The CMM and the AM will meet at least once a year to ensure the SMS is working.
The minutes of meeting must be documented.
- . Maintaining an effective working relationship with the Regulatory Authorities

1.17.1.5 Programming and conducting of flights

There was weekly and daily flights programming from the administration personnel after the Head of Training's authorization.

The authorization of each flight was in the HoT's area of responsibility and in the case of his absence the safety manager was responsible for this task.

Every instructor was responsible for the final flight authorization in the case of training flight.

The programme was revised daily according to the airplane's programmed inspections and the prevailing meteorological conditions.

1.17.1.6 Organizational Training Programme

The training program was conducted according to the CAA approved training manual and was divided into two phases, the theoretical training and the flying training.

Theoretical training course was comprised from nine (9) theoretical subjects, 130 hours of instruction in total.

The flying training shall comprise a total of at least 45 hours. Within the total of 45 hours, applicants shall complete at least 35 hours of dual instruction and at least 10 hours of supervised solo flight time.

The flying training is divided into two (2) phases. In phase 1 the trainee does exercises accompanied by the instructor for a total of at least 12 hours, before flying solo for the first time for a duration of 0.5 h. In phase 2 the trainee does exercises up to a total of 23 hours of dual flight instruction and 9.5 hours solo flight.

After the end of each flying lesson the instructor shall complete the evaluation form with all the necessary flight details and comments.

According to the school's training program, the seventh lesson, when the accident happened, includes preflight briefing, training flight and debriefing. During that flying lesson the student should have been trained in all kinds of descending.

1.17.1.7 Conclusions of the students' files examination

From part of the students' records examination and from the interviews the following details were summed:

- A student was found to be flying Solo from Preveza on the 24/01/2016 as well as 14 days after, on the 07/02/16, to be flying Solo from Arachthos without any prior dual training been registered.
- On January 24th, 2016, a student was found to be flying first solo flight and after that on February 7th, 2016, was found to fly solo navigation with the following legs, Arta-Preveza, Preveza- Kerkyra and Kerkyra- Preveza. The following flight time for each leg were logged: 09:30-09:50, 09:50-10:45, and 10:50-11:40. The above flight logs of take-offs and landings indicated flights without any stop. For each flight the pilot should have filed a new flight plan with the Aeronautical Information Center.
- From the students' record examination found three legs navigation without any prior dual training even more in international airports as Kerkyra LGKR or in landing fields as Karditsa and Kopaida.
- On June 9th, 2016, on a student's record was found that he had flown three solo flights whilst the aircraft was in Mesologi airfield from June 7th, 2016 until June 10th, 2016 for maintenance.

- On May 7th, 2016, a training flight on the student record was entered as solo flight while on the technical log was entered as dual training.
- From some of the students' records revealed entries as solo flights without being justified on aircrafts' tech logs and control tower's diary.

1.17.1.8 Safety Management System

A Safety Management System has been developed by the Organization as described in the Management Manual. The Accountable manager is responsible for the implementation and maintenance of the Organization's procedures and was also responsible for setting and signing the Organization's safety policy.

Part of the Safety Manager's as well as of the Compliance Monitoring Manager's duties are listed in paragraphs 1.17.1.3 και 1.17.1.4.

For the monitoring of the correct procedures application in the Organisation, an annual internal audit program had been established by the Compliance Monitoring Manager.

1.17.2 Civil Aviation Authority

The Civil Aviation Authority constitutes the regulatory authority responsible for the licensing and auditing of the Approved Training Organisations. These responsibilities are carried out by the licensing and certifications department of the Flight Standards Division. Approved Training Organization's audits are performed by the Aviation Standards Division Inspectors.

Flight Standards Division responsible for the certification and audit of ATO has issued the Personnel Licensing Procedure Manual where all audit checklists and procedures to be followed upon initial certification and during ATO audits, are included.

For an ATO to be licensed, all necessary documents and manuals have to be submitted to the flight standard division where they are delegated to an inspector from the licensing department. Following the manuals and facilities auditing and after having rectified any findings, the ATO's approval is issued.

Following the approval, the organisation falls under the annual auditing program carried out by the licensing department. Audits have to be completed every 24 months, as stated in the CAA's manual, whilst on new founded ATO the first audit must be carried out within a much smaller, not specified, time interval.

All documents related to the ATO licensing and operational procedures, are kept at the licensing and certifications department Record Keeping unit.

1.17.3 Airplane Technical Log

For the airplane flight record keeping, the West Greece Aeroclub used a technical log book which has been developed by the EL.MG.0050 Continuing Airworthiness Management Organization (CAMO)

The technical logbook was comprised of fields used for recording the following: aircraft defects and corresponding corrective actions, flight legs, crew details, flight hours, number of landings, fuel quantity of each tank separately, while there were fields to be filled before the first flight of the day as well as fields to be filled after the day's last flight.

Among the fields that had to be filled before each day's first flight were the following:

- Pre-flight inspection
- Airplane acceptance by the pilot
- Recording of the arranged fuel quantity to be supplied to the airplane

After the last flight of the day the last pilot signature had to be filled.

After having reviewed the technical logbooks of both ATO's airplanes it was found that all entries were of the same writing character, a number of them were written in pencil while others had been corrected using correction fluid.

Also, after the examination of the technical logs in comparison with the flight plans from Megara airport, it was found that the pilot's name reported was different than the name declared in the flight plan.

1.17.4 Instructor's integration procedure by ATO

On July 29th, 2015, the ATO submitted to CAA the application and the private agreement between the ATO and the instructor, in which the instructor is nominated as Chief Flight Instructor and Chief Theoretical Knowledge Instructor. From those two documents, it was revealed that the instructor's signature was different compared with other instructor's documents signature. In the instructor's file the examination revealed a private agreement where his signature was different from the above documents but the same in others documents signed by the instructor.

On September 22th, 2015, the instructor, who was killed in the accident, via personal report sent to CAA/Flight Standard Division, denies his participation in the newfound ATO as Chief Flight Instructor and also reports that he had never signed such an agreement while on October 21st, 2015, with his new personal report sent to CAA/Flight Standard Division also states he is not Chief Flight Instructor in the ATO due to his professional activities.

On October 10th, 2015, a new agreement had been signed with ATO reported his collaboration as instructor.

The initial trainer's evaluation form created by the Head of Training and Chief Flight Instructor, was located within the instructor's file, dated 22/04/2016.

The investigation revealed that the Airclub's president had been advised not to enrol the specific instructor in ATO due to the fact that he executed flights which were not consistent with the flight safety regulations. The president of the airclub had also been informed about a video showing stunts, but he had never watched it.

Head of Training and Chief Flight Instructor had not been informed in time that such a video existed and its notification to CAA.

1.18 Additional information

1.18.1 Aerobatic flights

On 03/02/2016 relevant correspondence from AAIASB informed CAA/Flight Standard Division regarding a post in a website showing an aircraft registered under the marks G-IMAD, flying low over a populated area, performing aerobatic manoeuvres. On the same correspondence the AAIASB asked CAA to take the necessary actions in the context of flight safety improvement and aircraft accident prevention.

The CAA/Flight Standard Division also informed the airclub owning this aircraft of this website post also notifying of the pilot's name, the kind of aerobatic manoeuvre and asked for a detailed report.

On 12/02/2016 a disciplinary committee formulated by the airclub and after examining the video identified all the pilot's violations deregistered him as aeroclub member.

The AAIASB had been informed from both CAA and aircraft's Aeroclub regarding the above mentioned actions after the accident. The pilot in the video had claimed that the video was a product of processing and the AAIASB asked from the Crime Research

Directory of Hellenic Police to verify the risky manoeuvres video validity, where it was verified that the video was valid.

1.18.2 Mountain waves

Air mass flow on windward side of topography is forced simultaneously above and around the ridge through existing valleys, resulting to decrease of wind speed (horizontal component) and increase of updrafts (vertical component).

On mountain ridge and under atmospheric stability conditions, the updrafts are reduced while the wind speed significantly increases due to Venturi effect.

At lee side of topography, the flow is under relief whose intensity depends mainly on the height of topography and atmospheric stability conditions. These result in formation of vortices and downdrafts or vertical wind shear conditions. The phenomenon is more intense when you fly too close and below the ridge line of sight.

1.18.3 Airspeed Indicator²

The airspeed indicator (ASI) is one of the basic airplane's instrument. In the ASI, a diaphragm is mounted inside the instrument's shell. Through pitot tube connection, air pressure is fed inside the diaphragm. Through static pressure ports connection, static pressure is fed to the interior of the shell and encompasses the diaphragm. As the aircraft speed changes, the pitot pressure expands or retracts the diaphragm. The mechanical connection between the diaphragm and the instrument's pointer causes the pointer's movement over the indicator display.

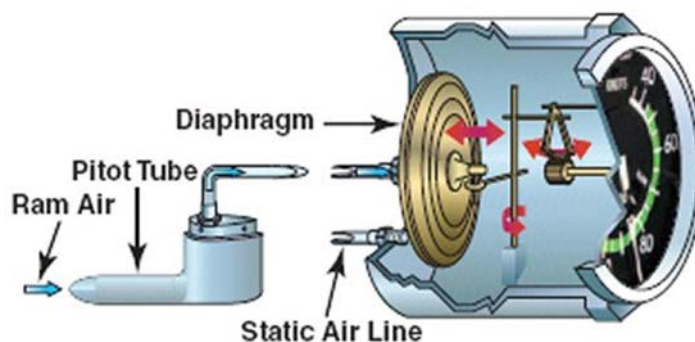


Fig.1: The Airspeed Indicator with the Pitot Tube

² From FAA Aviation Maintenance Technician Handbook

1.19 Useful or effective investigation techniques

Not applicable

2 ANALYSIS

2.1 Previous flights of the day

The accident flight was the fourth of the day for the airplane and the third for the instructor.

2.1.1 Flight preparation

2.1.2 Preparation of the three first flights

Before the first flight of the day, in the airplane's Technical Journey Logbook (TJL) designated area, the preflight inspection had been certified from an authorised pilot who had been trained by the CAMO.

The instructor also signed for the airplane's acceptance before the first flight of the day. For the next three flights there was no preflight inspection and airplane's acceptance signed by the pilot, because there were not designated areas in the TJL.

The airplane was scheduled to have on board 140 lt of fuel before the first flight. There was an amount of 40 lt of fuel remaining from the day before. On October 16th, 2016, the day of the accident, an amount of 86 lt of fuel was added to the remaining 40 lt giving a total amount of 126 lt of fuel, according to the recordkeeping book for fuel and of course less than what was reported on TJL.

Non existence of designated areas in the TJL for the certification of the pre flight inspections as well as the recorded difference between the TJL recorded and the above calculated fuel quantity did not contribute to the accident.

2.1.3 The first three flights

On October 16th, 2016, the first and second scheduled flights performed at 10:00 h and 13:05 h respectively by the accident instructor with two different trainees. The Megara Airport was the departure and destination aerodrome.

From 14:00 h till 15:40 h the third flight was performed. The accident instructor and trainee were not on board this flight.

A total of 02:50 h logged and nine landings were performed on these three flights while there wasn't any defect entry in the airplane's technical log.

2.2 Flight of the accident

2.2.1 Flight plan

Before the flight, a flight plan had been filed according to the CAA's designated form. The aircraft's intended flight according to the flight plan was navigation and was not compatible with the student's training flight exercise corresponding in his seventh lesson of the school's training manual.

2.2.2 The flight

At about 16:24 h the airplane took off from Megara airport for the fourth flight of the day which was a training one. After the airplane had been airborne it headed towards the points of KORINTHOS and PIKAD overflying the last one at an altitude of about 4500 ft at 16:50 h.

At about 17:20:20 h at the point with coordinates 38° 10' 33.5" N, 022° 12' 58.7" E and between the areas TRAPEZA and DIAKOPTO at an altitude of 4500 ft, the pilot turned left flying over mountainous terrain with 2714 ft mountain top.

At 17:21:29 h data of AACC secondary radar shows the last airplane's track at the point with coordinates 38° 8' 40.5" N, 022° 12' 5.5" E at an altitude of about 4400 ft. while at 17:25:00 h, the Air Force primary radar recorded the last airplane's position without coordinates provided. The aircraft's flying through the mountain terrain made its detection by the radars impossible.

The only information received regarding the aircraft's heading, comes from an eye witness located at 38° 06' 43,8" N and 022° 10' 41.1" who saw the aircraft flying above him with a southern course towards Profitis Elias and Fteroto areas in the Kalavryta area in Achaia county.

2.2.3 The accident flight as recorded by the action camera

The next aircraft flight records were retrieved from a video camera inside the cockpit. When the camera started to record, the aircraft was at an altitude of 1024 ft AGL inside

a gorge of the mountainous terrain as shows in fig. 5 of paragraph 1.11.3 headed southerly and controlled by the trainee.

The estimated prevailing wind on the windward side, at the aircraft's altitude was from 260°/15-20 kt. Due to mountainous terrain, at the mountain lee side vertical wind shear and rotors, that create turbulent waves mainly at the mountain top as well as in lower altitudes, may be formed

During the aircraft's flight inside the gorge and inside the valley a 10 kt fluctuation on aircraft indicated airspeed was noticed, a fact that proves the existance of turbulence.

From the two tank fuel quantity indicators it is evident that the aircraft had sufficient fuel and also, considering the fuel selector valve's position and the fact that both fuel quantity indicators had the same indication, it is evident that both fuel tanks were supplying the engine with fuel. The examination of the wreckage indicated strong fuel smelling.

The aircraft weight during the recorded flight was less than the maximum take-off weight. The aircraft's configuration during the flight was correct. In more detail, the mixture lever was in rich position and the carburetor heating lever was in full forward position, indicating that the carburetor heating was closed. The position of the above control levers was the indicated according to flight phase and the prevailing meteorological conditions. Also, the flaps were retracted.

2.2.3.1 Instructor's actions during the flight

From the recorded flight by the camera and in video time 00:22s when the aircraft was flying at an altitude of about 4550 ft inside the gorge, under the trainee's control the examination revealed lack of instructor's supervision since he was busy taking pictures with his cellular telephone of the outside of aircraft surroundings.

During the flight the instructor, after trainee's nod by making hand movement, gave instructions of the turning points inside the gorge and to move further to the right.

The instructor's behaviour during this flight leg, shows that he was familiar with the flight terrain.

In video time 01:59 s, while the aircraft entered the valley into turbulence at an altitude of about 4820 ft, the engine's RPM increased and the aircraft began climbing to clear a mountaintop of about 5340 ft and escape from the canyon. The distance to be covered to clear the mountaintop was calculated as 0.679 NM.

In video time 02:20 s, the aircraft reached its maximum climbing altitude of about 5150 ft with its maximum vertical speed of 1000 fpm, experienced a drop down of the climbing angle and the vertical speed decreased. The aircraft climbed 330 ft while 190 ft, was remaining to clear the mountaintop.

At that point where the instructor started his climb (point D of fig.6, paragraph 1.11.3), it was calculated that if the climb had been performed according to the speed and rate of climb indicated in the Pilot's Operating Manual, the aircraft would have climbed 245 ft at the end of a distance of 0.673 nm which is less than the required climb of 520 ft to clear the mountaintop. However the instructor had to ensure that the climb should have been initiated from a distance of 1.437 nm in order to enable the aircraft to clear the mountain terrain.

The above calculation had been performed without taking into account the existence of turbulence and downdraughts which were formed at the lee side of a mountain formation at that area and reduced aircraft's climb capabilities.

It is evident from the above that, due to the fact that the instructor was familiar with the specific flight area on one hand and overconfident in his ability to fly the aircraft on the other hand, since he was an experienced pilot, resulted to complacency from his side which prevented him from acquiring correct situational awareness of the aircraft's status.

This was probably the cause for the delayed instructor's decision to execute the climb and overflight the mountain top long before entering the last valey. The delay in making that critical decision, forced him to perform climb with rate of climb much greater than the maximum one according to the aircraft performance for the specific altitude it was flying, resulted to the reduction of the aircraft kinetic energy and its climb angle.

According to the values of the atmospheric pressure and temperature in the specific flight area, it was calculated that for the altitude of about 4900 ft the density altitude was 6450 ft. The density altitude⁵ of 6450 ft was greater than the flight level of the aircraft and had a negative influence in the aerodynamic performance of the aircraft and the performance of the engine and propellers, creating an aggravating factor for the aircraft climb.

From the available video it is noticed that when the climb angle of the aircraft started to reduce, the aircraft started also to bank to the left at an altitude of about 350 ft from the ground while the skid indicator reached its maximum deflection to the right.

When the instructor realized that the aircraft could not overpass the mountain he probably decided to make a left turn inside the valley in order to reverse the flight course. The maximum deflection of the skid indicator to the right was due to the left deflection of the rudder probably from the instructor's action. The aircraft was led to a left non coordinated skid turn at a 65 kt speed.

The continuous use of the ailerons and rudder resulted in an excessive increase of the aircraft banking which was also reinforced by the horizontal component of the airflow in the lee side.

At video time 02:23 s, the aircraft bank angle had reached 60° degrees and its speed was 58 kt. The aircraft bank beyond 60 deg continued with parallel reduction of its speed which reached a minimum value of 50 kt at video time 02:24 s where the bank reached 80 deg. Due to this great bank angle and low aircraft speed, the vertical lift component was reduced further, so the aircraft started to loose altitude with its simultaneous head drop. The head drop was reinforced by the excessive rudder use.

The aircraft got into a counterclockwise dive during which its speed increased by 25 kt in 3 s. The instructor and the trainee pilot in an effort to take control of the aircraft pulled the yoke at its full back position while the left rudder was fully pressed deflecting the rudder control while the yoke was at neutral position.

The combination of the low altitude and the great dive did not allow the instructor to perform the dive exit procedures resulting in the aircraft crash.

2.2.3.2 Airspeed indicator

From the recording video it is shown that the air speed indicator was pointing 75 kt at impact. The specific instrument was found and collected at the crash site with the indicator stuck at 130 kt.

From the macroscopic examination of the airspeed indicator it was concluded that due to the impact of the aircraft at the ground with high angle, the frame at which the deformation and relative movement.

Due to these two reasons described above it is possible that the mechanism which connects the diaphragm with the instrument pointer suffered relative movement towards to the pointer side, resulting in the change in the indicated airspeed at the moment of impact.

2.2.3.3 Airplane's Equipment During Flight

The flight video recording revealed that on trainee's instrument panel, there was on the artificial horizon instrument a small orange paper with dimensions 7,5x7,5cm which was covering the instrument and 'U/S' was written on it. The examination of the aircraft's records and the technical log book revealed that there was no record for the artificial horizon instrument malfunction. The note 'U/S' indicates malfunction of this instrument in previous flights, without however this being recorded in the technical log book.

In the Organization's Operating Handbook, part B, it is mentioned that the organization has produced a catalogue of the minimum equipment, which describes whether an instrument is allowed to be out of order in a flight and under which circumstances.

From the investigation it was concluded that the organization had not developed a catalogue of minimum equipment for the aircraft. The development of a minimum equipment catalogue was not obligatory for the kind of flights that the aircraft was performing.

According to the legislative framework of EASA, for VFR flights in day time is not obligatory an aircraft to be equipped with the artificial horizon instrument.

The malfunction existence did not influence this VFR day time flight and did not have any contribution to this accident.

2.2.3.4 Aircraft's Technical Condition

From the findings at the crash site, at the connecting point of the engine shaft with the propeller and the propeller itself it was concluded that the engine was operating at high RPM. This is verified from the video recording where it is clear that the indicators of the engine rpm, temperature and oil pressure gauges were in the green area of their operation readings which corresponded to the normal operating values according to Pilot's Operating Handbook (POH).

Generally, from the video analysis and the aircraft wreckage examination it was concluded that there were no indications of technical abnormalities that caused or contributed to this accident.

2.3 Flight operational manual

From the revision of the Pilot's Operating Handbook of the aircraft it was not found integrated the complimentary information as this is defined from the fuel STC.

The absence of this complimentary information did not have any contribution to this accident.

2.4 Meteorological data

From the meteorological data in the accident area it is concluded that during the flight of the aircraft with southern course it had the wind at the right side almost at an angle of 90°.

The atmospheric conditions in the area are described as stable and the few clouds in the satellite photo were medium or high in thin layers, the relative humidity was about 20% and the atmospheric pressure at mean sea level was relatively high.

The stable atmosphere in the area reinforced the wind turbulence as wind (horizontal component) combined with downdraughts (vertical component) at the lee side of gorge where the aircraft was flying, something that is recorded by the camera inside the aircraft in the form of turbulence. Also, it must be pointed out that the intensity of the above described phenomena could produce important variations at relatively short distances at the lee side area and under the mountain top. The phenomena in general fade out as we are going away from the mountainous area.

The existence of the turbulence and the vertical wind relative to the aircraft's course was a contributing factor to the increase of the left bank of the aircraft just before the crash.

2.5 Aircraft maintenance

2.5.1 Organizations of continuing airworthiness and maintenance management

The monitoring of the continuous airworthiness of the aircraft was made from a CAMO with certificate no. EL.MG.0050 following the contract from 29/05/2016 between the West Greece Aeroclub and the Organization.

The organization was certified from CAA to perform the continuing airworthiness management and to issue the Airworthiness Review Certificate for the specific aircraft type.

In the same contract, the Organizations responsible for maintenance of the aircraft were mentioned. The first Organization had certificate no. EL.MF.0006 and was certified by CAA and had the capability to perform maintenance on the specific aircraft. The second Organization had certificate no. CY.145.005 and was certified by the Civil Aviation Authority of Cyprus.

2.5.2 Maintenance Programme

The maintenance of the aircraft was carried out according to the maintenance program of small aircrafts which was approved by the Civil Aviation Authority of Cyprus. The maintenance program was issued on 30/11/2010 and the owner who signed it was different from the owner who was using the aircraft when the accident happened.

The CAMO Organization, according to the contract which had signed with West Greece Aeroclub, had the obligation for the development and revision of the maintenance program. According to this the CAMO should have established a new maintenance program where the new owner should be mentioned.

The current maintenance program was in line with the instructions of the aircraft and engine manufacturers while was taking into account the maintenance requirements of the Civil Aviation of Cyprus.

In the current maintenance program, the instructions of the propeller and the emergency locator transmitter manufacturers were not taken into account. The shortage of the structure in the maintenance program did not contribute and it was not the cause for the accident.

2.5.3 Monitoring of aircraft's continuing airworthiness

As mentioned in paragraph 2.4.1, the Organization with certificate EL.MG.0050 was performing the tasks of continuing airworthiness monitoring of the aircraft. From the examination of the aircraft's records it was concluded that the organization was monitoring and had the control of the scheduled inspections and replacement of the life limited and service life limited components, while on the accident day there was not an inspection or replacement the execution of which was over the scheduled programmed time.

2.5.4 Maintenance

The aircraft received the Certificate of Release to Service (CRS) on the 20/04/2016 after the inspection made by the maintenance organization CY.145.005.

In the above certificate of release to service in use, the completion of the 50 h inspection is not mentioned, although in the relative fields of the 50 h inspection of the work package this particular inspection has been certified. The above omission of the specific inspection did not contribute to the accident.

Since 20/04/2016 all scheduled inspections until the last one on 14/10/2016 were carried out by the maintenance organization with certificate no. EL.MF.0006 and were made on the correct time according to the latest revisions of the maintenance manual of the aircraft, engine and the propeller.

For the execution of maintenance works the maintenance organization EL.MF.0006 issued a work order which described the kind of the inspections and also attached copies of the manual pages where the relative works were described. The certification of the works execution was not made using task cards but it was made on the attached copies of the pages of the manual where these were described without the existence of the relative certification fields of the executed work and the certification of the double check of the works where this was necessary.

The non-issuance of the task cards did not affect the aircraft maintenance and it did not result to the omission of maintenance works.

2.5.4.1 Emergency Locator Transmitter Maintenance

As it is mentioned in the paragraph 1.15.2 the aircraft was equipped with emergency locator transmitter (ELT) type Kannad 406 AF-Compact which was installed in the aircraft on 14/10/2008.

The ELT maintenance requirements, are described in the manufacturer's manual. In these it is stated that an inspection must be made every six years which includes six checks one of which is the mandatory change of the battery.

From the inspection of the aircraft's records, it was shown that on the 03/03/2011 the ELT had been removed for reprogramming and it was reinstalled with new codes.

On 16/05/2016 the ELT battery was changed due to life limit expiration and a successful operational test was performed.

On 30/09/2016, as reported in the life limited parts list, an ELT operational test was accomplished.

According to the above, it is not evident that the ELT six-year inspection was accomplished for from the date it was installed in the aircraft.

The fact that this specific inspection was not accomplished, possibly influenced the ELT operation and contributed to absence of signal transmission after impact. Also the ELT examination was not possible since this was not found in the accident site and possibly was burnt out from the post impact fire.

2.6 Pilot's training organization

2.6.1 Training Accomplishment

For the accomplishment of training it had been issued from ATO a training manual which had also been approved by HCAA. In this it was described analytically the training procedures and the flying exercises which a student had to execute in each one of the training flights with a goal the training procedure standardization. Also the flight realization was made according to the organization procedure manual. From the revision of the training files of the students and the training manual, it was noticed that there were deviations regarding the exercises which were performed in the training flights in relation to the ones described in the training program.

From the revision to the files of some students of school, the conclusions of paragraph 1.17.1.6 have been proved, where they indicate the incorrect 'SOLO' flight programming from the organization side, since the way these flights were made contained an increased risk due to the combination of the following factors:

- . The limited experience of the students during 'SOLO' flights,
- . The landing in airports or airfields to which the students were not familiar since they had not made familiarization flights with an instructor
- . The long-time interval between the first and second 'SOLO' flights without proof that a flight with an instructor was made before the second 'SOLO',
- . The small runway length in the airfields of Arachthos and Messologi.

From the study of the students' records, it was noticed that there were no written remarks by the instructors, despite the fact that the students' records included a field for remarks.

From the investigation it was concluded that there was a verbal briefing amongst the instructors regarding the performance of students. This way of briefing was possible to have created misinterpretation regarding the performance of students and the points which should be emphasized by the instructors during the training in order the students' weak points to be corrected.

The above indicate that there was a standardization shortage in training performance since this was not accomplished according to the approved procedures as these were described in the operation manuals and there was not adequate training supervision.

The standardization shortage and the inadequate training supervision, were not causal factors to the accident.

2.6.2 Instructor

Reviewing the Instructor's CV as well his background info, it was deducted that he had sufficient experience in flying general aviation aircrafts. Furthermore, as an instructor he was likeable by the trainees and considered him a procedural pilot.

The fact that he had been trained in the execution of aerobatic manoeuvring flights as well as his experience in flying various types of light airplanes and helicopters, he possibly gained overconfidence and over reliance on his flying skills.

The instructor, operating in an Organization environment where the inadequate training supervision as well as the overconfidence in his skills, probably created the culture of acting outside Organizational procedures during training, disregarding training procedures and Organization's training program.

Due to the above reasons, the instructor decided not to continue his flight towards Rio, but insted to turn left and pursue a new course towards the mountain terain and flying at a low altitude. His decision was a causal factor in the chain of events that led to the accident.

2.6.3 Cooperation of the accident instructor with the ATO

The choice of the flight instructor was made by the chairman of the West Greece Aeroclub and was based on his personal opinion he had about the specific instructor since he knew him long ago from the times they were students in the Greek Airforce Academy.

The Head of Training and Chief Flight Instructor had not been informed about the video showing the instructor to perform aerobatic maneuvers and subsequent correspondence with CAA.

This was the basic factor in the sequence of the events that contributed to the accident, due to the fact that the HoT and CFI, who was responsible for the instructor choices for the school, should have possibly altered his decision regarding the continuation of the cooperation of the instructor with the school. The lack of information for the above event of the HoT and CFI demonstrate the lack of communication between the personnel of the Organization.

According to the Organization procedures manual, before the integration of an instructor in the Organization he must be evaluated by the HoT and CFI. If the evaluation was successful then an agreement was signed between the Accounting Manager of the Organization and the instructor.

From the review of the instructor's file, on 10/10/15 where the agreement between the Organization and the instructor was signed there is no instructor's initial evaluation form while on 22/04/2016 there is the initial evaluation form of the instructor but there is no signed agreement. From the completed form on 22/04/2016 all relevant fields have been checked from the evaluator as successfully performed by the instructor.

From the above there is no clear picture as for the time the instructor cooperated with the school and if all the foreseen procedures from the organization manuals were implemented.

2.6.4 Completion of the aircraft's technical log

After the accident the technical log of the aircraft that was involved in the accident as well as of the second aircraft of the Organization came to possession of the investigation team.

From the investigation it was revealed that the update of the aircrafts' technical logs, had been assigned to a specific person who was a member of West Greece Aeroclub as the technical logs were not on board the aircraft as this is indicated by the law. This fact explains why both aircrafts' logs were written with the same handwriting. From the interviews that were taken, it was concluded that this specific procedure was followed because previous erroneous log book entries were noticed which were corrected by

using white correction fluid. The person in charge was informed by telephone about the performed flights and the defects of the aircrafts.

From the above procedure of the technical log update, the accuracy or the non-omitting of the recorded flight hours and technical defects of the aircraft was not ensured.

From the examination of the fields of the technical log it was noticed, that in each one of the pages could be recorded up to eleven flight legs without however the existence of the relevant fields so that for each flight leg the pre-flight inspections, the captain's signature after the flight and the recording of the technical defects to be certified.

As a result, it was not clear when the refueling of the aircraft took place on the day of the accident, the uplifted fuel quantity and the non-certification of the pre-flight inspection.

The procedure followed for the entries of the technical log and their structure, although not being the correct one, did not contribute to the accident cause.

2.6.5 Compliance Monitoring System.

In the training Organization a compliance monitoring system was in effect, the procedures of which were described in the Organization's management manual. From the review of the Organization records, it was concluded that the foreseen audits had been accomplished by the compliance monitoring manager within the foreseen time frames without detecting non-compliance with the requirements, while complementary inspections were made without non-compliance detections also.

From the review of the fields in the checklists which were examined during the organization audits, was concluded that there was a specific field which focused on the inspection of the students' records so as to check the accuracy and compliance with the Organization training program.

In all check lists, for this specific field, was not detected non-compliance with the requirements. The investigation and the review of the records of some trainees revealed the conclusions of paragraph 1.17.1.7.

It is possible that if during the course of the audits, more student records were examined or other kind of inspection method was applied as mentioned in the Organization's management manual, some findings as regards the paragraph 1.17.1.7 would have been detected.

Despite the fact that the internal inspections accomplished within time limits and were in numbers more than the foreseen ones, they were not able to detect the non-compliances in the Organization's training program.

The organization's internal audits did not detect hazards, which could potentially form latent causes of an accident or serious incident, so as within the framework of safety management system their risk be evaluated and mitigated.

The non-efficient internal audits were not immediate cause of the accident.

2.6.6 Safety Management System

In the training organization was in effect safety management system the responsibility being the accounting manager's task. Its operation frame includes the timely identification of the hazards through, among others, the safety incidents reports from the organization personnel and the Organization's internal audit findings.

During the organization operation from the issue of the license up to the accident, there were not recorded safety reports, which in conjunction with the ineffectiveness of the internal audits did not result in detecting unreliable situations. The absence of safety reports, although it was not the direct cause of the accident, indicated that in the organization has not been built the reporting culture that is factor for the implementation and the evaluation of the safety management system.

From all the above, there is no clear indication that the safety management system was operating efficiently.

From the investigation procedure it was concluded that the accountable manager did not have adequate knowledge of his duties, as these were described in the organization manuals, whilst he did not have complete knowledge of all the aspects of the Organization operation.

The inadequate knowledge of his duties was probably a factor which did not result in the promotion of the organization's safety culture, as the accountable manager has the overall responsibility of the organization's safety system as the establishment and the support of the safety culture must be started and supported by the higher management level.

2.7 Civil Aviation Authority

2.7.1 ATO's Licensing procedure

In the licensing application form which was submitted to CAA on 06/07/2015 the areas were mentioned, in which the training would take place, apart from Arachthos airfield and the airports of Megara and Aktion.

From the investigation, was concluded that only at Arachthos airfield a prior organization licensing audit was carried out on 13/08/2015 while it is not resulted that in the two other airports an audit was carried out, as this is foreseen from the corresponding CAA manual.

During the audit, prior to the licensing, of the organization and the completion of the relevant checklist, some fields were not completed without justification of the non-completion reason.

According to the CAA procedures manual, before the final licensing approval, the licensing procedure should undertake an internal inspection before the final approval is granted. From the above it is evident that the internal inspection procedure did operate efficiently so as licensing procedure omissions and errors to be detected.

2.7.2 ATO Supervision

After the ATO licensing, the Organization is integrated into the CAA's annual audit program.

For the audit program of the relevant department of the CAA/D2 for year 2015 there are not available data.

For year 2016 it had been programmed an audit in the second ten days of October which was finally accomplished in November 2016, the month after the one that the accident happened and it was the first audit that was accomplished in the ATO after its licensing. From the examination of the audit program of 2016, it came up that there were in total 27 organizations which were integrated into the audit program, which should be conducted by four auditors in total. From the interviews of personnel who work in the relevant department of D2 revealed a lack of auditors in the department of certificate and license while there were periods that the total number of auditors was not more than two. This lack of personnel had also been revealed in EASA's inspection in 2014.

During the investigation it was found that in the CAA file regarding this particular ATO there were organization requests, referring manual revision approvals. For the majority of manual revisions requests there was no written answer from CAA although the organization had issued a repetition of these requests. From the examination of the organization manuals it was not possible to conclude for the current status of the organization manuals revision status.

Furthermore, in the above file it was found that on 14/07/2016 a written request had been submitted from the ATO to the CAA for the substitution of the person in charge of the tasks of safety manager and the compliance monitoring manager while on 15/09/2016 the above request was submitted revised so as the above mentioned person to possess the position of the safety manager only. There was no reply by CAA to any of these requests.

Under these circumstances the implementation of the scheduled audits could not be met and most possibly the department wasn't able to perform effectively its duties according to the current regulatory framework thus reducing the possibility to timely identify in this specific newly founded ATO dysfunctions which could be accident latent causes and could contribute in the formation of organization culture.

After the ATO licensing it was sent from ATO to CAA, on different dates, the ATO has signed private employment agreements with its employees. In these private agreements it was determined the new persons in the position of the accountable manager, the Head of Training and the Chief Flight Instructor. After the documents inspection it was concluded that the CAA foreseen procedure for the above personnel substitution was not followed since there are no data which prove that the necessary foreseen form was submitted to CAA for the issue of their acceptance certificate, whilst the revision of the corresponding manuals was not submitted.

It was noticed that during organization audit by CAA in November 2016, a different check list was used, which was not included in the CAA operation manuals, from the one that was used in the initial organization licensing.

From the above, it is evident the insufficient standardization of the operational procedures and supervision from the relevant CAA department, resulting to an unsuccessful supervision of the organization.

3 CONCLUSIONS

3.1 Findings

3.1.1 Flight

- The instructor held all required valid certificates and licenses.
- The instructor's and trainee's rest time was within the organization's procedures limits.
- The accident flight was training flight and conducted outside foreseen training area.
- During aircraft flight the submitted flight plan was not followed.
- The artificial horizon in the trainee's instrument panel was inoperative without being registered in the aircraft's technical log.
- The aircraft was flying in low altitude inside the mountainous terrain.
- During the flight inside the gorge the aircraft experienced turbulence due to the rotors at the leeward.
- The aircraft was under the control of the trainee inside the gorge
- There was not fuel starvation during the accident.
- The aircraft configuration during the flight was correct.
- The instructor was familiar with the flight area.
- The instructor failed to make a timely decision for climbing and escape from the valley
- The instructor after the failure to overpass the mountain in front of him, decided to reverse his flight course with a left turn.
- The aircraft entered a left not coordinated skidding turn and ended up to a dive where its airspeed increased by 25 kt within 3 s.
- Due to the aircraft's low height above ground, the instructor was not able to recover the aircraft from the created situation.
- From camera's footage and from the deformations of engine's propeller blades and also from the connection of the engine's shaft with the propeller, revealed that the engine was rotating with power at impact.
- The engine's operation was within normal limits.
- There was no evidence of any preimpact mechanical anomaly that caused or contributed to the accident.

- There was no fuel or oil quantity found after the impact in order to get samples for further examination
- The aircraft was structurally intact before the impact.
- The aircraft was totally destroyed from the crash and postimpact fire.
- The probable cause of the airspeed indicator's variation was the internal mechanism deformation at the time of impact with excessive diving angle.
- There were no physiological factors and no detected drugs that affected the performance of the crew during flight. In addition, no chemical substance related to carbon monoxide was detected.

3.1.2 Training Organization

- The training organization was certified by the CAA.
- The organization's accountable manager did not have complete knowledge of his duties
- There was inadequate communication between the organization's staff members.
- The procedures applied within the organization for the instructor's integration were not in accordance with the ones described in Organization's manuals.
- There was incomplete standardization in training implementation and supervision.
- In the organization, had been created norms different from the certified ones, due to the incomplete standardization and inadequate training supervision.
- In the organization had been performed more than the scheduled compliance audits without detecting non-compliances with the requirements.
- No remarks for the trainees' performance were written down in the trainee files after the flights.
- The aircrafts' technical logs were not on board.
- The update of the aircraft's technical logs was not performed by the pilot and had been assigned to an Aeroclub member who was informed by telephone about the flight performance.
- The followed procedure for the recording of the aircraft's technical logs did not ensure the accuracy of the recordings.

- The corrections in the technical logs of the aircraft were done by using white correction fluid.
- The aircraft's technical logs' structure wasn't the correct one while the pre-flight inspection could not be verified and wasn't clear in which flight leg the refueling of the aircraft took place.

3.1.3 Civil Aviation Authority

- During the organization licensing there were omissions that weren't detected by the internal inspection procedure of the relevant CAA department before the final issue of the organization's operation certificate.
- In the training organization had never been performed an audit from its license date until the accident date.
- In the CAA licensing department, which was responsible for training organizations approval, there was a small number of inspectors in relation to the licensees and the training organizations in operation. Probably this department was not able to properly perform its duties according to the current legislation framework.
- The CAA department of certificates and licenses was not responding to the majority of the written requests of the training organization. There was no proper communication between the competent authority and the training organization.
- The substitution of the managers of the training organization, was not made according to the foreseen procedure.
- There was a standardization shortage in the performance of licensing and supervision of the training organization by the relevant CAA department.

3.1.4 Airplane Maintenance

- The aircraft was integrated into a continuing airworthiness management organization certified by EASA with capability to the particular aircraft type and was maintained accordingly from an EASA certified maintenance organization according to the current regulations.

- The aircraft was maintained according to an approved maintenance program and to the latest manufacturer manuals revision.
- The maintenance program in use did not indicate the right owner of the aircraft and had deficiencies in its structure.
- Task cards that would define the certifying fields of the maintenance works were not issued by the continuing airworthiness management organization.
- It is not concluded from the aircraft maintenance records that the emergency locator transmitter (ELT) foreseen six year inspection had been performed, and it is possible that its operation was degraded resulting in the non signal transmission at the aircraft impact.

3.2 Causes

The investigation established that the coordination of the following chain of events caused the accident:

- The execution of an uncoordinated left turn at low airspeed and low altitude combined with the right hand, vertical to the aircraft track, wind that resulted in aircraft dive without the required altitude to recover.
- The insufficient situational awareness of the instructor that resulted in the non-timely execution of climb to overfly the mountain top and exit from the valley.
- Non implementation of the filed flight plan that resulted in the aircraft flying into the mountainous terrain at low height.

3.3 Contributing Factors

The investigation revealed the following contributing factors:

- The incomplete standardization during the implementation and supervision of training as well as the inefficient compliance monitoring according to the Organization's procedures.
- The inadequate communication between the managers of the organization resulting to the incorrect evaluation of the instructor from the HoT and CFI.
- The failure of the CAA to perform audits on the training organization to verify its compliance with the current regulatory framework.

4 SAFETY RECOMMENDATIONS

4.1 To the Civil Aviation Authority

4.1.1 During the investigation it was concluded that in the newly founded Organization, from its licensing until the accident day, had not been performed a compliance audit. From the audit program notified by CAA it was concluded that there was a restricted number of certified auditors in relation to the number of the training organizations to be audited whilst only one compliance monitoring audit had been programmed in 2016.

2018 - 12 The CAA to examine the revision of the procedures so that in newly founded training organizations more frequent compliance audits to be programmed.

4.1.2 In the procedure manual of the relevant CAA department for the organization licensing is described the procedure of the licensing and supervision of a training organization. According to this the licensing procedure undergoes an internal inspection followed by the final approval or extra actions to be taken. Also, it is described the procedure which has to be followed for the substitution of a training organization managers. From the investigation is concluded that during the licensing procedure and the organization's managers substitution, omissions occurred which were not detected during the internal inspection procedure.

2018 - 13 The CAA to review the licensing and supervision procedures of the training organizations so that to detect possible omissions during the internal inspections.

4.1.3 During investigation and after the relevant interviews that were taken from the personnel of CAA's licensing department, it was concluded that the specific department was understaff and its inability to fully implement the approved procedures as well as the inadequate resources for audits implementation during initial audits and for the fulfillment of the audit program for the maintenance of the issued licenses and certificates.

2018 - 14 Based on the number of certified training organizations and the project of licensing department, the CAA to review the staffing, the equipment and the available resources for the fulfillment of the

project which is required by the legal framework and approved procedures of initial certification and continuous monitoring for the Organizations that certifies, authorizes and monitors.

4.2 To the training organization of West Greece Aeroclub

4.2.1 From the examination of the Organization's trainees records it was evident the incomplete standardization in the implementation and supervision of the training procedure.

2018 - 15 The ATO to proceed to the reconsideration and revision of the operational procedures for complete standardization and supervision.

4.2.2 From the investigation process and the analysis of collected data, it was revealed that at the ATO had been performed more compliance monitoring audits than those which had been programmed without detecting non-compliances.

2018 - 16 The ATO to proceed to reconsideration and revision of internal audits procedures and organization's check lists so as the performed audits to become effective.

4.2.3 The investigation revealed that in aircraft's technical logs were discrepancies in the entries which were corrected in wrong way so the airplane's recordkeeping was unreliable. Also, the aircraft's technical logs were not on board the aircraft in contrary to current regulating framework. The process of transferring the aircraft's data and technical discrepancies by telephone was not securing their accuracy.

2018 - 17 The ATO to proceed to the pilot training for the correct update of aircraft's technical logs.

4.3 To the Organization of Continuing Airworthiness Management

4.3.1 Examination of the aircraft's technical log revealed that due to its construction, all the necessary data for aircraft's flight it could not be recorded. More specifically, with the current technical log structure the accomplishment of the pro flight inspection could be certified and also it was unable to be determined the leg at which the aircraft was refueled.

2018 - 18 The continuous airworthiness management organization in collaboration with the training organization to re-examine the aircraft's technical logs structure so that all necessary data, according to the current legislating framework, are recorded.

4.3.2 For the maintenance implementation, the continuing airworthiness management organization must issue the total maintenance works in task cards in such a form that every step of the performed work to be certified separately. During the investigation it was proved that task cards were not issued with the above mentioned form but for the total of the works there were signed copies of the maintenance manual pages.

2018 - 19 The continuous airworthiness management organization to examine the establishment of a procedure for the issuance of job cards in such a way that will permit the monitoring and certification of performed tasks.

Nea Philadelphieia, 07 September 2018

THE CHAIRMAN

Athanasios Binis

THE MEMBERS

P. Vasilopoulos

A. Tsolakis

N. Goutzouris

Ch. Tzonos-Komilis

5 APPENDICES

5.1 Graphics depictions of airplane flight parameters

After the video examination where the aircraft's flight between the mountain terrains had been recorded, data of aircraft's flight had been recorded every 7 s and the following graphics had been arised.

Additionally in Fig.2, the graph represents variations for the last seconds of the aircraft flight, of the indicated airspeed in relation with the video time, not every 7 s but at intervals were significant variations in the flight's condition took place.

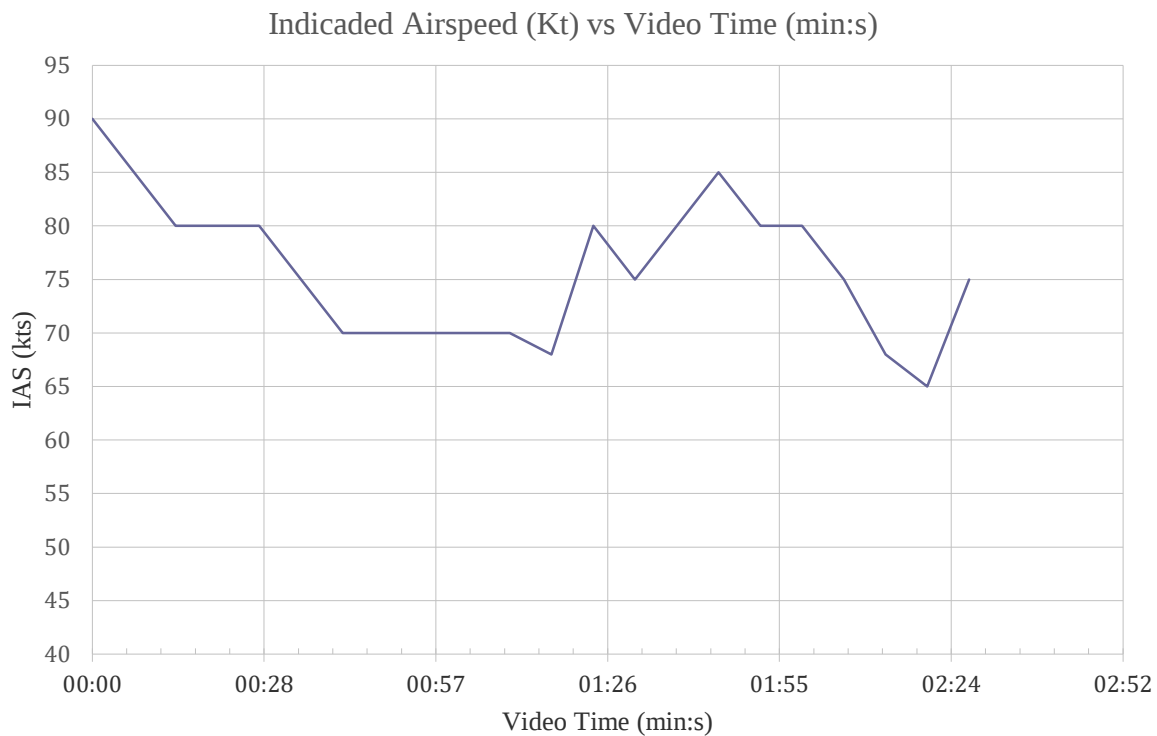


Fig. 1 Aircraft's airspeed variation in relation with video time.

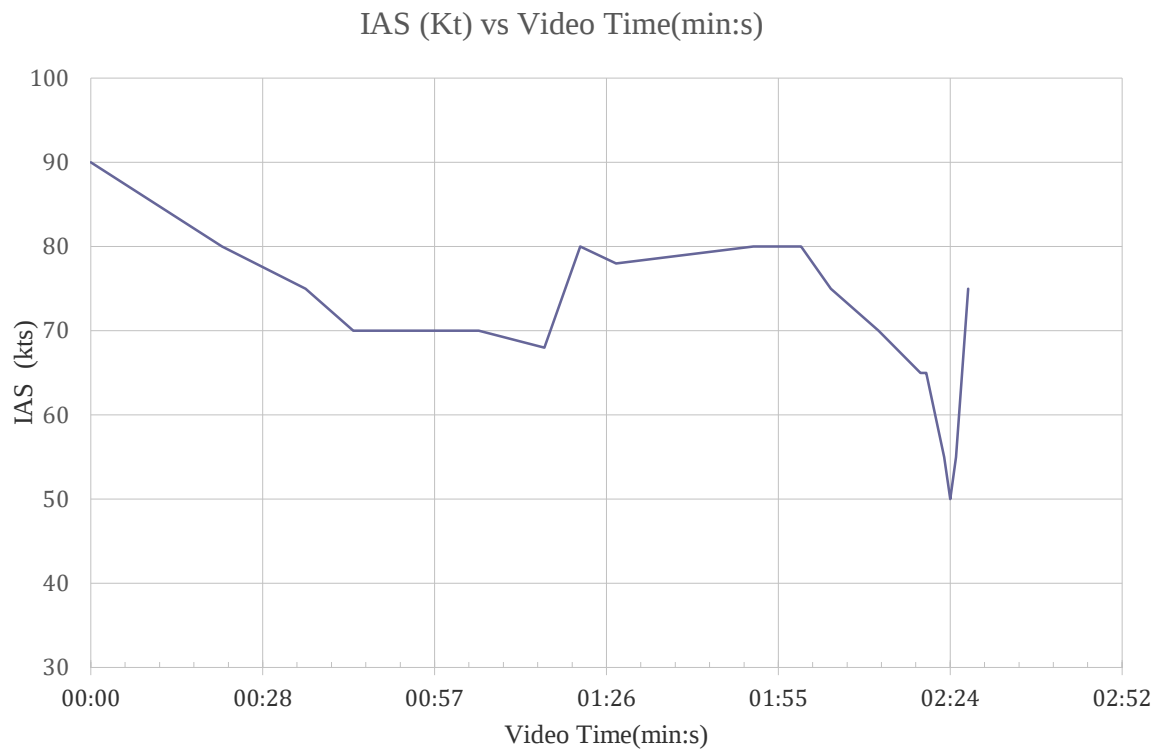


Fig. 2 Aircraft's airspeed variation in relation with video time

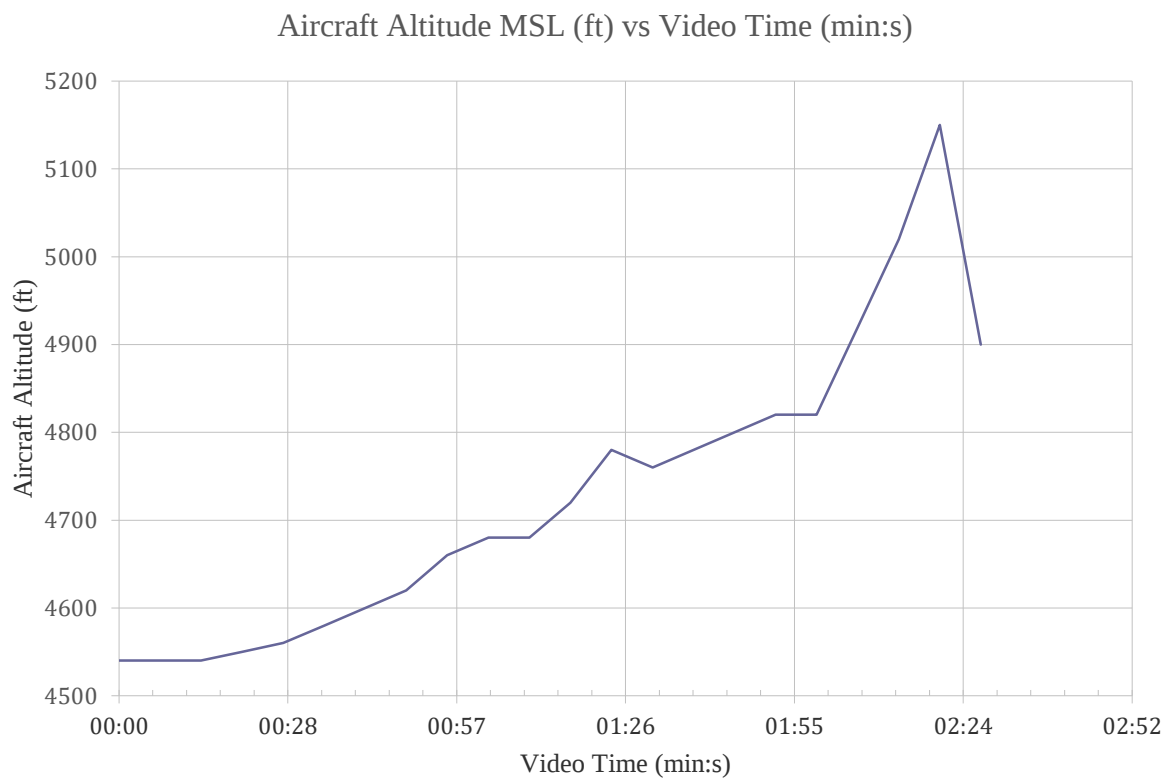


Fig. 3 Aircraft Altitude Variation (MSL) vs Video Time.

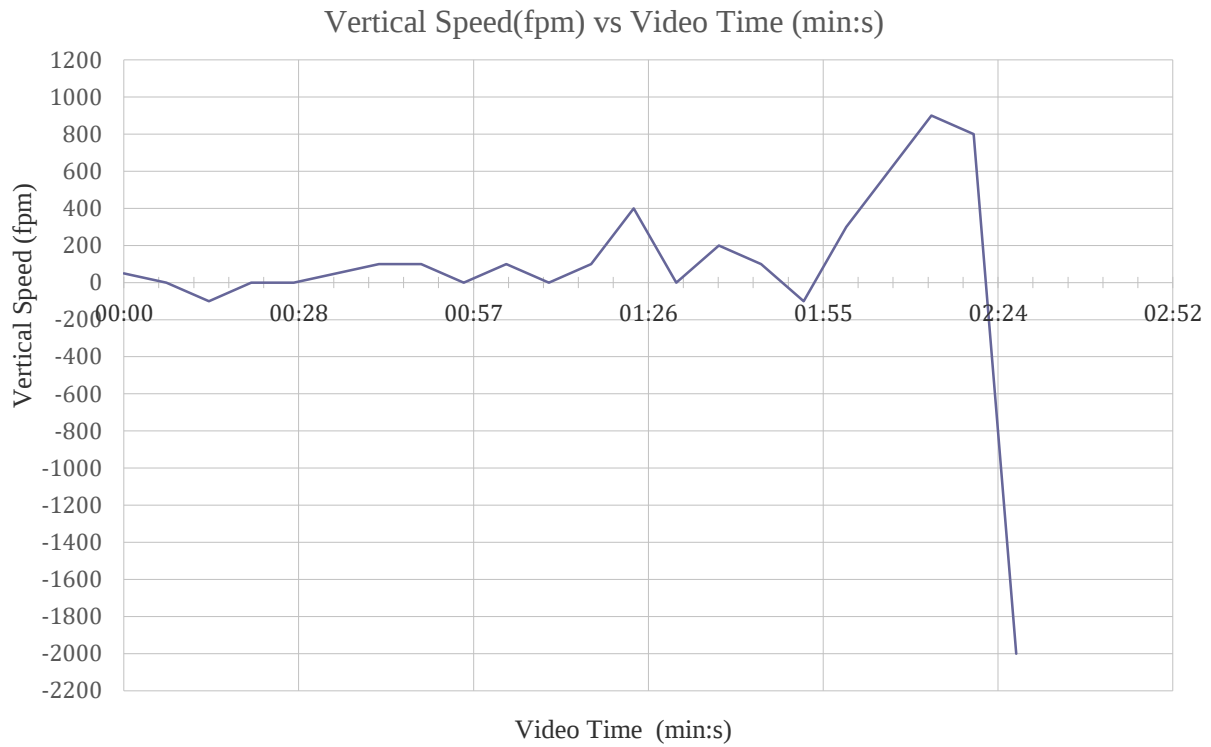


Fig. 4: Vertical Speed Variation vs Video Time

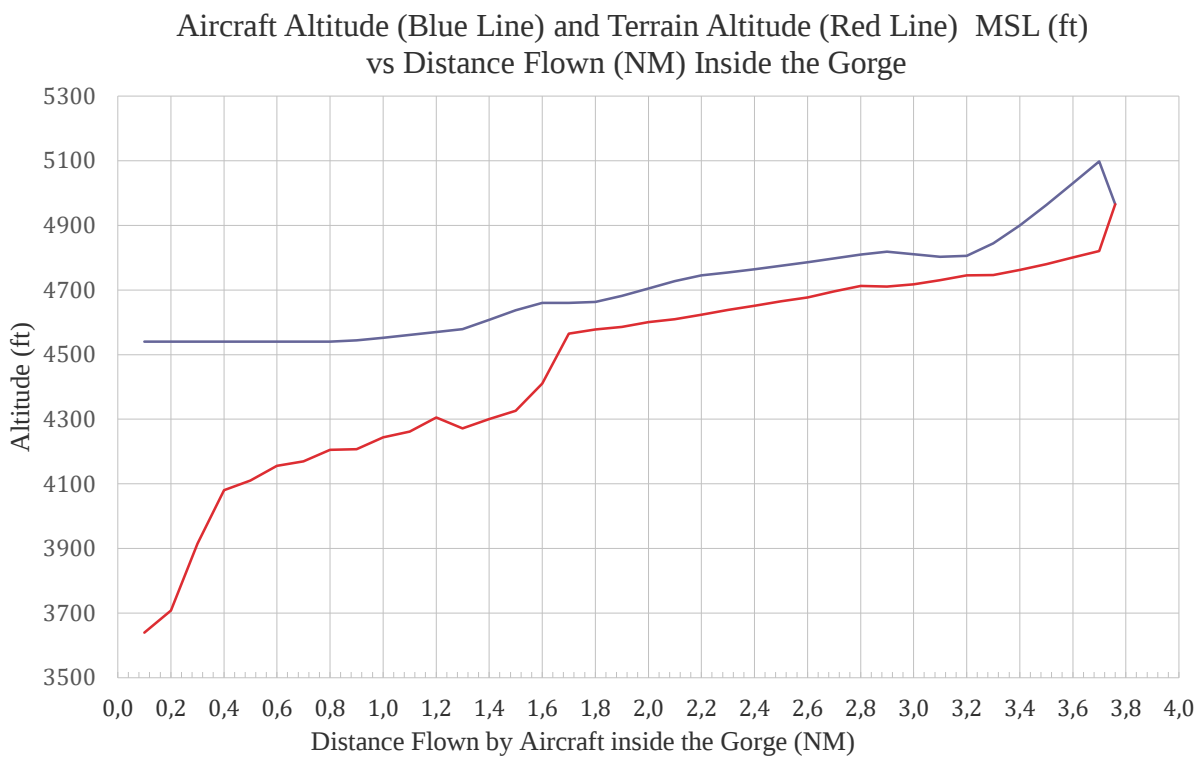


Fig. 5: Altitude Variation of the Aircraft Altitude vs Distance Flown inside the Gorge. The Area Between the two Altitude Lines, Represents the Aircraft Altitude in Relation to the Ground (AGL)



Picture. 2: The Aircraft Flight Track Acc. to Data taken from AACC Radar and from the Onboard Video Camera