DANSK UL-FLYVER UNION
DANISH ULTRALIGHT FLYING ASSOCIATION

ACCIDENT WITH OY-9479 VL-3 EVOLUTION

16.October.2017

Location: AUDEBO, NORTH OF EKHK (HOLBÆK), DENMARK

Investigators:

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Report issued 16.03.2018

ACCIDENT INVESTIGATION:

Ultralight aircraft maintains a national operating permit, and is therefore according to Danish AIC B 21 2013 considered to be without national registration and is exempt from the national Accident Investigation Boards obligation to investigate.

DULFU *(Danish Ultralight Flying Association)*, is therefore tasked with investigating accidents with aircraft owned and/or operated by the union.

RESPONSIBILITY:

The investigation and this subsequent report, is compiled alone with the intent to contribute to improve safety in DULFU operations.

This report will not determine question of quilt, but merely provide an account of known events and from this possibly make recommendations.

The report is produced voluntarily and reflects the interest of the DULFU.

DULFU has limited resources and authority, thus on several points this report may not be complete and/or exhaustive.

DULFU does not consider this document as adequate documentation for insurance and judicial purposes and therefore disclaim any such responsibility for its contents.

COOPERATION:

This investigation is produced in a cooperative effort and with assistance from the Danish Police Authority *(Midt- og Vestsjællands Politi (Holbæk)*, the Danish NAVIAIR *(Navigation Via Air)*, the Danish AIBD *(Accident Investigation Board Denmark)*, DAO Aviation AS, Garmin UK Ltd., DULFU's Group of Owners and others *(see links in appendix).*

INDHOLD

ABBREVIATION AND EXPLANATION

AIC	Aeronautical Information Circulars - issued by Naviair
Airwork	Describes manoeuvring with aircraft, as opposed to straight and level flight
ASI	Air Speed Indicator – shows speed relative to ambient air
ATC	Air Traffic Control,
Attitude Indicator	Instrument depicting the aircraft's orientation in space
BL	Bestemmelser for Luftfart, regulation for aviation in **COIF**
	Copenhagen Information.
DULFU	Danish Ultralight Pilot Union,
EBBY	EBBY, ICAO-code for Baisy-Thy Airport in Belgium
EKHK	EKHK ICAO-code for Ny Hagested/Holbæk Airfield west of the city of Holbæk in Denmark
EKRK	EKRK ICAO-code for Roskilde/Tune Airport west of the city of Copenhagen, Denmark
ELT	Emergency Locater Transmitter
EMS	Engine Management System,
Feet	= 0,3048 meter. Used as altitude/level indication in aviation,
g	g = Standard Gravity,
GA	General Aviation, all civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire,
Glas Cockpit	When Computer Screens are used in aircraft, instead of analogue instruments,
GPS	Global Positioning System
HSI	Horizontal Situation Indicator - instrument used for navigation
km/h	Kilometer per hour
KMZ	Keyhole Markup Language - an XML notation for expressing geographic annotation and visualization within Internet-based, two-dimensional maps and three-dimensional Earth browsers.
Litre	SI metric system for Unit of Volume
Medical	Popularised abbreviation for Medical Certification for Pilots
PFT	Periodical Flight Training, tests to be passed by Pilots at regular intervals.
Pitch	Roll, Pitch or Yaw. One of the three rotational dimensions of an aircraft
FOM	Flight Operations Manual, pilots primary operational reference and regulatory handbook,
PPL	Private Pilots License,
S-Certifikat	Glider Pilot Certificate,
SD	Secure Digital Card, computer memory card,
SLV	Civil Aviation Authority Denmark - Danish Transport, Construction and Housing Authority,
Spin	Autorotation of an Aerodynamically Stalled Aeroplane,
Stall	The loss of effectiveness of an aerodynamic surface,
TBST	Danish Transport, Construction and Housing Authority,
TMA	Terminal Manoeuvring Area,
TMG	Touring Motor Glider, fixed-wing aircraft that can be flown with or without engine power,
UL	Ultra Light, class of aircraft, nationaly regulated with a total weight of 450/472,5 kg,
UL Class B	Ultra Light, aircraft, rudder controlled (3 Axis), as opposed to Class A which is Weight Controlled (Trike) ,
UTC	Universial Time Coordinated,
VCL	Valid By Day Only (medical colour deficiency),
VDL	Correction for Defective Distant Vision, must carry glasses or corrective lenses,
VFR	Visual Flight Rules,
VMC	Visual Metrological Conditions,
VNE	Velocity Never Exceed,
VNL	Correction for Defective Near vision. must carry glasses or corrective lenses,
VSI	Vertical Speed Indicator,
Yaw	A yaw rotation is a movement around the yaw axis of a rigid body that changes the direction it is pointing.

SYNOPSIS

NOTIFICATION

DULFU was, in the evening of the 16th of October 2017, made aware that a UL-aircraft had crashed 4 km north of Ny Hagested airfield, also called Holbæk Airfield *(EKHK, position 55°44'03.1"N / 11°36'05.8"E),* in Denmark (see Appendix 1).

DULFUs Operations Manager contacted the Duty Officer of the Midt- og Vestsjællands politi *(Middel- & Western Zealand Police),* offering assistance in investigating the the reported aircraft accident.

DULFUs Accident Investigation Group (AIG) was then instructed to convene on the position of the accident on the subsequent day, the 17th of October 2017 09:00 hrs.

SYNTHESIS

During a training flight the pilots looses control over the aircraft. The aircraft enters a spin and the pilots are unable to regain control and it shortly thereafter impacts the ground in a manner that kills both pilots.

Investigation showed that both pilots was properly certified and current, and the aircraft was fully certified as per regulations.

No other maneuvers was carried out during the flight except those described in the approved curriculum for the annual PFT. The pilots lost control of the aircraft, entered a spin from which they could not recover from in the altitude available at thetime.

The AIG presume, after having exhaustively researched a number of reports about similar accidents, that the VL-3 type of aircraft does have an inadvertent and unfavourable aerodynamic characteristica which makes it possible to enter into a spin from which it is almost impossible to recover.

FACTUAL INFORMATION

The flight was planned to be a PFT *(see definition above),* with Pilot A in the left seat of the aircraft and Pilot B in the right seat of the aircraft, the jointly owned VL3 aircraft registered OY-9479.

The flight was carried out in VMC conditions.

Both pilots was co-owners of the aircaft OY-9479, together with others.

The pilots knew each other from previous activity in the same glider club and both was certified gliding instructors.

The aircraft took off EKRK (Roskilde) RWY 21 at 14:58 hrs., local time, heading north.

After having departed EKRK Control Zone communication between the aircraft and ATC makes it clear that the plan is to fly westward towards the area of Lake Tissø This position puts the aircraft outside the TMA covering the island of Zealand and therefore provides the needed altitude to perform airwork.

The pilots communicated with the COIF, that they intend to climb tp 2500 feet when passingthe western perimeter of theTMA. The perimeter line runs through the city of Holbæk. The area north of EKHK airfield is designated as a training area as the location is free from major conurbations, and mainly consist of open fields.

15.13.23 UTC the aircraft reaches an altitude as per the onboard GPS of 2656 feet and initiate a power off stall.

Later simulator flights emulated the accident flight. In these it appears that the pilots may have attempted flight close to stall by using the rudder to balance the aircraft.

15.13.59 UTC the aircraft drops the right wing with 45° in a stall, which is corrected (2546ft).

15.14.20 UTC the exercise is repeated, but the aircraft drops its left wing 35° and after recovery to the right the aircraft rolls onto its back and enters a right handed spin (2381 ft).

15.14.43 UTC After having rotated 8,5 times the rotation to the right stops and the G-meter measures the load to be 3,8G. At that point in time it is possible the left wing of the aircraft separated and the rest of the airframe continue spinning towards the left (635ft.).

Another possible scenario at this time could be that the pilots succeeded in terminating the stall but the excessive speed suggests the aircraft may have entered into a high speed stall, which may explain the lack of rotation at impact.

15.14.44 UTC last log entry is at 526 ft, with a pitch angle of 43°, a roll angle 61° and with a roll rate of -20° per second. The aircraft disappears from the ATC radar at this time, but as the pilots had informed about doing airwork, it is not before 15.18.16 that the COIF attempts calling the aircraft.

The impact of the aircraft in the potato field is observed by a farmer on his tractor in the nearby field. He states when interviewed: "I saw a white plume of smoke coming from the aircraft". This was more than likely cooling water evaporating from the hot engine. The farmer ran towards the aircraft in order to ascertain if he could help in any way only to conclude it was nothing he could do. He then proceeded calling the emergency services.

At impact the onboard Emergency Locator Transmitter (ELT), began transmit signals on frequency 121,5 MHz and a rescue helicopter is immediately dispatched and the COIF directs a General Aviation aircraft close to EKHK airport, to home in on the emergency signal. When the pilot of the GA- aircraft spots the impact location, he spots people standing around the wreckage and become convinced it must be the pilots having left the aircraft.

INJURY TO PEOPLE

Type of injury	Crew	Passengers	Others
Deceased	0	0	0
Serious injury	0	0	0
Minor injury	0	0	0

DAMAGE TO THE AIRCRAFT

The aircraft was totally destoyed. The fuselage broke in two on both sides over the wing. Severe compression damage to the rear part of the fudelage. The nose section of the aircraft was completely demolished, right back to the leading edge of the wing. Both wing tanks had ruptured and the fuel discharged onto the ground. When investigated no defects where found that was not caused by the accident. The two float chambers in the engine was dismantled and found to contain fuel. The electronic engine log showed the engine had been operating normally during the entire logging period.

OTHER DAMAGE

Small impact grooves in the field and approximately 45 litres of aviation fuel was discharged into the potato field at impact.

PERSONELL INFORMATION

PILOT INFORMATION - PILOT A

Pilot A, male 61 years, gained the right to pilot Ultralight Aircraft Class B based on previous S-certificate with TMG rights as per Danish BL 9-6 item 9.1 dated 01st June.2013. 10th October.2017

a particular UL-Certificate was issued by the Danisg Civil Aviation Authority (Trafik-, Bygge- og Boligstyrelsen). The validity of the pilots PFT was due to expire on the 23rd October.2017
The pilots medical certificate (Medical Class 2), was valid until 13th April.2018, with the limitation "VDL" - correction for defective distant vision. Pilot A received rights on: ATEC Faeta the 1st of June 2013 and for VL3 on the 25th October 2016.

In Flight Experience	Last 30 days	Last 90 days	Total
All aircraft types	00:55	07:56	**440:02**
Accident type	00:55	07:56	**94:01**

PILOT INFORMATION - PILOT B

Pilot B, male, 56 years, retained the right to pilot UL-aircraft Class B based on S-certifikat issued 26th June 2010. On 9th June 2017a particular UK-certificate was issued by the Danish Civil Aviation Authority (Trafik-, Bygge- og Boligstyrelsen). Pilot B retained an instructor certificate issued by the Dansk Ultralight Flying Association on the 17th March 2017 valid for UL class B with the annotation PFT-Instructor / Examiner. The pilots medicalcerificate (Medical Class 2), was valid until 16th May 2018, with the limitation "VNL" - correction for defective near vision and "VCL" – valid by day only (colour deficiency). Pilot B received rights on: ATEC Faeta the 26th June-2010 and for VL-3 on the 19th September 2016.

In flight experience	Last 30 days	Last 90 days	Total
All aircraft types	01:55	12:30	
Accident type	01:55	12:39	**220:45**

Pilot B's Glider Certificate is issued by the Civil Aviation Authority on the 15thJuly 1993. The Accident Aviation Group has not been able to locate the pilots Glider Pilot Logbook.

Pilot A and Pilot B knew each other from earlier activity in the same glider club. Both pilots was licensed as Glider Pilot Instructors Class 1.

AIRCRAFT INFORMATION

Registration:	**OY-9479, previously OO-H45**
Aircraft type:	**VL3 (JMB Aircraft s.r.o)**
Serial Number:	**VL3-150**
Flight Rules:	**VFR**
Operations Type:	**Training / PFT**
Phase of flight:	**Stall training**
Aircraft category:	**Ultralight Class B (Rudder Controlled)**
Last departure from:	**Denmark EKRK (Roskilde/Tune)**
Planned arrival at:	**Denmark EKRK (Roskilde/Tune)**
Damage to aircraft:	**Total**

Certificate of Airworthiness was issued on the 21st September 2017. Insurance was valid until 19th September 2018. Dispensation for payload was issued on the 27th September 2016. The aircraft is a VL3 Evolution, built by JMB Aircraft s.r.o., in 2014.

NOTE:

The aircraft is a modern Ultra-Light Aircraft constructed in Fiberglass and Carbon Fibers, with Retractable Undercarriage and Constant Speed Propeller. When presented to the market it was introduced as the world's fastest UL-aircraft with a V_{NE} of 305 kmh. The aircraft was bought used on the 10th September 2016 from the producer in Belgium (EBBY), after having completed approximately 150 hours as a demonstrator.

Gengivet med tilladelse fra fotografen

METEOROLOGICAL I N F O R M A T I O N

Observation location:	**EKHK / Ny Hagested 15:00 UTC**
Position:	**55,7°N 11.6E° 16th October 2017**
Wind:	**220°/5 kt**
Temperature:	**16,1°C Dewpoint 12,7**
Altimeter setting / Barometric pressure:	**QNH 1019,0 HpA**
Visibility:	**15 km**
Clouds:	**1/8 @ 3100 ft (automatic)**

RADIO COMMUNICATION

In the transcript of radio communication between the aircraft and the COIF, the following appears:

15:06:39 UTC, when the aircraft left Roskilde Control Zone via the reporting point Valby, the pilots calls COIF and informs that they wish to route towards Lake Tissoe and from there return to Roskilde Airport.

15:09:43 The pilots contact COIF, requesting clearance to climb to 2.500ft in order to begin airwork. TMA at this position is controlled by Roskilde Approach and COIF advises that if they would like to climb from present position, thay should contact Roskilde Approach. If they on the other hand continue another 4,0 nautical miles west, they are free to climb as they choose.

15:11:27 COIF contacts the aircraft and informs that they now are cleared to climb to 2.500 feetm and the pilots confirm. Thereafter COIF ha no further contact with the aircraft.

AIRPORT INFORMATION

Roskilde Control Tower confirms having no comments to the aircraft's takeoff and departure from EKRK.

FLIGHT RECORDER

The aircraft was equipped with two – 2 Garmin G3X Glass Cockpit, configured in a "Master-Slave"" configuration. Both units suffered hardly any damage during the accident. Both units is equipped with SD-Slots into which SD-Cards can be inserted and onto which details of the flight is logged. The log kan be converted to KMZ format and be displayed on Google Earth. During this flight no SD-Cards was inserted, in either unit, but with assistance from DAO Aviation in Roskilde and from

Garmin UK, extracting the log from the units was successful. This log contains information about approximately 90 different parameters, each being logged about 10 times per second. Among these are GPS-based Position Information, Analogue ASI and Barometer Information, HSI, Attitude Indicator, EMS-Information and more. The log shows all operations with the aircraft since 27th August 2017.

For reasons knot known, the last log entry on the day of the accident was made at an altitude of 600 feet above ground. At this point all engine parameters was logged as being normal and in idle position.

With the information from the onboard logging system and assistance from an expert on the software program Microsoft Flight Simulation (FSX), a reconstruction of the last flight with OY-9479 was possible, and can be viewed in FSX.

WRECKAGE AND ACCIDENT LOCATION

The aircraft hit the ground nose first at an angle of approximately 40,0°, from a spin which rendered the aircraft almost perpendicular to the ground. VSI log at this point reads approximately 6000

At impact the fuselage fractures just between the rear of the firewall and the leading age and the middle of the cockpit over the wing. The Cockpit Canopy Locking Mechanism is sheared off and the plexiglass canopy flips forward. The front part of the canopy shatters and pieces are spread in fan-like fashion up to 10 meters in front of the aircraft. Pulling forces rips the shoulder harnesses from the beam onto which they are secured.

At impact both elevator bobweights brakes away. The right one is located below the elevator and

the left approximately 4 meters rear of the aircraft.
If the bobweights has broken away from the aircraft as the tail hits the ground, or by severe oscillation of the control column, can not be determined.

At impact both the internal wing mounted, integral fuel tanks ruptured at their lowest point and the fuel runs to the ground.

A propeller blade is severed at impact and is subsequently located under the aircraft on the starboard side (underneath the co-pilots rudder pedals). The second blade remains intact and attached to the propeller hub, pointing to starboard relative to the aircraft.

The release mechanism for the Rescue Parachute has severed from its attachment bracket box and has not been released. The Security Pin was removed.

MEDICAL AND PATHOLOGICAL INFORMATION

Autopsy evidenced that both pilots died immediately on impact. The injuries on them was as could be expected after having been subject to massive G-forces and the load imposed by the shoulder harnesses, which did not work properly.

FIRE

There where no ensuing fire after impact, a fact contributed to the fact that the fuel tanks are in the wings and not in the fuselage.The fuel tanks ruptured and the fuel was discharged to the ground. The aviation fuel did not come indirect contact with the hot engine or any possible electric igniting sources.

SURVIVAL ASPECTS

The autopsy documented that the accident was not survivable, even if the shoulder harnesses had kept the pilots in their seats.

WITNESSES

According to poice reports an individual, at the time of the accident, observed an white aircraft spinning towards the ground. Time and place is consistent with the accident described herein. The witness was located approximately 6 km north of the accident location.

A farmer on his tractor in the nearby potato field did not observe the impact, but did observe a plume of white smoke coming from the aircraft. Presumebly this observation happened after the actual impact of the aircraft. As stated earlier in this report, the white smoke appareantly came from vaporizing coolant.

FURTHER INFORMATION

A member of the group of aircraft owners for OY-9479 inform the Accident Investigation Group that at the time of delivery of the aircraft in Belgium, the demonstration pilot from the vendor did not want to demonstrate stalls, as it was not possible at the location to reach and maintrain an altitude of 4000 feet. An attempt to have stalls demonstrated after the aircraft had been with the producer for minor repairs, was not made possible either. Two pilots rom the Group of Owners recorded later on video showing stalls with the aircraft. The video shows that as soon as a stall was detected, the control column was moved to the full nose down position.

JMB Aircraft, Nadrazni 365, 56501 Chosen, Czech Republic, produces the VL3 aircraft. On the 20th October 2017 the manufacturer issued an amendment to its Operating Procedures that power-on stalls was strictly forbidden, and at the 15. October 2017 issued information concerning how a power-off stall should be carried out (Appendix 2).

The Manufacturer has revised its Operating Procedures, recieved by the Danish Owner Group on the 9th December 2017. Neither the old or the new Operating Procedures is dated or given a designated version.

The Accident Investigation Group have received non-collaborated information from various sources that the airfoil used on the aircraft may have some "unfortunate" stall properties (Appendix 3).

The Accident Investigation Group is also made aware, by various sources, that several incidents and accidents has happened with aircraft type VL3, some similar to the accident with OY-9479 (Appendix 4).

ANALYSE

THE FLIGHT

An altogether normal flight with two experienced pilots, with the intent to carry out the biannual competency check (PFT). During the flight the pilots looses control of the aircraft, and it enters a spin. The pilots was unable to regain control of the aircraft before it impacts the ground. The fitted Rescue Parachute was not deployed.

VISUALIZATION

Based on the onboard electronic log, it was possible to reconstruct the flight in question by the aid of the adaptable software Microsoft Flight Simulator X.

On the footage one can see that the aircraft performs a stall and that it in the stall drops a wing but is immediately corrected and brought back to normal flight.

The exercise is repeated and shows that the left wing drops. In this exercise it seems like the correction is rather abrupt, resulting in a right wing down condition.

35° wingdrop

correction

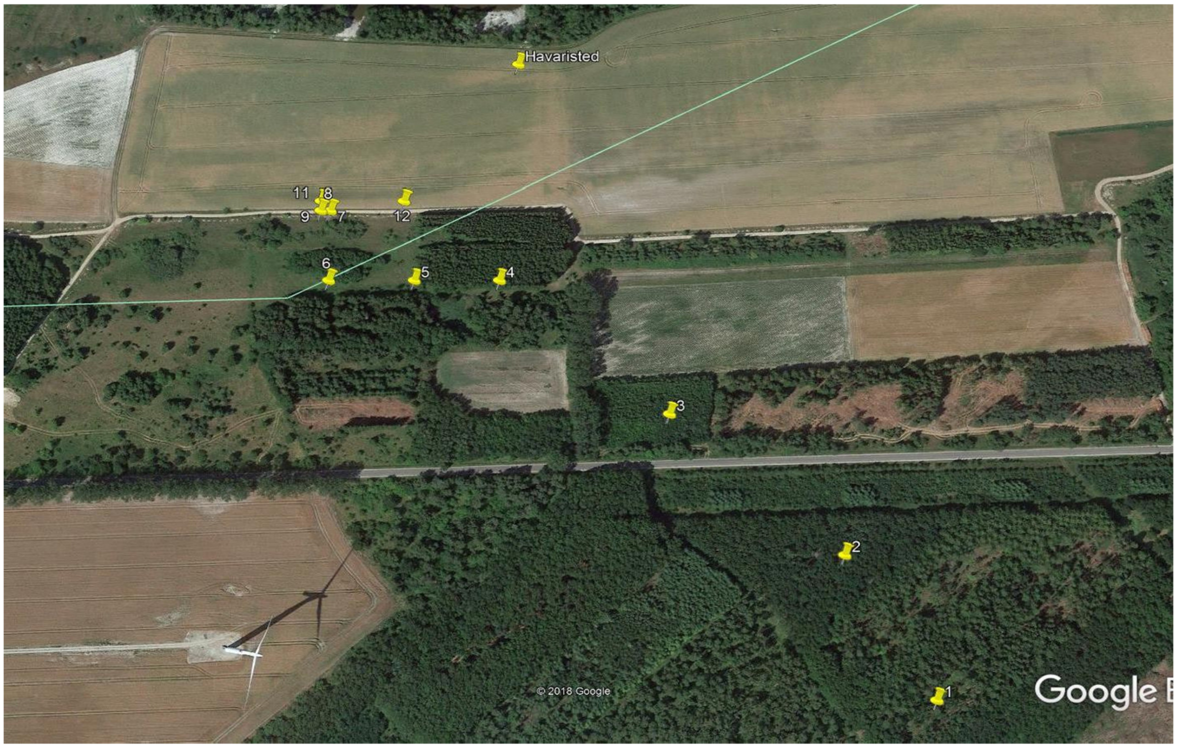
Right wing drop

Thereafter the aircraft is in a fully developed stall and the aircraft rotates 8,5 times to the right.

Upside down

Spinning

After having rotated 8,5 times it appears that the pilots are able to halt the rotation to the right at approximately 600 feet. Unfortunately the automatic logging of parameters stops at this time. The Accident Investigation Committees assumption concerning this, is that the aircraft has stopped rotating, but continues its descent in a state of a high-speed stall, until impact.



Location of the Impact Site with recorded GPS Coordinates

VL3 THE AIRCRAFT

The VL-3 aircraft is sold by the Belgian registered company JMB Aviation Rue Cache de Lannoy 7, 7750 Amougies, Belgium. The company assumed responsibility for production of the aircraft in 2012 from Aveko Servomotory s.r.o., Lipovà 234/22, 602 00 Brno, Czech Republic.

The aircraft was built and marketed as the fastest Ultra-Light Aircraft in the world, with a V_{ne} of over 300 km/h. The aircraft have similarities with the aircraft Lancair 360, which has the same wing profile, designated NLF(1)-0115.

AIRPLANE PARACHUTE SYSTEM

A number of Ultra-Light Aircraft are now fitted with a parachute system that is able to carry the weight of the airplane including its occupants in case of an emergency. Some types are able to be deployed and be effective as low as 300 feet AGL. Several accidents with aircraft fitted with this system has resulted in the parachute being deployed either to late or not at all.

SHOULDER HARNESSES

In this accident the shoulder straps attachment of the four point safety harnesses, was forcefully ripped from its fastening arrangement behind the two pilots. Although this fact had no bearing on the accident as such, it should be considered as a risk factor that in this case possibly caused fatalities.

WEIGHT AND BALANCE

After having received information about the weight of the pilots from the autopsy, and assumed the weight of the fuel onboard at the time of the accident, the Accident Investigation Committee made the following Weight & Balance Calculation

Veight & Balance OY-9479

NOTE:
As per Aircraft Flight Operations Manual, the Center of Gravity Range is between 21% and 34% of the Mean Aerodynamic Cord (MAC)

Aircraft Empty Weight	**347**	kg
Pilots Weight	**100**	kg
Co-pilots Weight	**83**	kg
Fuel	**72**	Liter
Baggage	**5**	kg
Empty Centre of Gravity (CG)	**22,5**	%
Wing Leading Edge at	**540**	mm
Mean Aerodynamic Cord (MAC) offset	**68**	mm
Mean Aerodynamic Cord (MAC)	**1236**	mm
Takeoff Weight (TOW)	**587,2**	kg
Centre of Gravity (CG) position in mm of the Mean Aerodynamic Cord (MAC)	**408**	mm
Centre of Gravity (CG) position in % of the Mean Aerodynamic Cord (MAC)	**33**	%

HUMAN FACTORS

Stress:

Pilot A arrived at the airports gate (EKRK), at 07:46 local time and has possibly spent the entire day at the airport. He has, among other contacts, been in touch with several of the companies residing at the airport. We (the AIC), assume that he also spent time preparing the aircraft for the pending flight, including the required pre-flight check.

Pilot B arrived at the airports gate (EKRK), at 16:25 local time. Logging in the aircraft starts at 14:47 UTC. This gives 22 minutes in which to move from the Guarded Gate to the aircraft hangar, to discuss the days flying program and tasks with time for a possible change of clothes, possible closing of hangar doors and time to work through the required check lists.

Flight Plan was submitted at 14:01 UTC in which ETD is set for 14:40 UTC. It is not registered if it is Pilot A or Pilot B that submits the Flight Plan, but it is assumed it is Pilot A, as he has spent the day at the airport. This could also explain why, after having taken off on Runway 21, they choose to depart towards the north (via Valby), instead of proceeding directly west and leave the area via RK, if the plan was to fly towards the area of Lake Tissø. Sunset at EKRK was at 16:08 UTC and Take-off occurred at ca. 14:58, which gives a maximum of 01:10 to complete the planned PFT-program, which is set to last approximately one hour. Thereafter it should be time to return to the airport and land before sunset. It is possible that the pilots could have felt pressed for time, which is supported bye the radio call registered at 15:09:52 UTC to the COIF, requesting clearance to climb inside the TMA to 2599 feet.

Confusion when a sudden and unexpected spin occurs:

When a sudden and unexpected spin occurs one could assume that a not unsignificant number of seconds would pass before the situation is processed mentally by the pilots. In this case this could be valuable seconds relative to a more fortunate outcome.

Who is In Control, the Instructor or the Student?

(extract from)

Guidelines for Evaluation during the Practical Test for the issue of an Ultra Light Certificate

*”The test is noted as **Not Passed** if the Flight Examiner has to call for "My Controls!" in order to gain or regain control of the aircraft and resume a safe flight."*

Confusion relative to the above could have been a contributing factor in this accident. Doubt about who is actually in control, i.e. "Pilot-in-Command", is a vital factor in a situation like this. In addition, it is also possible the examiner delayed his intervention in order to see if the student carried out the required corrections, which if so, could have led to a further delayed reaction from the examiner.

Another element in this is if the pilots, both being Certified Instructors, perceive the situation differently and unintentionally opposes each other's reaction.

Why was the Emergency Parachute not deployed in time?

It is possible both pilots hoped for a successful recovery and therefore did not deploy the parachute. Both pilots was both trained and tought spin recovery in gliders, and could therefore become uncertain when the aircraft did not respond according to this experience.

AERODYNAMIC FACTORS

In a spin, an aircraft with fuel tanks in the wings will result in the fuel being slung towards the direction of rotation, thus increase the inertia of the rotational forces. It can be seen in the electronic log that the Fuel Content Registration dropped significantly during the spin, as the metering unit is located in the wing tank, close to the fuselage..

The Wing Profile NLF(1)-0115, is utilized in order to provide the wanted high $V_{ne.}$ It is also possible that if the profile could show an unwanted and unexpected performance during stalls. This could have contributed to the accident (Appendix 3).

TRAINING AND EXCERSIZES IN UL-AIRCRAFT - STALLS AND STALL WHILST TURNING

Aerobatics is defined as follows by the Authorities.
"Abrupt changes to attitude or speed, more than 60º bank and/or 30º nose up or down.

An Accident Report from Belgium dated 8th September 2015 described an accident with a JMB VL3, from which is seems prudent to make a parallel observation. It says:

> "*Following ICAO definitions, a stall is not considered as aerobatics, especially if it is conducted for the purpose of flight training. By extension, it would be safe to say that stall exercises performed during a refresher training or even during solo training flights would also not be considered as aerobatics provided it is approved by the aeroplane manufacturer and performed safely. Stall training in a controlled environment will help the pilot to gain, or later to maintain, adequate skill and the ability to recognize stall symptoms early".*
>
> (https://mobilit.belgium.be/sites/default/files/downloads/accidents/2015-aii-10_final.pdf)

Practicing stalls during flight is permitted by many countries in Europe and is recommended by most of the manufacturers of UL Aircraft. In Denmark, in the tests in conjunction with the issuance of UL-Certificates and for the annual or bi-annual PFT, stalls and stall recovery with and without engine power must be demonstrated. In the Skill Test for Private Pilot License A (PPL) (Powered Flight), section 2: General Airwork, states the following:

- **stall,**
- **clean stall and recover with power,**
- **approach to stall in a descending turn with bank angle 20°, approach configuration,**
- **approach to stall in landing configuration.**

The term “Clean Stall and Recover with Power” means: straight forward and level flight without flaps.

The other two types of stall is difficult to demonstrate in a UL-aircraft. There is no legal requirement that they must be fitted with a Stall Warning System (SWS), or an Angel of Attack Indicator (AOA), thus the pilot may experience difficulties in identifying an approaching stall. Some aircraft are designed so that the pilot feels the aircraft is becoming lighter on the controls or that the aerodynamic control surfaces and the control yoke is moving rapidly back and forth by itself when approaching a stall (stickshaker). Other types of aircraft provides no warning of impending stall and can be prone to a rather dramatic drop of a wing. In some cases it may even roll upside down, which means the bank angel exceeds more than 60°, exceeding the permitted angle.

In the POH (Pilot Operations Handbook), for 15 of the most commonly used aircraft in Denmark, it is concluded that approximately half of these is approved for stalls. Only two types is approved for other types of stalls than what is termed a "Clean Stall". One aircraft type (an older construction), approves a spin with up to three revolutions. The other half of these aircraft do not approve stalls, but writes that the aircraft is only approved for non-aerobatic maneuvers. One aircraft states in its POH that stalls, spins and other aerobatic maneuvers are strictly prohibited. Generally, intentional spins are prohibited with Ultra-Light Aircraft used in Denmark.

AIRCRAFT MANUALS

The Pilot Operating Handbook (POH), section 2.9 states that the aircraft is designed for Normal Flight with a the bank angle never to exceed 60°. The warning in the POH (appendix 2), dated 15th October 2017, reads as follows:

> ***Aerobatics, intentional spins and power-ON stalls are prohibited***
> Training of stalls have to be practiced [above] at least 4000 ft AGL

OTHER ACCIDENTS WITH VL-3

Researching other and earlier accidents reports, a pattern appear to be visible. A net search (https://aviation-safety.net), reveals that 12 accidents with VL-3 is registered since April 2008 (Appendix 4). Of these twelve, eight are confirmed caused by stalls followed by spins (loss of control). All sixteen occupants of these eight aircraft deceased.

KONKLUSION

CAUSES

It is the opinion of the Accident Investigation Committee that the:

- **aircraft was airworthy and had a valid permit for flight,**
- **aircraft was exceeding the prescribed weight limitations, but the Center of Gravity (CG), was within limits,**
- **pilots was licensed according to requirements,**
- **flight was carried out during VMC conditions,**
- **during practicing stalls the aircraft stalled and entered an unintentional spin,**
- **pilots was not able to regain control of the aircraft and spun from an altitude of approximately 2500 feet.**
- **pilots did not deploy the security parachute, which could have saved the pilots life.**
- **wing profile of the aircraft is of an advanced type and may have aerodynamical properties that may have contributed to the accident.**

SAFETY RECOMMENDATIONS

USE OF SAFETY PARACHUTE

Within the Ultra-Light Aircraft Community there is a lack of Standard Operating Procedures (SOP) for when and under what conditions a Safety Aircraft Parachute System should be deployed. The reason is possibly because the system is new to this environment.

The Accident Investigation Group recommend that when control of the aircraft is lost and cannot be regained, the parachute must/should be, deployed. An item in "The Before Start Checklist" should makes it mandatory for the Pilot-in-Command to declare vocally when and under what circumstances the parachute will be deployed, thus facilitating mental awareness of the subject..

STALL PRACTISE WITH UL-AIRCRAFT

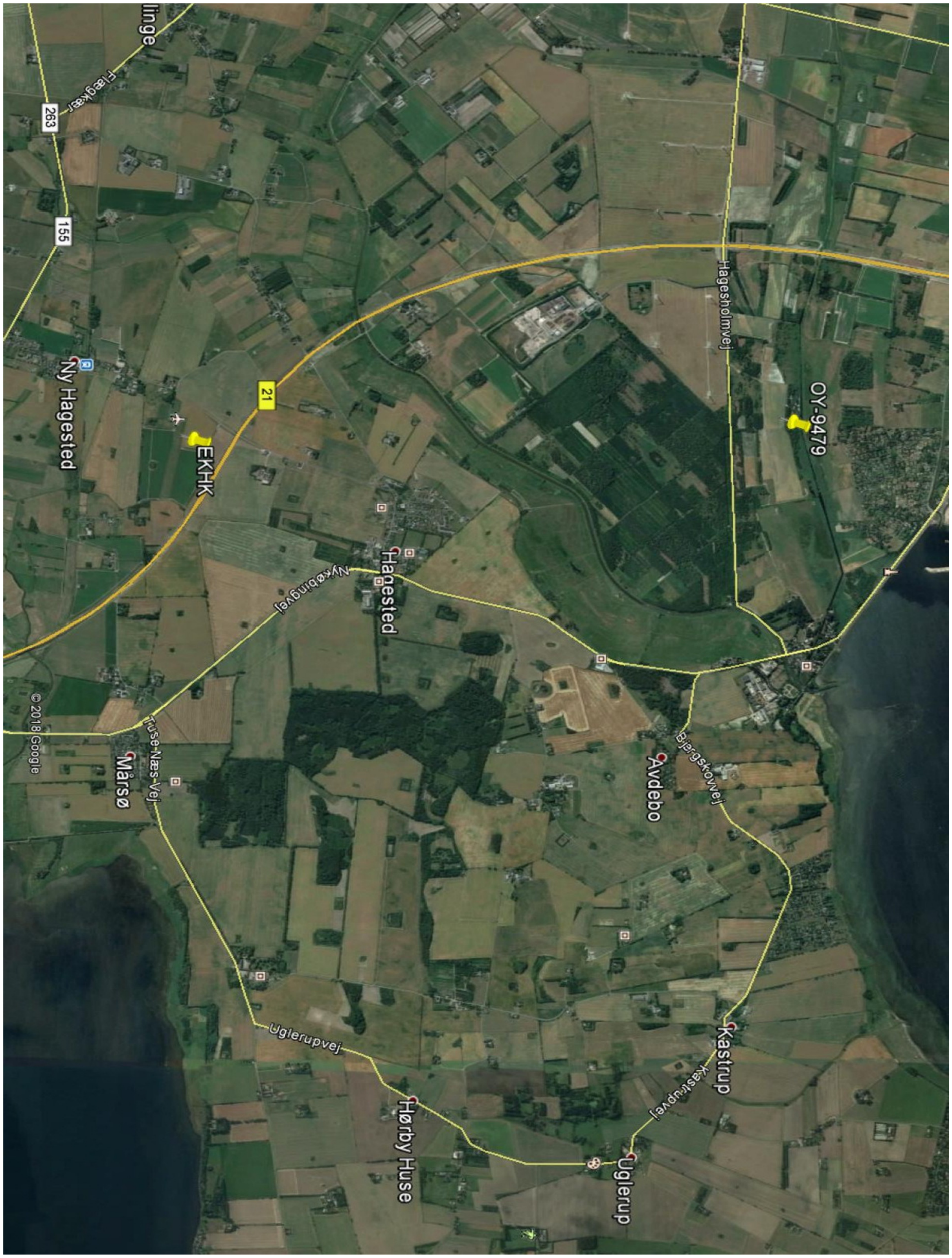
It is a part of the practical training of UL-pilots and also a part of maintaining a UL-certificate (PFT), that stalls are practiced. Earlier it was normal that the student demonstrated capability to maintain directional control and stability with the aid of rudder, throughout the stall regime.
The Accident Investigation Committee therefore recommend that this practice is removed from the curriculum and replaced with an immediate termination of procedures when a stall is ascertained.
The Group also recommends that due consideration is given to establish whether the aircraft is in fact approved for such exercises, what conditions are required and at what altitudes they can safely be carried out.

STALL WARNINGS / AOA I ADVANCED UL-AIRCRAFT

The Accident Investigation Committee is of the opinion that Stall Warning and/or Angle of Attack devices should be mandatory in UL-aircraft (advanced types), not least for heavier and more advanced aircraft, which, may be, will be according to the coming set of regulations called "600 kg", under EASA Annex 1.

APPENDIXES

APPENDIX 1



ANNEX 2
PILOT OPERATING HANDBOOK VL-3

2.9 Approved manoeuvres

2.9.1 Aeroplane category and approved manoeuvres

Aeroplane Category: NORMAL
The aeroplane is approved for normal category and manoeuvres listed below:

- Steep turn not exceeding 60° bank

Warning
Aerobatics, intentional spins and power-ON stalls are prohibited!

Remember that an airplane can stall at any airspeed and altitude (high speed stalls) but the recovery is always the same: stick forward and add power! Training of stalls have to be practiced at least 4000 ft AGL. The rudder is effective in keeping the wings level throughout the stall. Be familiar with standard spin recovery procedures in the event of an inadvertent spin entry while practicing stalls **– see chapter 3.6 Recovery from unintentional spin**

2.9.2 Power-OFF stall recovery

The following procedure must be used for stall recovery:

1. Control stick	- push forward
2. Rudder pedals	- use to keep the horizontal position
3. Throttle	- increase smoothly as necessary
4. Wing flaps	- after reaching 120 km/h IAS in normal flight position slowly close wing flaps
5. Control stick	- after reaching 140 km/h IAS pull slowly back

NOTE: Wing drop is possible during stall – in this case push control stick forward and rudder pedals push to opposite side of wing drop

1. Power-OFF stall training

When practicing power-OFF stall, hold the nose up in a slight climb attitude, gradually bringing the stick back as the speed bleeds off (approximately 2 km-h/s), until the plane begins to stall. Practice power-OFF stall at next wing flap and gears setting to get the feel of the each stall mode:

1. Gears retracted + wing flaps closed
2. Gears extended + wing flaps take-off position
3. Gears extended + wing flaps landing position

Before reaching the stall, use ailerons to keep the airplane in the horizontal flight position!

NOTE: 1) For practice of power-OFF stall we strictly recommend you check, that quantity of fuel in both main fuel wing tanks is appoximately same!

Note
If wing flaps are extended with the gear retracted, the gear warning horn will sound unless an override breaker has been installed in the gear warning circuit and the breaker is opened for practicing stalls.

date of issue: 15.10.2017

APPENDIX 3

Transcript of letter from Mr. Loek Boermans to Mr.Ole Gellert Andersen, Denmark

Mr. Loek Boermans is Associate Professor at the Low Speed Aerodynamics Laboratory of the Delft University of Technology, Faculty of Aerospace Engineering.

Dear Mr. Andersen,

Airfoil NLF(1)-0115 is different from the airfoil I had in mind when we discussed the matter in Middelfart.

The airfoil has been designed by M.S. Selig, M.D. Maughmer and D.M. Somers, see paperNLF0115.pdf attached. This is a paper about the theoretical design of the airfoil and the calculated performance. As for as I know the airfoil has never been wind tunnel tested.

The dangerous phenomenon I mentioned in our discussion is leading edge stall, a sudden loss of lift after the maximum lift coefficient due to complete separation of the flow from the nose of the airfoil, which might lead to a spin.

It is caused by bursting of a very small laminar separation bubble on the nose (just a few mm in length). This bubble starts at the separation position of the laminar boundary layer caused by the adverse pressure gradient after the low pressure peak on the nose. Then, at a very short distance downstream, the separated laminar boundary layer turns turbulent (transition) above the surface, and again a very short distance downstream the separated turbulent boundary layer reattaches on the surface, thus closing the bubble.

However, when the adverse pressure gradient is very steep and consequently the pressure increase between transition and reattachment is very large, it can happen that the separated turbulent boundary suddenly fails to reattach and the laminar separation bubble bursts.

The Eppler code used for the design of NLF(1)-0115 is not able to predict bubble bursting. Even more, as far as I know there is no theoretical airfoil analysis and design code that can predict bubble bursting.

There is a semi-empirical method that correlates stalling characteristics with Reynolds number and airfoil geometry, as described in: D.E. Gault, A correlation of low-speed, airfoil-section stalling characteristics with Reynolds number and airfoil geometry. NACA TN 3963, 1957 (to be downloaded by google NACA TN 3963). This method correlates the upper surface ordinate at the 1.25%-chord station (which is a measure of the sharpness of the nose and the corresponding low pressure peak) with the stalling behavior and Reynolds number. I attached fig.1 of Gault's paper.

With the well-known airfoil analysis and design code XFOIL I calculated this upper surface ordinate at 1.25%- chord for airfoil NLF(1)-0115, it is 2.24% chord. According to the paper of Selig/Maughmer/Somers the takeoff/landing condition is $Re=2.6*10^6$. Fig. 1 of Gault's paper shows that this situation is on the boundary of "Combined leading-edge and trailing-edge stall". This means that the lift curve is not linear but at increasing angle of attack the gradient becomes lower due to separation of the turbulent boundary layer that gradually moves forward, and finally at the maximum lift coefficient leading edge stall occurs.

The Eppler code does not take the effect of turbulent boundary layer separation properly into account. As a result the lift curve of NLF(1)-0115 in Fig. 3 of the paper of Selig/Maughmer/Somers is quite straight with maximum calculated lift coefficient at about $\alpha=12°$.

The lift curve calculated with XFOIL is not straight due to separation of the turbulent boundary layer gradually moving forward, see attachment XFOILcalcNLF0115.pdf, with maximum calculated lift coefficient at $\alpha\approx15°$.

Detailed boundary layer calculations show that at $\alpha=15°$ a very short laminar separation bubble is present on the leading edge. But, like the Eppler code, XFOIL cannot predict if this bubble will burst / leading edge stall. Finally, due to a downward aileron deflection, an additional low pressure peak is generated on the upper surface at the hinge position as well as on the leading edge of the airfoil. This enhances the possibility of bubble bursting/leading edge stall and a spin.

In summary, these results suggest but do not guarantee that leading edge stall occurs or not. The only ways to find out what really happens are wind tunnel tests of the airfoil or flight tests of the aircraft at high altitude performed by test pilots.

I hope that this explanation is helpful for you.

Best regards,

Loek Boermans

APPENDIX 4

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date	type	registration	operator	fat.	location	dam.
13-APR-2008	Aveko VL-3D1 Sprint	D-MHJM	private	2	near Fronhoven, NW	w/o
29-MAY-2010	Aveko VL-3 Flamingo	ZU-VDW	Private	2	Near Bela-Bela, Limpopo	w/o
30-MAY-2010	Aveko VL-3 LSA	N801GB	Denco Remodeling Group Inc	0	Southwest of Boyd, rural Wise County, TX	sub
02-OCT-2010	Aveko VL-3-B Sprint	OO-G55	West Aviation Club	2	Les Moëres	w/o
06-JAN-2014	Aveko VL-3RG Evolution	D-MXKO	Private	0	Eisental, Vasoldsberg, Near Graz-Thalerhof Airport - LOWG	sub
19-APR-2014	Aveko VL-3 Evolution	LY-VLA	Private	2	Paluknys	w/o
15-AUG-2014	Aveko VL-3 Sprint	OK-LUU 05	Private	2	Near Trebovice	w/o
08-SEP-2015	Aveko VL-3-B Sprint	OO-H43	Private	2	Cordes, Velaines near Tournai	min
08-MAY-2016	Aveko VL-3RG Evolution	D-MVLX	Private	2	Teising, Near Altötting	w/o
08-APR-2017	Aveko VL-3 Sprint	57-AVB	Private	2	Dieuze - Moselle (57)	w/o
30-APR-2017	JMB Aircraft VL-3A Evolution	83-ANS	Private	2	Roquebrune-sur-Argens (Var)	w/o
16-OCT-2017	JMB VL-3 Evolution	OY-9479	Private	2	near Holbæk, Zealand	w/o

APPENDIX 4