



Safety Investigation Report

ACCIDENT TO A CESSNA 172 AIRPLANE AND AN AVEKO VL-3-B IN LES MOERES (FRANCE) ON 02 OCTOBER 2010

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FOREWORD

This report is a technical document that reflects the views of the investigation team on the circumstances that led to the accident.

In accordance with Annex 13 of the Convention on International Civil Aviation, it is not the purpose of the aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the determination of the causes, and define recommendations in order to prevent future accidents and incidents.

In particular, Art. 17.3 of EU Regulation 996/2010 stipulates that a safety recommendation shall in no case create a presumption of blame or liability for an accident, serious incident or incident.

Safety recommendations and Safety messages

When AAIU(Be) issues a **safety recommendation** to a person, organization, agency or Regulatory Authority, the concerned person, organization, agency or Regulatory Authority must provide a written response within 90 days.

That response must indicate whether the recommendation is accepted, or must state any reasons for not accepting part or all of the recommendation, and must detail any proposed safety action to give effect to the recommendation.

AAIU(Be) can also issue a **safety message** to a community (of pilots, instructors, examiners, ATC controllers), an organization or an industry sector for it to consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to a safety message, although AAIU(Be) will publish any response it receives.

The accident occurred in France and the Bureau d'Enquête et Analyse, initially in charge of the investigation, delegated the investigation to the Air Accident Investigation Unit of Belgium.

The investigation was conducted by L. Blendeman, with the support of the Bureau d'Enquête et Analyse of France.

The report was compiled by L. Blendeman

NOTE:

1. For the purpose of this report, time will be indicated in UTC, unless otherwise specified.
2. ICAO doc. 9859 was used for the identification of the hazard and the consequence.

Synopsis.

Date and hour of the accident

October 2nd, 2010 at 09:03 UTC

Aircraft

Aircraft 1. Cessna 172 msn F17201324, registered in Belgium
Aircraft 2. Aveko VL-3-B (P) msn VL-3-71, registered in Belgium

Accident location

Les Moères, France

Aircraft operator

General Aviation - Local

Type of flight

Private

Persons on board

2 persons in each aircraft

Abstract.

The aeroclub, owner of the recently acquired VL3, wanted in-flight pictures of the newly purchased airplane and a club member inquired the possibility to obtain pictures among multiple people. Three persons volunteered, along with the pilot of a C172. A photographer would be seated in the C172, and two persons would take the brand new VL-3-B airplane to the sky.

The two pilots in command briefly discussed the mission, focussing mainly on the pictures to be taken. The two airplanes took off and flew along the coastline in each other's close vicinity in the direction of France.

Passing the French border, the two airplanes headed south. Pictures were taken and the C172 turned left with the intent of returning to the airfield. The two airplane collided with each other during the turn. The right wing of the VL-3-B was severed and the airplane spiralled to the ground, killing the two occupants upon impact. The C172 was damaged, and the pilot managed to perform a controlled emergency landing in a field. The two occupants climbed out of the wrecked C172 with minor injuries.

Cause(s).

The collision of the two aircraft was caused by a manoeuver initiated by one of the two aircraft flying in formation, without visual contact, and not previously announced.

A major contributing factor was the lack of proper prearrangements between the two pilots to perform a flight in close formation.

Hazards¹ identified during the investigation..

Formation flight without adequate preparation and training.

Consequences².

In-flight collision.

1. Factual Information

1.1. History of flight.

The aeroclub, owner of the recently acquired VL3, wanted in-flight pictures of the newly purchased airplane and a club member inquired the possibility to obtain pictures among multiple people.

At first, the intention was to use another ULM of the club to take the pictures from during the photo shooting, but the intended ULM was unavailable.

Three persons volunteered, along with the pilot of a C172. A photographer would be seated in the C172, and two persons would take the brand new VL-3 airplane to the sky.

The two pilots in command briefly discussed the mission, focussing mainly on the pictures to be taken.

The VL-3 was serviced with 90 liters of Super 98 MoGas.

The friend of the ULM pilot got seated in the C172 while another club member got seated in the VL-3.

The airplanes proceeded to the runway for take-off.

The C172 took off first at 08:40UTC and the VL-3 followed 5 minutes later.

As agreed, the C172 turned West, and flew along the coast line. The VL-3 caught up with the C172 over De Panne. After having crossed the French border, both airplanes headed South and pictures were taken.

The VL-3 was flying lower than the C172, left and slightly behind. Both airplane had the radio tuned on Koksijde radio, but both airplanes switched to an aircraft-to-aircraft frequency upon request of the ground station. At that time, the VL3 had announced maintaining 1200ft, so the C172 could approach and fly next to the VL3.

The last pictures showed the VL-3 slightly in front of and below the C172.

¹ Hazard – Condition or object with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.

² Consequence – Potential outcome(s) of the hazard

After the last picture was taken, the pilots decided to turn back to Koksijde. The C172 made a unannounced turn to the left and both airplane collided.

A ground witness recalls seeing the VL-3 in front of the C172, then the C172 catching up, slightly higher, just prior to the collision.

The right wing of the VL-3 was severed, and the ULM spiraled out of control, almost vertically, crashing into the ground and killing the two occupants.

The pilot of the C172 felt the collision, experienced difficulties to control the airplane, then landed the C172 in a field just in front of him. The C172 touched down and toppled over, ending up inverted in the field. The two occupants climbed out, with only minor injuries.

1.2. Injuries to persons.

Injuries	Pilot	Passenger	Others	Total
Fatal	1	1	0	2
Serious	0	0	0	0
Minor	1	1	0	2
None	0	0	0	0
Total	2	2	0	4

1.3. Damage to aircraft.

The VL3 was totally destroyed, the C172 suffered heavy damage.

1.4. Other damage.

There was no other damage.

1.5. Personnel information.

Pilot of the Aveko VL-3

Female

Age: 23 years old

ULM Pilot License, first issued October 6th, 2005, last issued September 30th, 2009, valid until September 30th, 2011.

Medical Certificate: Class 3, issued December 22th, 2008, valid until December 22th 2013

Flight Experience

Number of flight hours flown per year:

2007: 41:44 FH as PIC; 0:15 in DC

2008: 12:45 FH as PIC

2009: 16:19 FH as PIC

Total estimated; 100 FH as PIC

The pilot flew a total of 5:39FH on the VL-3 since July 3rd, 2010; her last flight was performed on September 5th that same year (01:23FH).

Pilot of the Cessna 172.

Male

Age: 70 years old

Private Pilot License, first issued May 15th, 1997, last issued on October 26th, 2009, valid until October 31th, 2011. A Belgian National PPL License was issued on September 07th, 1993.

Rating: SEP

Medical Certificate: Class 2, issued October 23rd, 2009, valid until October 29th, 2010.

Flight experience

Total: 831 FH, including 636 FH as PIC.

The last flight of the pilot was a local flight on August 14th, 2010.

Passengers.

The passengers of both airplanes were student pilots.

1.6. Aircraft information.

Aveko VL-3

The **Aveko VL-3** is a Czech ultralight aircraft, designed and initially produced by Aveko of Brno. The aircraft is supplied as a complete ready-to-fly-ULM. The ULM features a cantilever low-wing, in a two-seats, side-by-side configuration with an enclosed cockpit, fixed or retractable tricycle landing gear and a single engine in tractor configuration. The aircraft is made from composite materials.

General characteristics

- **Crew:** one
- **Capacity:** one passenger
- **Length:** 6.24 m (20 ft 6 in)
- **Wingspan:** 8.44 m (27 ft 8 in)
- **Height:** 2.05 m (6 ft 9 in)
- **Wing area:** 9.77 m² (105.2 sq ft)
- **Empty weight:** 285 kg (628 lb)
- **Gross weight:** 472.5 kg (1,042 lb)
- **Fuel capacity:** 90 to 120 litres (20 to 26 imp gal; 24 to 32 US gal)
- **Power plant:** 1 × Rotax 912ULS four cylinder, liquid and air-cooled, four stroke aircraft engine, 75 kW (101 hp)

Performance

- **Maximum speed:** 292 km/h (158 kts)
- **Cruising speed:** 250 km/h (135 kts)
- **Stall speed:** 53 km/h (29 kts)
- **Never exceed speed:** 305 km/h (165 kts)
- **Rate of climb:** 6 m/s (1,200 ft/min)

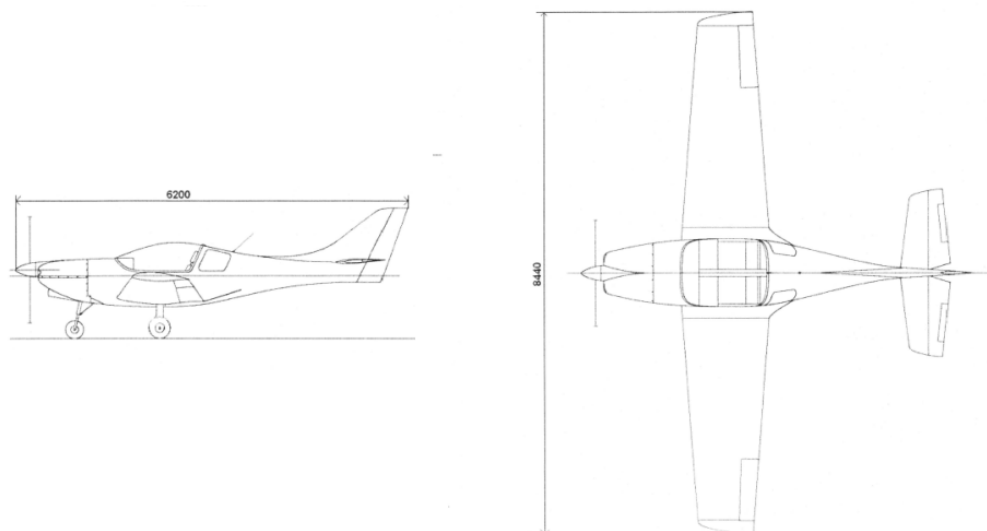


Figure 1 - VL-3-B airplane

Airframe

- Manufacturer: Aveko.
- Type: VL-3-B(P)
- Serial Number: VL3-71
- Total Flight Time: 87 FH
- Built year: 2009

Certificate of Registration: N°6648 issued by B.CAA on June 16th, 2010.

ARCA (permit to fly): ref Nr N-1999-650 of June 24th, 2010.

Authorized flights: VFR, training.

Engine

- Manufacturer: Rotax.
- Model: 912ULSFR
- Serial Number: 676095
- Total Flight Time: 87 FH

Propeller

- Manufacturer: Pezke.
- Type: AS1700
- Serial Number: 352
- Total Flight Time: 87 FH

Cessna 172

The Cessna 172 Skyhawk is a four-seat, single-engine, high-wing fixed-landing gear, fixed pitch propeller airplane. The first Cessna 172 flew in 1955 and are still in production.

General characteristics

- **Crew:** one
- **Capacity:** 3 passengers
- **Length:** 8.22 m
- **Wingspan:** 10.97 m
- **Height:** 2.68 m
- **Wing area:** 16.16 m²
- **Empty weight:** 695 kg
- **Gross weight:** 2300 lbs
- **Fuel capacity:** 42 Gallons (std tanks)
- **Power plant:** 1x Lycoming O-320-E2D four cylinder, four stroke aircraft engine, 112 kW (150 hp) at 2700 RPM

Performance

- **Maximum speed (sea level):** 226 km/h (122 kts)
- **Cruising speed (75% power at 8000ft):** 213 km/h (115kts)
- **Stall speed:** 81 km/h (44 kts)
- **Rate of climb:** 645 ft/min

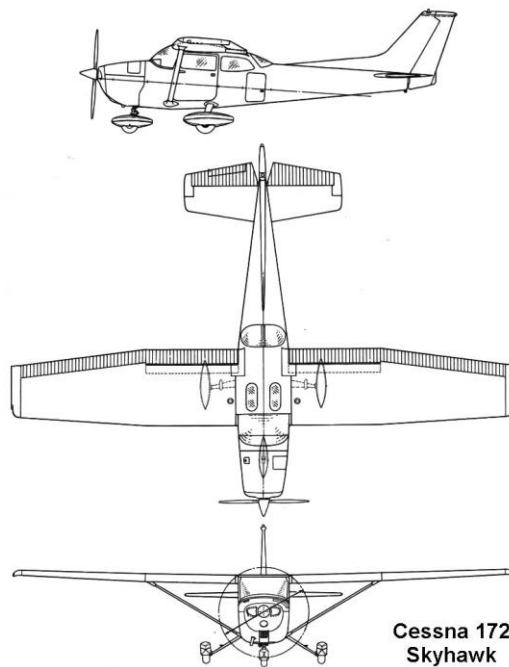


Figure 2: Cessna 172

Airframe

- Manufacturer: Cessna.
- Type: F172M
- Serial Number: F17201324
- Total Flight Time: 2188:12 FH
- Built year: 1975

Certificate of Registration: N°2535 issued by B.CAA on April 1st, 1999.

Airworthiness Certificate: issued by B.CAA on October 1st, 2007.

Airworthiness Review Certificate: last issued on July 1st, 2010, valid until June 30th, 2011

Authorized flights: VFR, night VFR.

Engine

- Manufacturer: Lycoming.
- Model: O-320-E2D
- Serial Number: L-39697-27A
- Total Flight Time: 2188:12 FH

Propeller

- Manufacturer: Mc Cauley.
- Type: 1C160DTM7553
- Serial Number: 725340
- Total Flight Time: 2188:12 FH (1871:34 FH since Overhaul)

1.7. Meteorological conditions

Belgian Coast (Ostend airport) EBOS 09:50

Wind

Direction: 190 Degrees,
Speed: 4 kts

Temperature: 17°C

Visibility: +10km

QNH: 1008 hPa

Clouds

Few at 2300/1700 ft
Broken at 7000/6000 ft
Scattered at 7000 ft

Koksijde Air Base EBFN 08:55

Wind

Direction: 180 Degrees,
Speed: 5 kts

Temperature: 16°C

Visibility: +10km

QNH: 1007 hPa

Clouds

Few at 1300 ft
Broken at 2400 ft
Scattered at 7000 ft

1.8. Aids to navigation.

Both aircraft flew in VFR conditions. The transponder of the C172 was turned off during the flight. The radar was monitoring the flight of the VL3.

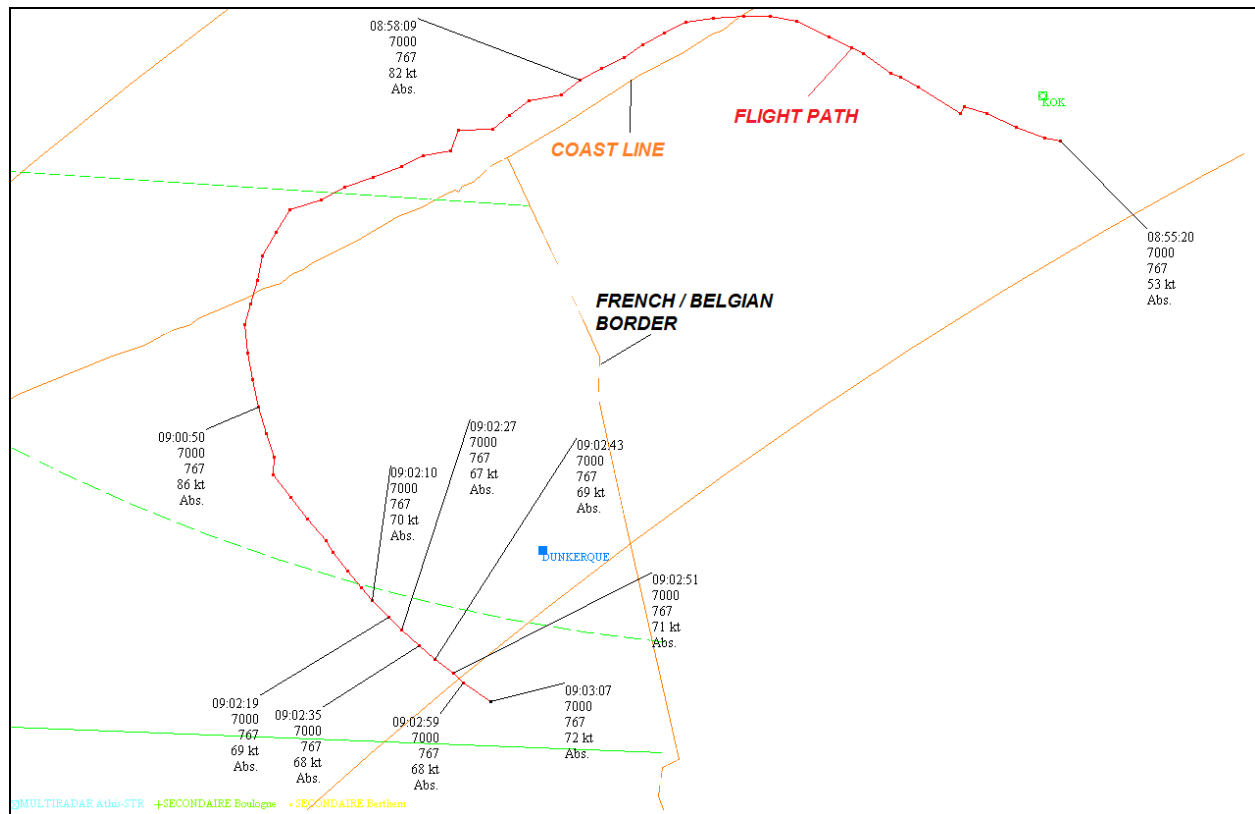


Figure 3: Radar data

1.9. Communication.

The two aircraft were in radio contact with Koksijde radio on 122.1 MHz. Later, Koksijde radio requested the two aircraft to switch to 123.45 MHz (a frequency unofficially used in Belgium for inter-aircraft communication).

Time UTC	Calling Station	Text (extracts, translation and anonymization)
8:51:30	C172	This is the C172, can we stay on the same frequency ?
8:51:38	KOK radio	– koksijde radio, Roger – You can proceed as requested
8:51:47	C172	I did not understand that.
8:51:51	KOK radio	Just do it.
8:51:52	C172	Xxxxxx chirping xxxx to Koksijde when the third aircraft is here, we'll start
8:51:59	VL3	That's copied
8:52:04	C172	VL3, did you understand ?
8:52:06	VL3	Yes, we stay on the same frequency
8:52:08	C172	Yes, that's good, ok
8:52:25	C172	Lining up for Runway 29 for a local flight
8:52:31	KOK radio	you can line up and take-off at your own discretion, Runway 29.
8:52:37	C172	That's copied,
8:52:59	VL3	Koksijde radio, we are holding on Runway 29
8:54:31	C172	C172, (reaching) 800 feet
8:54:37	C172	Proceeding to the coast line,
8:55:17	C172	Proceeding along the coast line, did you hear that ?
8:55:23	VL3	That's copied. The C172 is proceeding along the coast line, VL3 is following
8:55:40	C172	I will slow down a bit.
8:56:02	VL3	VL3 has C172 in sight
8:56:16	C172	I am flying 90 kts right now, I am above the monument in De Panne.
8:56:22	VL3	90kts, above De Panne, yes, OK
8:56:34	C172	On which side you want to pass?
8:56:36	VL3	I will pass on the Right hand side

Time UTC	Calling Station	Text (extracts translation)
8:56:48	C172	Lower, higher or the same height ?
8:56:51	VL3	I am at 900 feet at the moment
8:56:54	C172	Me too, more or less; I'm flying at a small 1000 ft now
8:56:58	VL3	Yes, OK, otherwise, I will descend a bit to 800 ft
8:58:50	VL3	Calling C172
8:58:54	C172	Yes, I am listening,
8:58:56	VL3	You know we're above France without a flight plan.
8:59:01	C172	(...) pass and we'll take a picture.
8:59:05	VL3	Ok, I am coming on the Right Hand side
8:59:26	C172	I will make a slow turn to the left, towards inland.
8:59:31	VL3	Ok, I will turn and come to your side, on the left.
9:00:12	C172	Do you still see us?
9:00:14	VL3	Yes, you are on my one o'clock
9:00:20	C172	(You) will pass on the left side.
9:00:22	VL3	On the left side, and a little bit below you, 900 feet
9:00:40	VL3	You are now at two o'clock
9:00:44	C172	You need to come closer, I will also come closer
9:01:02	C172	We are still too much apart
9:01:06	VL3	Are you flying straight ahead
9:01:12	C172	VL3, a little bit higher
9:01:18	C172	I'm staying at 1000 feet
9:01:19	VL3	Ok that's fine
9:01:22	C172	Now you climb
9:01:30	C172	You may climb higher, you know
9:01:35	C172	You are practically under me, well, left under me
9:01:46	C172	Can you slow down?
9:01:48	VL3	Yes, I fly now 120 km/h
9:02:01	VL3	I cannot (fly) slower
9:02:03	C172	I may fly faster
9:02:05	VL3	I keep flying at 1200, let you come beside me
9:02:16	KOK radio	C172 and VL3, this is Koksijde radio, any possibility to switch over to 12345 ?
9:02:24	C172	That's copied, 12345
	VL3	Switching to 12345, VL3

1.10. Aerodrome information

Not Applicable

1.11. Flight Recorder

1.11.1. GPS.

The 2 airplanes were fitted with a GPS, both able to record flight data.

- The VL3 was equipped with a portable Garmin GPSmap296 (sn 10711931).
- The C172 was equipped with a Skyforce Skymap1 (sn KB0570).

The GPS were sent to BEA-France for read-out.

GPSMap296.

The equipment was in good condition and showed no traces of external shock. An internal visual inspection was performed before the reconditioning. The internal memory was read out and provide the flight tracking of the last flight.

The data include;

- The time, although the correlation with the data provided by the other means (radar, picture, communication) is difficult to determine precisely.
- The position (WGS84)
- The altitude

Skymap1

The external visual inspection revealed no defect. The equipment was quite old, and BEA requested the technical documentation to the manufacturer. After study, the laboratory concluded this GPS type could not record flight tracks.

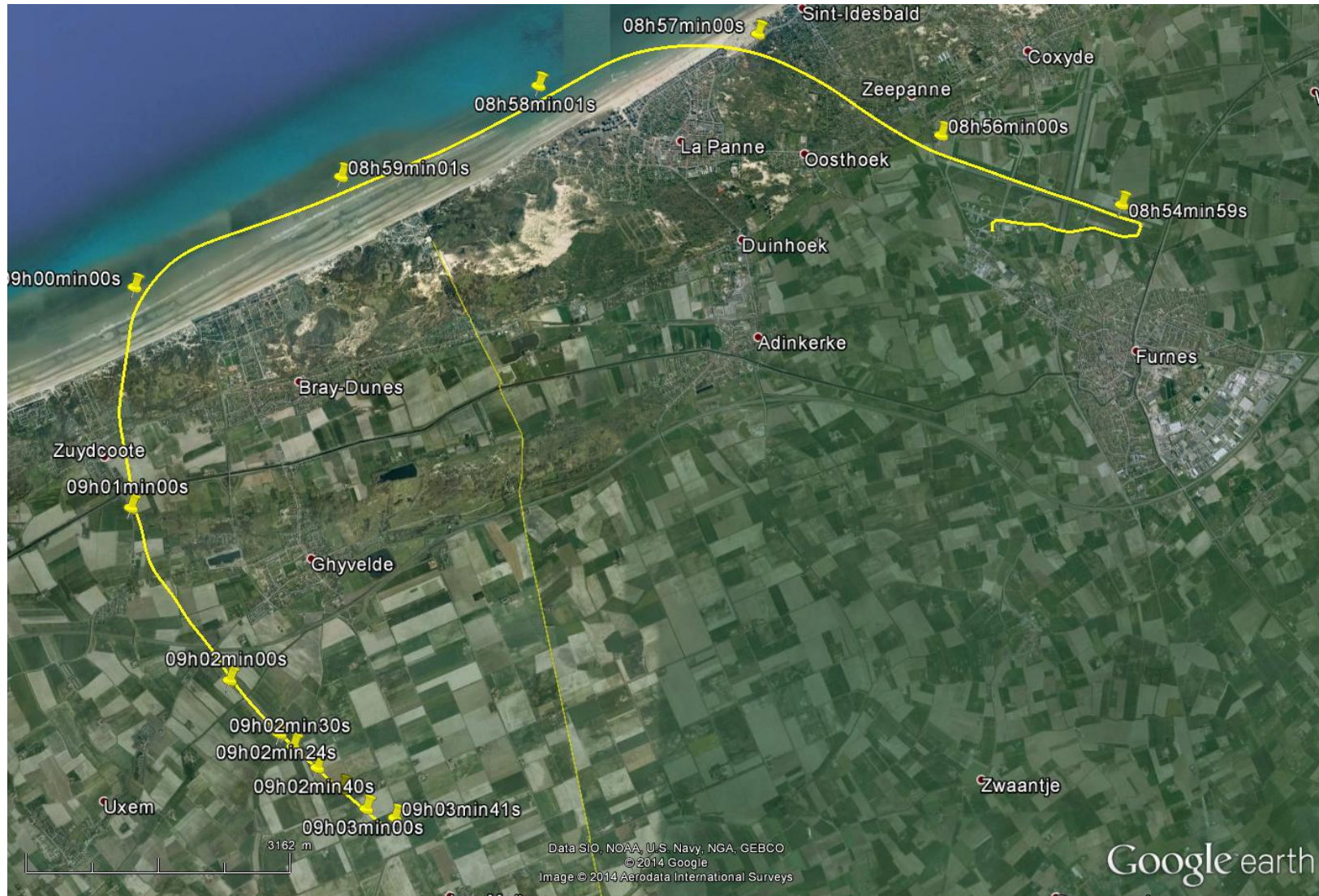


Figure 4. The GPS flight track

The speed of the VL3 can be derived from the GPS data;

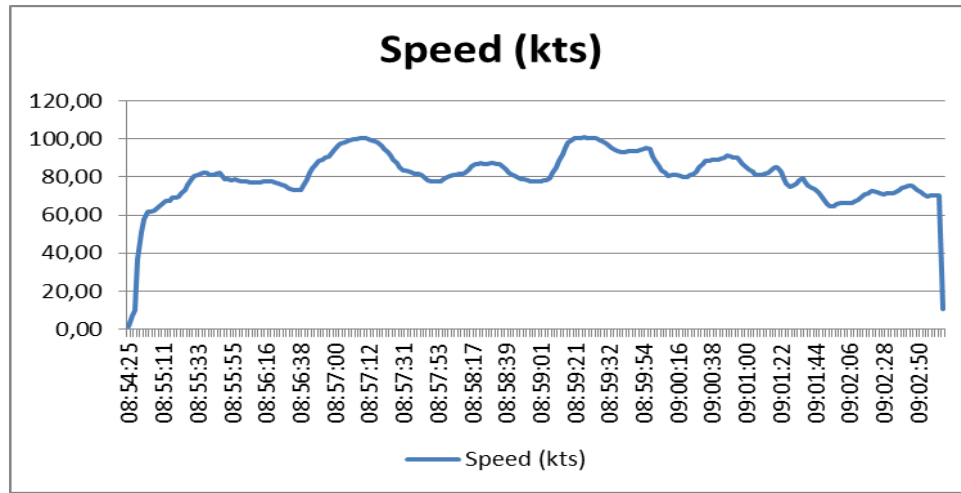


Figure 5 : Speed data

The GPS also provided altitude information. However, the absolute value of altitude provided by the system is not as precise as the information delivered by an altimeter (problem inherent to most GNSS systems), but could provide additional information on the evolution of the VL3 in the vertical plane.

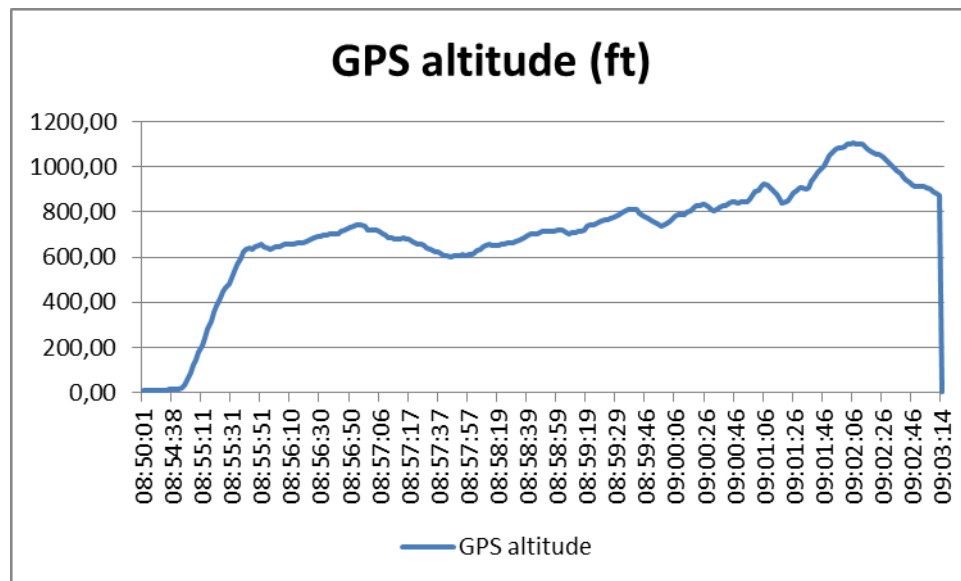


Figure 6: Evolution of the VL3 - altitude

1.11.2. The pictures.

The purpose of the flight was to take pictures of the VL3 airplane, the passenger of the C172 plane, was sitting next to the pilot for this purpose, and was taking pictures through the side window. 12 Pictures in all were taken. The camera time stamp was corrected using a reference clock.

Image ref. Nr	Local time	UTC
2888	10:39:25	08:39:25
2889	10:55:09	08:55:09
2890	11:01:06	09:01:06
2891	11:01:18	09:01:18
2892	11:01:22	09:01:22
2893	11:01:26	09:01:26
2894	11:01:35	09:01:35
2895	11:01:39	09:01:39
2896	11:01:47	09:01:47
2897	11:02:11	09:02:11
2898	11:02:39	09:02:39
2899	11:02:50	09:02:50

The time and the scenery was used to correlate the pictures and the flight track. The pictures reveal the respective positions of the two aircraft.



Figure 7: Images. 2890-93: VL3 behind and lower



Figure 8: Image 2894: VL3 and C172 side-by-side, VL3 lower.



Figure 9: Image 2896 – 97 VL3 above C172 and in front



Figure 10: Image 2897 VL3 behind and lower.



Figure 11: Image 2898 and 2899 (last picture taken): VL3 in front and lower

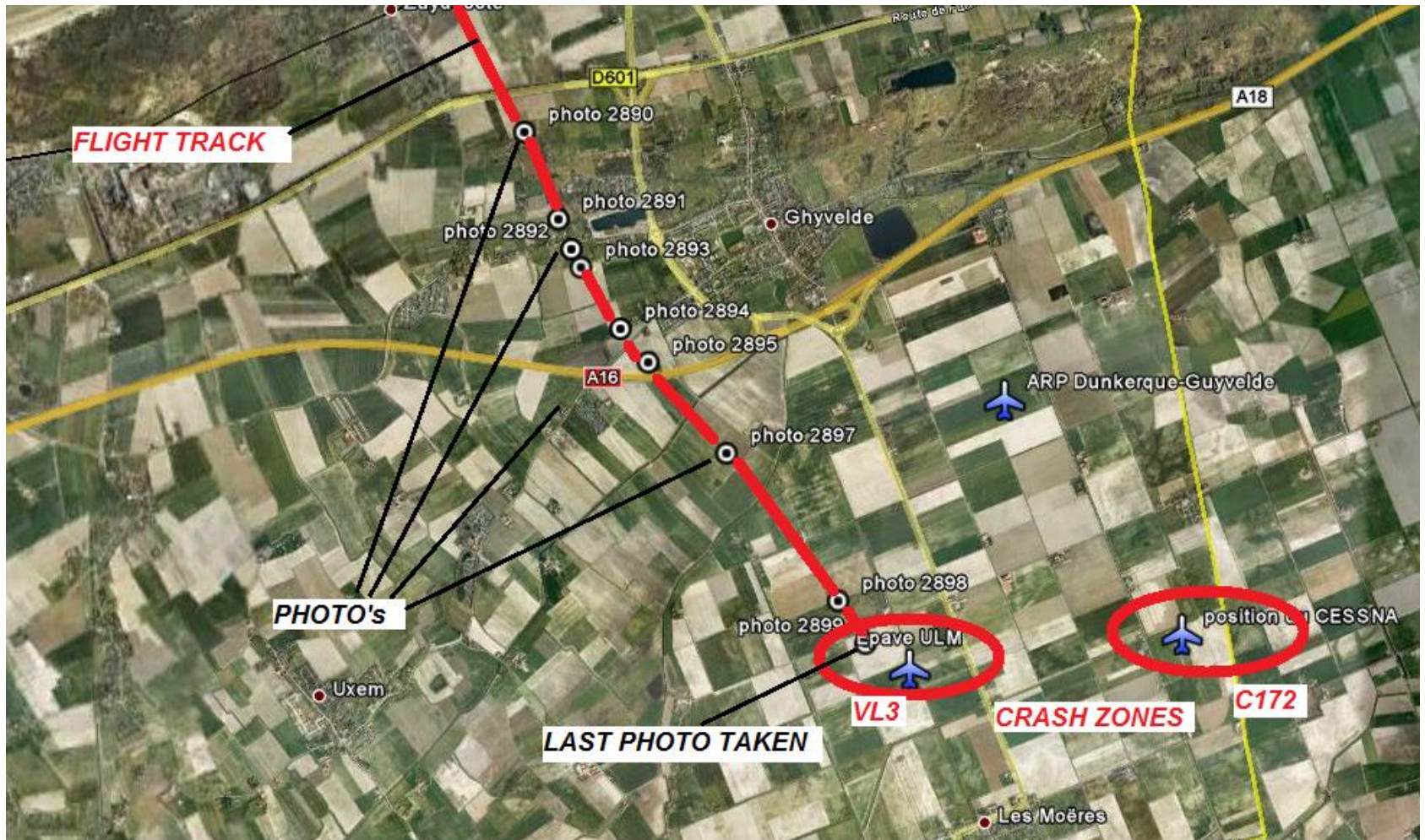


Figure 12. Location of the pictures taken.

1.12. Wreckage and impact information:

1.12.1. Witnesses.

Ground witness.

A witness, located 2 km away, saw the airplanes approaching, the VL3 in front of the C172. The witness had the impression the C172 was catching up with the VL3, flying above it. The witness did not recall seeing the actual collision, but saw the VL3 falling vertically, and a wing separating. Upon the VL3 colliding with the ground, the witness saw the parachute deployment.

The witness saw the C172 in a LH turn flying in direction of Belgium, and disappearing.

The witness stated the sky was clear, sunny and that there was a good visibility.

Photographer on board the C172.

The photographer recalled that after he took the last picture, he stowed the camera. At that time, he could not see the VL3. He saw the C172 pilot quickly turning the airplane to the left (qualifying the turn as a more-than-‘rate 1’ turn, occurring in two strokes). Shortly after that, he felt a shock on the left side and saw white debris flying around.

The airplane was unable to maintain altitude and the passenger of the C172 noticed the pilot had difficulties to control the airplane; the airplane turned left and the pilot managed to land on a field. As soon as the wheels touched the ground, the airplane toppled over.

The C172 pilot.

The pilot stated he was flying at 1000 ft and that during the flight he could not see the VL3. He stated the VL3, at that time was flying lower than him at 800ft, slightly to the left while the passenger was taking pictures. He asked the VL3 to move closer to the C172 and after the pictures were taken, he performed an unannounced 10-15 degrees turn to the left. The pilot felt a shock and sudden vibrations. He lowered the flaps, and directed the airplane for an emergency landing.

1.12.2. Wreckages.

1.12.2.1. Position

The C172 crashed 2 km away eastward of the location where the wreckage of the VL3 was found.

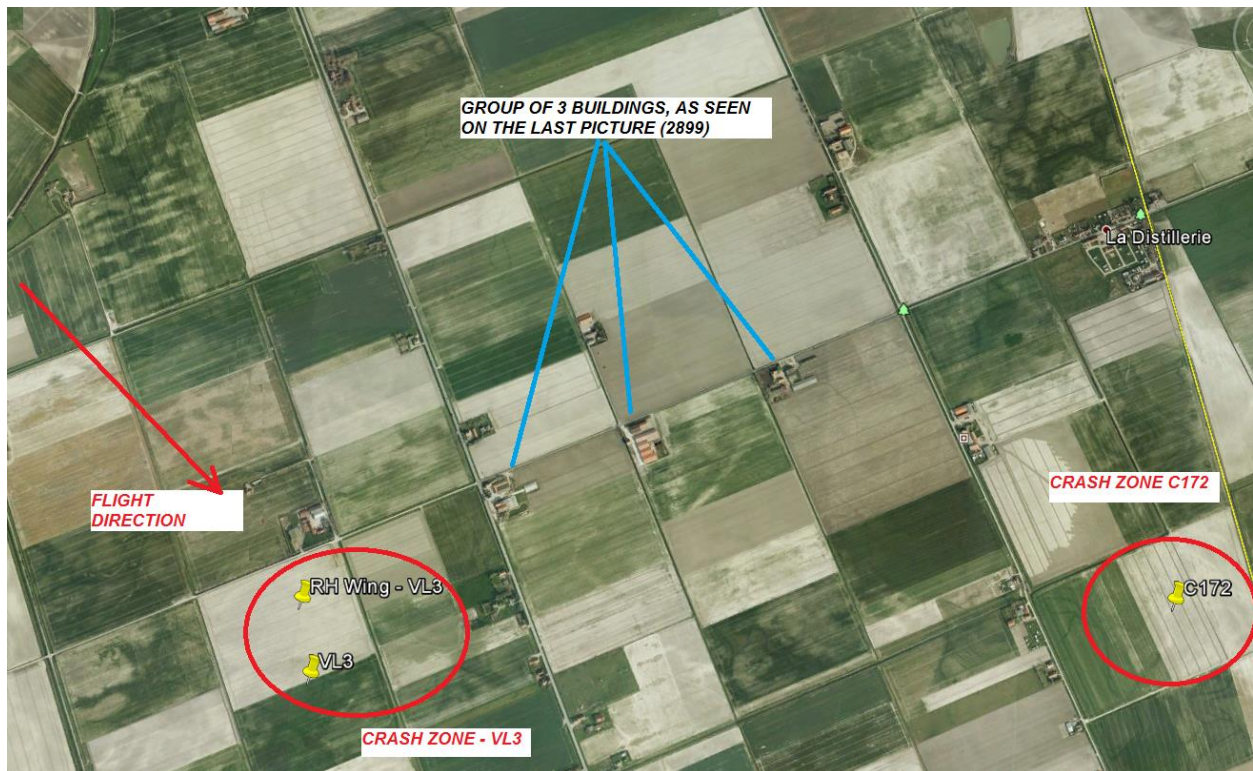


Figure 13: Position of crash zones.

1.12.2.2. VL3.

There are two distinct crash sites, 200m apart. The Right wing, along with small debris is found severed and separated from the VL3.

The main wreckage rested on a muddy cultivated field (potatoes) on its RH side.

The main wreckage is quite concentrated, all parts being found within a small perimeter. The left wing, severed from the fuselage, rested next to it. The tail section was broken off and the front section was torn open. The engine was buried in the ground.

The parachute was found still attached, partially deployed.



Figure 14: VL3 wreckage – front side

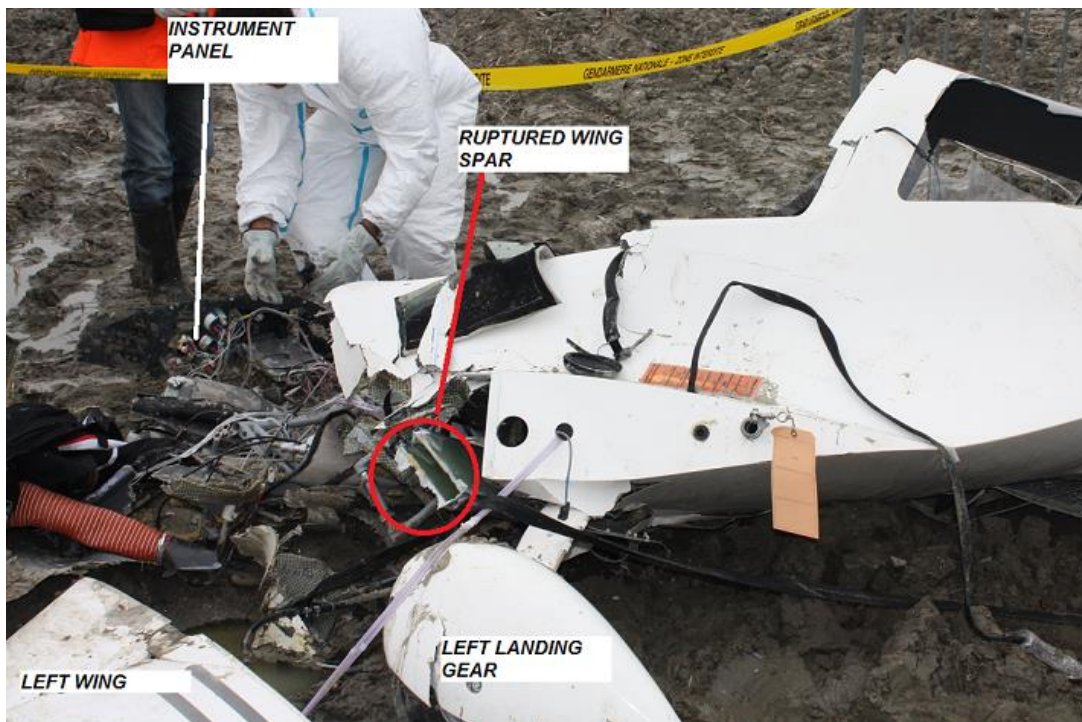


Figure 15: VL3 wreckage LH side

The instrument panel was heavily damaged, but the engine RPM instrument was found blocked at 2000 rpm. The position of the master switch was “on”, and magnetos on “both”.



Figure 16: engine RPM gauge



Figure 17: Ignition key and Master switch

Right Wing.

The right wing was found 200m north from the main wreckage, along with several debris and a metallic part from the left wing tip of the C172.

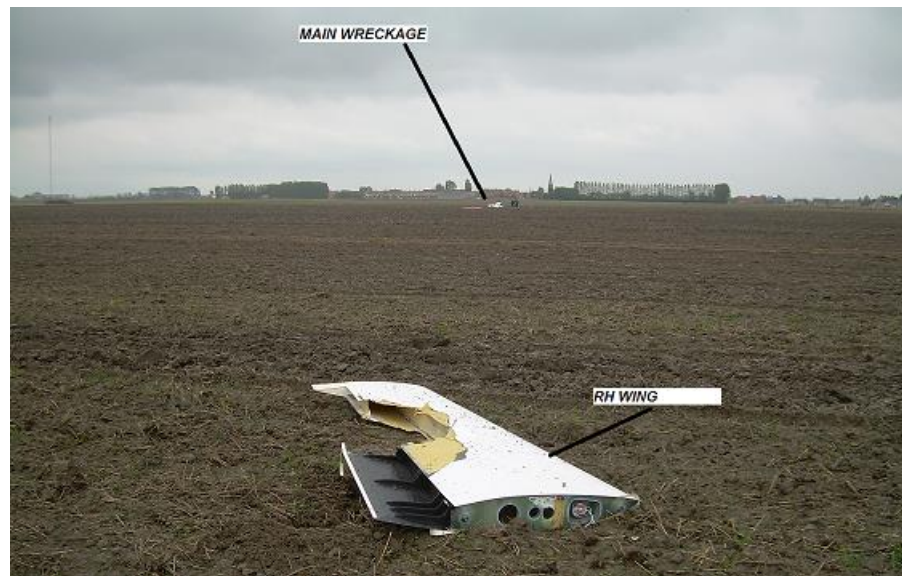


Figure 18: Location of the right wing.

The right wing is damaged from the trailing edge to the main spar. The front part of the wing did not show any damage. The RH wing was reconstructed with the parts found around the wing.



Figure 19: Lower side right wing



Figure 20: Upper side right wing

The damage on the lower side of the wing shows evidence that an important part was ripped off in a downward movement, while the upper side shows damage caused by a cutting effect. The damage cut on the aileron is remarkably sharp.



Figure 21: Right wing aileron damage (lower side)

The damages on the right wing are oriented on an angle of 45°.

A metallic chip was found inserted in the wing spar, along with grooves caused by friction.



Figure 22: Metallic part in the right wing spar.

The inspection of the rupture of the main spar shows it failed by forces of compression on the forward end, and tension on the rear end.

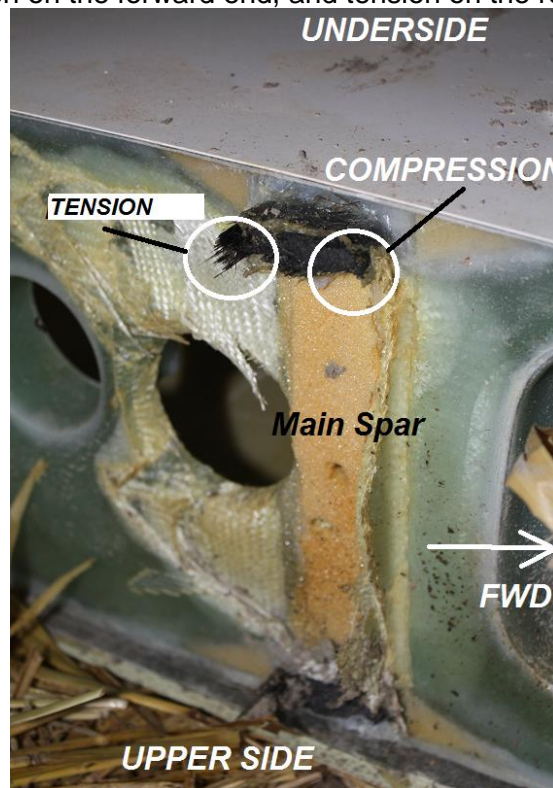


Figure 23: Right wing main spar failure

1.12.2.3. C172.

The C172 made an emergency landing. Terrain showed wheel traces over a length of 20m. The nose landing gear leg broke, and the airplane went upside down. The RH wing is relatively intact, while the LH wing shows 2 areas of impact damage near the leading edge.



Figure 24: C172 front view



Figure 25: C172 right wing



Figure 26 : C172 left wing

The leading edge of the left wing shows compression damage, and composite parts, consistent with the material of the VL3 wing were found inserted.



Figure 27: Impact damage on the C172 LH wing leading edge

Also, the metallic part found next to the VL3 right wing was found to be part of the C172 wing tip.

The frequency selected on the radio were 122.1 and 114.5.

1.13. Medical and pathological information.

The investigation team did not have access to the autopsy report. It was clear that the occupants of the VL3 died instantly from the impact forces.

1.14. Fire.

There was no fire.

1.15. Survival aspects

Parachute.

The VL-3 was equipped with a rescue ballistic parachute GFS 5-6D. A witness saw the beginning of the deployment of the parachute upon impact.

The system is activated mechanically by pulling a handle located in the cockpit. The handle operates a striker that ignites the solid fuel of a rocket engine. The rocket accelerates out of its cover pulling the parachute out of the airplane. The parachute opens gradually as the slider moves down.

The airplane is attached to the parachute by ropes, attached to the structure in 4 points.

According to the manufacturer, the rescue parachute should be fully opened in 2.1 to 3.2 seconds.

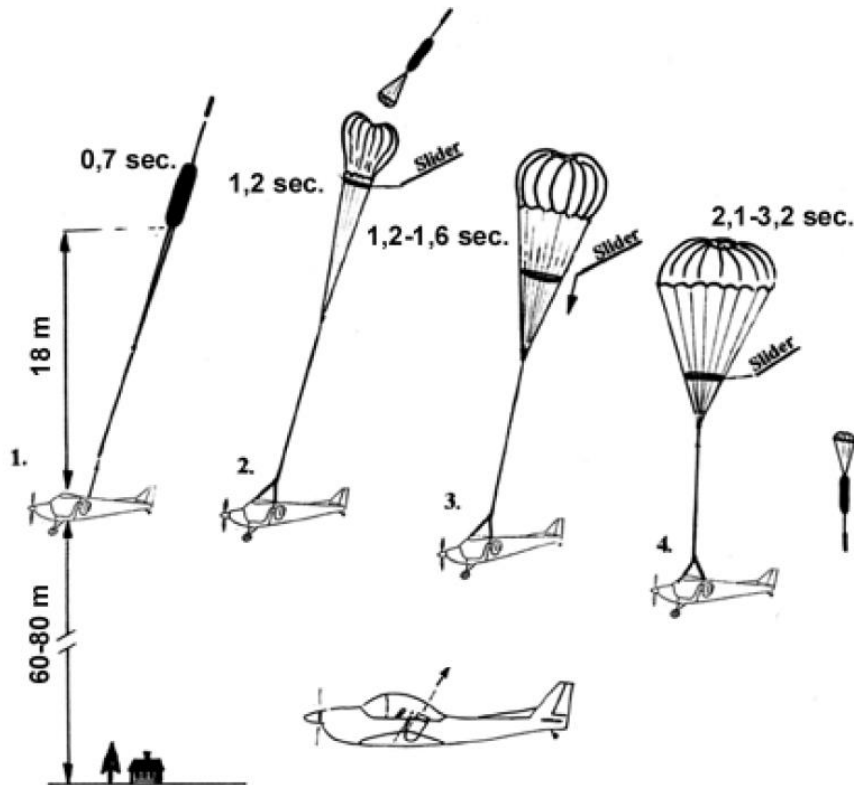


Figure 28: Operation of the rescue ballistic parachute

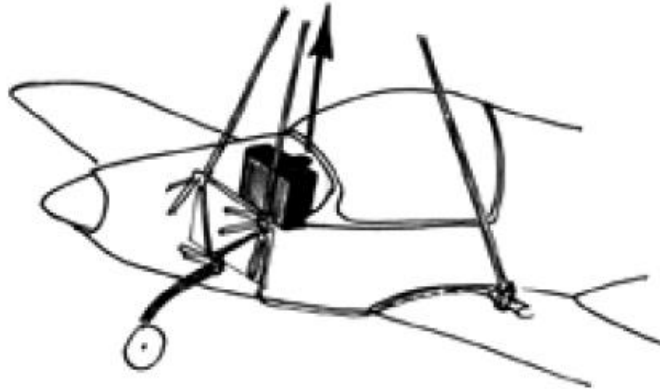


Figure 29: parachute ropes installation: typical.

The main parachute was found extracted. The extraction device was connected to its small parachute and pouch. The rocket had been fired; the exhaust showed powder residue.

The slider was half down.



Figure 30: Extraction rocket.

The rocket support cylinder in the airplane was found deformed.



Figure 31: Rocket Support cylinder.

The handle was displaced from its original position, the safety pin was not in place.



Figure 32: Operating handle

The four ropes, attaching the airplane to the parachute were found connected to the respective attachments. However, three attachments were found separated from the airplane's structure. Only the rear left attachment was still connected.



Figure 33 and 34: Attachment points

1.16. Test and Research

1.16.1 Similar cases.

This case bears striking similarities with another accident that occurred 19 years before.

On June 2, 1990, a Belgian airline arranged a Piper 601P Aerostar to shoot a promotion film on one of the new aircraft the airline recently acquired. It was to fly in formation with an Embraer 120 Brasilia near the Antwerp Airport.

The Brasilia departed Liège Airport at 17:57 and headed for Antwerp. The Aerostar took off from Antwerp at 18:43 and headed for Kallo where both aircraft would join for and start the formation flight. It was agreed that the Aerostar would fly to the left of the Brasilia because the camera crew was sitting on the right side of the Aerostar.

After circling the city of Antwerp, the crew of the Brasilia contacted the Antwerp Tower, stating his intentions to carry out a low pass over runway 29 followed by a high speed pass. The Aerostar would be alongside the Brasilia on both occasions. After that they would break and continued to Brussels.

Antwerp Tower issued clearance at 19:06. At 19:08 the Brasilia radioed their plans to the Aerostar: "I am starting approach and descent. I am going over the runway. I will not make a touch and go, I will just pull up, left and then back high speed." The pilot of the Aerostar replied: "OK... I will go straight ahead".

At 19:11 both aircraft made a low pass over runway 29 at a speed of 140 kts. The Brasilia was climbing away in a left turn when a mid-air collision occurred with the Aerostar. The tail of the Aerostar was sheared off and the aircraft crashed out of control near a railway line, killing the 4 occupants. The Brasilia was able to make a safe emergency landing at Antwerp.

PROBABLE CAUSES:

1. The lack of visual contact between the crews of both aircraft. Insufficient vision of the pilots of the Brasilia during or before the execution of a maneuver. (Sharp climbing turn at low altitude).
 - The Captain: controlled the plane and needed attention to perform the maneuver.
 - The co-pilot: was instructed just to monitor the engine instruments.

The inability of the pilot of the Aerostar to observe the Brasilia during the pull-up maneuver and sharp bank. The Captain of the Aerostar was in the usual left hand seat of the aircraft. From that position it was impossible to observe an aircraft approaching from right below. The pilots took insufficient precautions to avoid a collision.

2. Performing a maneuver: steep turn at low level of the Brasilia, knowing that the other aircraft was in the immediate vicinity, without actually knowing the actual position.
3. A misunderstanding between the captains due to incomplete preparation of the assignment, mainly on the agreement when to end the assignment and leaving the formation flight.
4. The erroneous interpretation of the last radio message.

Note: the full report (in Dutch) is available by simple request at info.aaiu@mobiliteit.fgov.be.

1.16.2. FAA Aviation News

The risks of formation flight is a recurrent topic, and the FAA wrote several articles on the subject in the FAA Aviation news.

January/February 1992 issue.

The article “Safe formation flight requires preparation and training” was written by Mr D. Chamberlain after a series of mid-air collisions in the USA.

Extracts:

“From 1965 through the summer of 1991, the NTSB report listed 43 midair collisions involving some type of formation flight. (...) The average of about 1.6. formation related midair collisions per year is part of an overall average of about 26 midairs per year from all causes from 1964 through June 30, 1991”

“Five (out of the 43) of the accidents involved some forms of aerial photography”.

“Although formation flight midairs represent less than 6.2 percent of all midairs (...), they are 6.2. percent that should never happen. They should also be the easiest midair collisions to prevent. The reason is both pilots involved know there is another aircraft close by. Each pilot is deliberately flying near to the other aircraft. The accident report indicate the typical formation flight midair is normally the result of carelessness on the part of one or more of pilots involved”

“No pilot should ever fly in formation with another aircraft without adequate training and preparation”.

March/April 2008 issue.

Mr Tom Gregory III wrote an article on the art of (safe) formation flying in the March/April 2008 issue of FAA Aviation News. The article stresses on the importance of flight preparation, and pre-arrangements between the pilots involved.

Extracts:

“Many photo flights have resulted in tragedy due to improper briefings, poor formation skill and untrained “subject” aircraft pilots.”

“Here’s another rule: Never attempt formation flying with pilots you do not know or trust. Remember that your life depends upon their skill and discipline.”

The document is available at;

http://www.faa.gov/news/safety_briefing/2008/media/marapr2008.pdf

1.17. Regulation

Formation flights.

The Royal Decree of 15 September 1994 defines the rules to be adhered to by pilots. The Decree is based on the Annex 2 of ICAO (Convention of Civil Aviation). With respect to formation flights, the annex defines the following in the Chapter 3 - General Rules:

3.1.8 Formation flights

Aircraft shall not be flown in formation except by prearrangement among the pilots-in-command of the aircraft taking part in the flight and, for formation flight in controlled airspace, in accordance with the conditions prescribed by the appropriate ATS authority(ies). These conditions shall include the following:

- a) the formation operates as a single aircraft with regard to navigation and position reporting;
- b) separation between aircraft in the flight shall be the responsibility of the flight leader and the pilots-in command of the other aircraft in the flight and shall include periods of transition when aircraft are manoeuvring to attain their own separation within the formation and during join-up and breakaway; and
- c) a distance not exceeding 1 km (0.5 NM) laterally and longitudinally and 30 m (100 ft) vertically from the flight leader shall be maintained by each aircraft.

3.2. Avoidance of collision

Nothing in these rules shall relieve the pilot-in-command of an aircraft from the responsibility of taking such action, including collision avoidance manoeuvres based on resolution advisories provided by ACAS equipment, as will best avert collision.

Note 1.— It is important that vigilance for the purpose of detecting potential collisions be exercised on board an aircraft, regardless of the type of flight or the class of airspace in which the aircraft is operating, and while operating on the movement area of an aerodrome.

- 3.2.1.** An aircraft shall not be operated in such proximity to other aircraft as to create a collision hazard.

The Royal Decree of 15 September 1994 (as well as the Belgian A.I.P.) reflects the ICAO standards defined hereabove in art. 16 and 17.

<p>Art. 16. Un aéronef ne peut évoluer à une distance d'un autre aéronef telle qu'il puisse en résulter un risque d'abordage. La vigilance exercée en vue de déceler les risques d'abordage ne doit pas être relâchée à bord des aéronefs en vol, quels que soient le type de vol et la classe de l'espace aérien dans lequel l'aéronef évolue, et au cours des évolutions sur l'aire de mouvement d'un aéroport.</p>	<p>Art. 16. Een luchtvaartuig mag een ander luchtvaartuig niet zo dicht naderen dat aanvaringsgevaar ontstaat. De waakzaamheid betoond voor het aan het licht brengen van aanvaringsrisico's moet onverminderd aangehouden worden aan boord van luchtvaartuigen in vlucht, welke ook het vluchttype is of de klasse van het luchtruim waarin het luchtvaartuig zich bevindt. Deze waakzaamheid blijft dezelfde tijdens de bewegingen op het bewegingsterrein van een luchtvaartterrein.</p>
<p>Art. 17. Les vols en formation ne sont permis qu'en conditions météorologiques de vol à vue et moyennant entente préalable entre pilotes commandants de bord. De plus, les atterrissages et les décollages en formation sont subordonnés à l'autorisation du directeur général de l'Administration de l'Aéronautique. Les vols en formation sont interdits aux aéronefs transportant des passagers contre rémunération.</p>	<p>Art. 17. Vluchten in formatie zijn slechts toegestaan onder zichtweersomstandigheden en mits voorafgaande afspraak onder de bestuurdersgezagvoerders. Daarenboven dient voor landingen en opstijgingen in formatie de toestemming bekomen van de directeur-generaal van het Bestuur van de Luchtvaart. Vluchten in formatie zijn verboden voor luchtvaartuigen die passagiers tegen vergoeding vervoeren.</p>

2. Analysis.

2.1. Flight preparation.

The flight preparation for both aircraft dealt with the fundamentals for each individual flight.

However, the “prearrangements” between the 2 pilots with respect to the mission – taking pictures of the VL3 aircraft from the C172 – and the resulting formation flight seemed to have been minimal.

- The route chosen by the aircraft – the coast line towards France – took them in 2 minutes over France for which a flight plan would have been required.
- At 8:56:33, the C172 pilot asked the other pilot over the radio on which side he wanted to pass. Later, they discussed their respective altitude and speed.

The radio communication between the two aircraft demonstrates that the essential data for the mission were not decided upon, prior to the flight: Which route? What separation?, What respective position? What speed? What altitude?. It can therefore be assumed that the procedure for join-up and breakaway were not discussed either.

2.2. The aircraft

Both aircraft are fundamentally different in their configuration; the VL3 is a ULM, one of the fastest in its category, with a significantly higher cruise speed in comparison to the C172. It is lighter, with a rate of climb twice as high as the C172. This causes the delay in reactions to the pilot’s inputs of both aircraft to be very different.

Maintaining a tight formation flight with two aircraft having such different characteristics is not easy, and does not come naturally. Military pilots, for example, are specifically trained. None of the two pilots involved received a specific training for formation flights.

This difficulty was recognized by the pilot of the VL3, who consistently flew at a greater distance away from the C172 than was suggested repeatedly by the pilot of the C172 pilot over the radio.

In addition to the differences in performance of both aircraft, the aircraft are also different in configuration; the C172 is equipped with a high wing, while the VL3 is equipped with a low wing. This causes a difference in visibility outside of the cockpit: This is demonstrated with image 2896 when the VL3 flew higher than the C172; both pilots would have had difficulties to see each other’s aircraft.

During the last turn, the C172 would lower its LH wing, impeding the lateral vision of the pilot of the C172.

2.3. Communication

The communication between both aircraft was performed using the Koksijde radio frequency (this allowed the recording of the conversations). The chatting between the pilots became a nuisance for the communication of other planes with the airfield, Koksijde radio requested both airplane to switch to another frequency.

The message was acknowledged by both pilots, the pilot of the VL3 confirming “switching to 123.45”. However, the examination of the VL3 wreckage could not determine whether the pilot of the VL3 actually changed the frequency, but the radio of the C172 was still showing the previous setting (122.1 MHz and 114.5 MHz). Different frequency settings would have interrupted the communication between airplane at a crucial moment;

- a change of respective position in the formation flight (stated by the VL3 pilot at 9:02:05 : “I keep flying at 1200, let you come beside me”), or
- a change of heading, as actually performed by the C172

Either way, the pilot of the C172 stated that he did not announce the initiation of the final left turn.

2.4. Respective position of the aircraft during the flight.

From the pictures taken and the communication, it may be concluded that, with respect to the C172 ;

- The VL3 approached the C172 from the rear, left side, maintaining a vertical separation of 200ft below the C172,
- The VL3 gradually caught up with the C172, flying side-by-side.
- The VL3 climbed above the position of the C172, and moved in front of it.
- The VL3 then evolved to a lower altitude, passed below the level of the C172. The vertical separation increased accordingly.

Just prior to the final turn of the C172 made to the left, the VL3 was flying in front of the C172 at a lower altitude, as also confirmed by an external witness. This would normally allow the pilot of the C172 to have a visual contact with the VL3.

2.5. Collision and impact.

The GPS of the VL3 shows no change of heading prior to the collision. As stated by 2 witnesses, the C172 initiated a left turn. Doing this, the left wing lowered and the airplane likely lost altitude. During this manoeuvre, the pilot stated he had no visual contact with the VL3. This movement was very quickly followed by the collision with the VL3.

The inspection of the C172 wreckage showed that the leading edge of the left wing of the C172 impacted the trailing edge of the right wing of the VL3, with a penetration angle of 45°. Additionally, thorough examination of the VL3 wing damage showed the lower wing skin was bent downward, and ripped off by the C172 wing impacting the VL3 from above. The forces on the wing of the VL3 caused the rupture of the main spar.

The Right wing of the VL3 separated from the fuselage. The C172 did not suffer any catastrophic failure, and was able to perform an emergency landing.

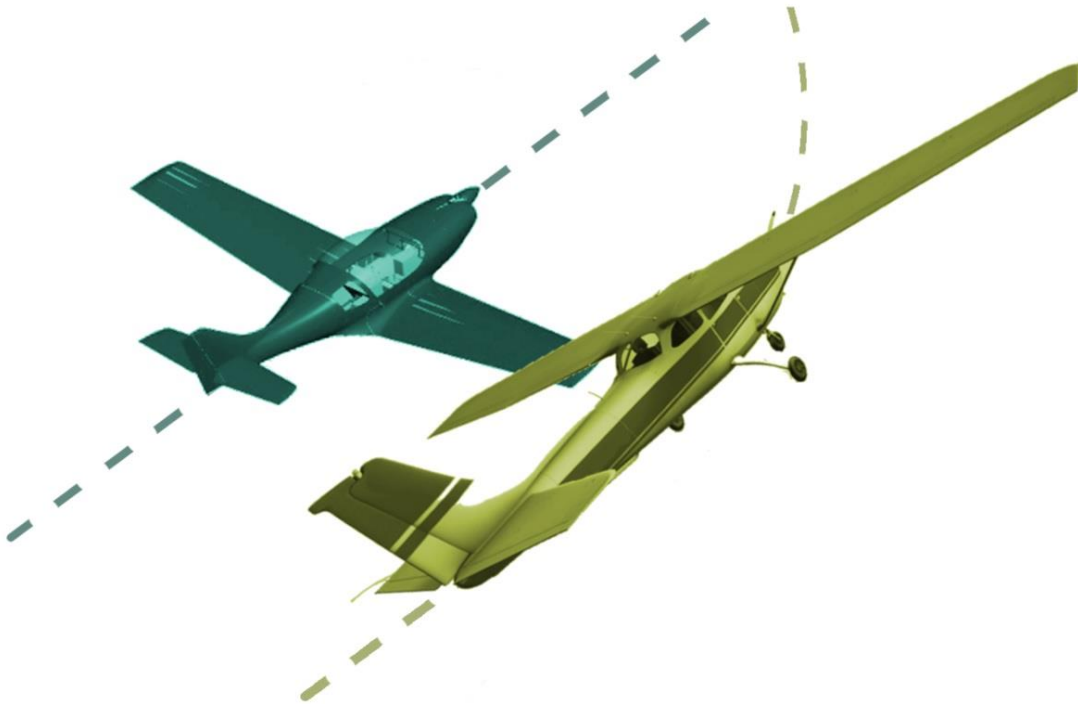


Figure 35: sketch of in-flight collision

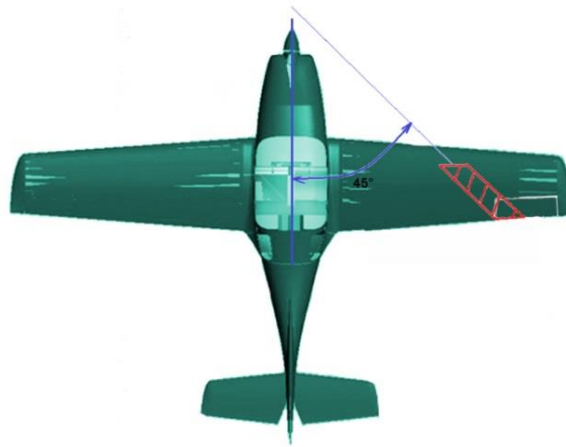


Figure 36: penetration angle of 45° in right wing VL3

The VL3 entered in a spiral dive, close to a vertical dive. The dive lasted only briefly.

The crew of the VL3 succeeded in pulling the handle of the rescue ballistic parachute, but too late for the parachute to deploy. Also, the failure of the wing caused the disruption of at least one of the attachment points of the parachute rope.

The impact of the VL3 with the ground occurred nose first and on the right side, due to the imbalance caused by the loss of the wing. The shock was violent and the two occupants died instantly.

2.6. Regulation

The Regulation requires re-arrangements between the pilots involved in a formation flight, without further describing the scope of these pre-arrangements. Literally, there were pre-arrangements made between the pilots, although, as in the case of the 1990 accident, they failed to address fundamental aspects of the flight.

3. Causes

Findings:

- Both airplanes were airworthy.
- There were no pre-impact technical failure found in any of the two aircraft.
- Both pilots were duly qualified and certified.
- The prearrangements for the performance of the photographic mission in a formation flight were minimal and did not cover all essential aspects of the flight.
- No indication were found showing the pilots were trained to perform flights in close formation.
- As requested by EBFN radio, the pilots had to change radio channel. However, the radio of the C172 was still tuned to the EBFN radio (twr and approach) frequencies after the crash.
- EBFN radio communication recordings show the C172 pilot did not check that the communication with the VL3 was established after the requested frequency change.
- EBFN radio communication recordings show no radio communication before initiating the course change.
- The C172 pilot made an unannounced left turn without having the VL3 in sight.
- The leading edge of the left wing of the C172 impacted the trailing edge of the right wing of the VL3, causing its failure.
- The crew of the VL3 operated the rescue ballistic parachute, but too late for the parachute to open.

Cause

The collision of the two aircraft was caused by a maneuver initiated by one of the two aircraft flying in formation, without visual contact, and not previously announced.

Contributing Factor.

A major contributing factor was the lack of proper prearrangements between the two pilots to perform a flight in close formation.

4. Safety recommendation

Recommendation 2014-P-7 to BCAA.

AAIU(Be) recommends BCAA:

- To review the requirements pertaining to formation flights, as laid out in the Royal Decree of 15 September 1994 and / or
- Develop additional guidance on the subject.

The recommendation was accepted by BCAA in a letter dated 14 October 2014, stating BCAA will develop a leaflet with regards to the flight preparation of formation flights. The leaflet will among others stress the importance of proper pre-arrangements between pilots to perform a flight in close formation.



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