Federal Public Service
Mobility and Transport
Air Accident Investigation Unit

Air Accident Investigation Unit (Belgium)
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Safety Investigation Report

ACCIDENT
TO A UAV NAVIGATION ATLANTIC /OCULUS
AT DIZY-LE-GROS, FRANCE
ON 29 FEBRUARY 2016

Ref.:
AAIU-2016-AII-01

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Final

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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 and EU Regulation 996/2010, it is not the purpose of 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 to define recommendations in order to prevent future accidents and incidents.

In particular, Article 17-3 of the EU regulation EU 996/2010 stipulates that the safety recommendations made in this report do not constitute any suspicion of guilt or responsibility in the accident.

The investigation was conducted by the AAIU(Be) with the support of Vito NV, UAV Navigation, the Spanish Safety Investigation Authority CIAIAC, the French Safety Investigation Authority BEA, the French State Aviation Accident Investigation Bureau BEAD-Air and the Belgian Military Aviation Safety Directorate ASD.

Note:

About the time: For the purpose of this report, time will be indicated in UTC, unless otherwise specified.

SYMBOLS AND ABBREVIATIONS

’	Minute
°C	Degrees centigrade
AAIU(Be)	Air Accident Investigation Unit (Belgium)
ACC	Area Control Center
AcRep	Accredited Representative of a State Investigation Unit
AD	Aerodrome
AIRBEAM	Airborne information for Emergency situation Awareness and Monitoring
AMSL	Above Mean Sea Level
AP	Auto-Pilot.
ASD	Aviation Safety Directorate
ATC	Air Traffic Control
ATCC	Air Traffic Control Center.
ATCO	Air Traffic Controller
BEA	Bureau d’Enquêtes et d’Analyses
BEAD-Air	Bureau Enquêtes Accidents Défense – Section Air
BCAA	Belgian Civil Aviation Authority
BIPT	Belgisch Instituut voor Postdiensten en Telecommunicatie.
BRU FIR	Brussels Flight Information Region
BTN	Between.
CANAC	Computer Assisted National Air Traffic Control Center
CAVOK	Ceiling and Visibility OK.
cc	Cubic Centimeter.
CIAIAC	Comisión de Investigación de Accidentes e Incidentes de Aviación Civil
CTR	Control Tower Region.
DA	Desert Aircraft.
DGTA-DGLV	Belgian Civil Aviation Authority
DP	Dew Point
E	East
EBAW	Antwerp Airport
EBCI	Charleroi Airport
EBBR	Brussels Airport
EBLG	Liege Airport
EBOS	Ostend Airport
EBWE	Weelde Airfield
EASA	European Aviation Safety Agency
EU	European Union
FH	Flight Hours
FL	Flight Level
FP	Flight Plan
ft	Foot (Feet)
FW:	Follow (next action)
GCS	Ground Control Station
GHz	GigaHertz
GPS	Global Positioning System
HP	Horse Power
HPA	HectoPascal
KT	Knots
LH	Left hand
LOS	Loss of Communication

LUL	Long Uplink Loss
LUMEN	Light UAS in non-segregated airspace for Maritime and Environmental surveillance.
m	Metre(s)
MAX	Maximum.
MHz	MegaHerz
MNM	Minimum
MS	Minus
N	North
NOSIG	No Significant Change
NOTAM	Notice to Airmen
PC	Personal Computer
POH	Pilot Operating Handbook
PS	Plus (positive value)
QNH	Pressure setting to indicate elevation above mean sea level
RH	Right hand
RPAS	Remotely Piloted Aircraft Systems.
RTBF	Radio-Télévision Belge de la communauté Française.
RWY	Runway
SCR	Sistemas de Controllo Remoto SL
SEP	Single Engine Piston
SFC	Surface
SN	Serial Number
SSR	Secondary Surveillance Radar.
SUL	Short Uplink Loss
UAV	Unmanned Aerial Vehicle
UHF	Ultra High Frequency
UTC	Universal Time Coordinated.
T	Temperature.
TMA	Terminal Manoeuvring area
TSA	Temporary Segregated Area.
UAVN	UAV Navigation
VFR	Visual Flight Rules
VIS	Visibility
VITO	Vlaams Instituut voor Technologisch Onderzoek
VRB	Variable.
WSPD	Wind Speed.
WP	Waypoint.
WX	Weather

TERMINOLOGY USED IN THIS REPORT

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either:
(a) the occurrence would probably not have occurred; or
(b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or
(c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Safety issue: a safety factor that
(a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and
(b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency on its own initiative in response to a safety issue.

Safety recommendation: A proposal by the accident investigation authority in response to a safety issue and based on information derived from the investigation, made with the intention of preventing accidents or incidents. When AAIU(Be) issues a safety recommendation to a person, organization, agency or Regulatory Authority, the person, organization, agency or Regulatory Authority concerned 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 bring the recommendation into effect.

Safety message: An awareness which brings to attention the existence of a safety factor and the lessons learned. AAIU(Be) can distribute a safety message to a community (of pilots, instructors, examiners, ATC officers), an organization or an industry sector for it to consider a safety factor 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.

SYNOPSIS

Date and hour of the accident: 29 February 2016 at 15.05 UTC

Aircraft: UAV Navigation Atlantic

Accident location: In a field North of Dizy-le-Gros, France (49° 38,752 N, 004° 01,224’ E)

Aircraft operator: Vlaams Instituut voor Technologisch Onderzoek (VITO)

Type of flight: General aviation **-** Test flight

Abstract:

The purpose of the flight with the UAV (named Oculus B by the operator) was to fly a predetermined flight path within a Temporary Segregated Area (TSA) around the airfield of Weelde (EBWE) crossing some waypoints programmed in the autopilot as a test, before doing a flight taking a camera system on board.
Immediately after take-off, the UAV reported communication problems to the ground control station. As a result, the ground station commanded the UAV to enter in a Hold mode to which it initially responded, starting to fly a holding pattern.
After communication was lost, the aircraft left the holding pattern and initiated an automatic landing sequence, that failed. After several attempts, the aircraft flew away from the ground control station, in a southerly direction.

The pilot immediately warned the ATC about the loss of controls.

The UAV continued a steady flight at 4000ft until the engine stopped operating and the UAV crash landed in the North of France.

Cause(s):

The accident was caused by a series of interruption of the communication between the ground station and the aircraft, causing the autopilot to initiate the automatic landing procedure. A flaw in the autopilot logic software caused the aircraft to interrupt the landing sequence and to continue flying in a 199 degrees heading after the maximum endurance was reached.

Contributing factors.

Operational factors

- The interruptions of communication between the ground station and the aircraft that occurred during pre-flight was not identified by the crew (the crew stated they considered it as a positive check) as a potential serious problem.
- Not all safety features were selected before the flight; the use of the automatic parachute was not selected before the flight.
- The manual parachute deployment was not commanded when the crew realised that the SAFE mode did not work as expected.

Technical factors

- The autopilot was not originally designed for the incorporation of a transponder, requiring the development of a software solution in order to open up another communications port in the autopilot to connect the transponder into the setup.
- The acceptance procedure after the different modifications to the autopilot software was insufficient to identify the change in the logic.

1 Factual information.

1.1 Flight History.

The purpose of the flight with the UAV was to fly a predetermined flight path within a Temporary Segregated Area (TSA) around Weelde airfield (EBWE) crossing some waypoints programmed in the autopilot as a test, before doing a flight taking a camera system on board. No payload was carried on this flight. These were test flights operated by Vlaams Instituut voor Technologisch Onderzoek (VITO) within the framework of European projects with the intention to use UAVs in conjunction with studies on agriculture, coast and heathland monitoring.

The plan was to fly for about one hour in the TSA around EBWE (3 NM radius, inside Brussels FIR, 4500ft AMSL) and approx. 11.9 liters of fuel was carried on board (full tank). Pre-flight checks were done at 13:07. No anomaly was identified by the crew. However, several interruptions of communication (9 interruptions – 7 short duration, 2 long duration) occurred during preflight, but it was considered normal by the crew, stating they physically stood between the antennas, blocking the transmission and the interruptions were only temporary.

The VITO crew filed a flight plan and got a SSR-code with the call sign VITO0200 and squawk code 1414.

At 13:46, the aircraft took-off in AUTO mode. Above its first waypoint (WP 1) there was a short alarm of a communication failure. The aircraft continued on its programmed flight path by making a turn to the right. However, above waypoint 3, the communication failure warning re-appeared.

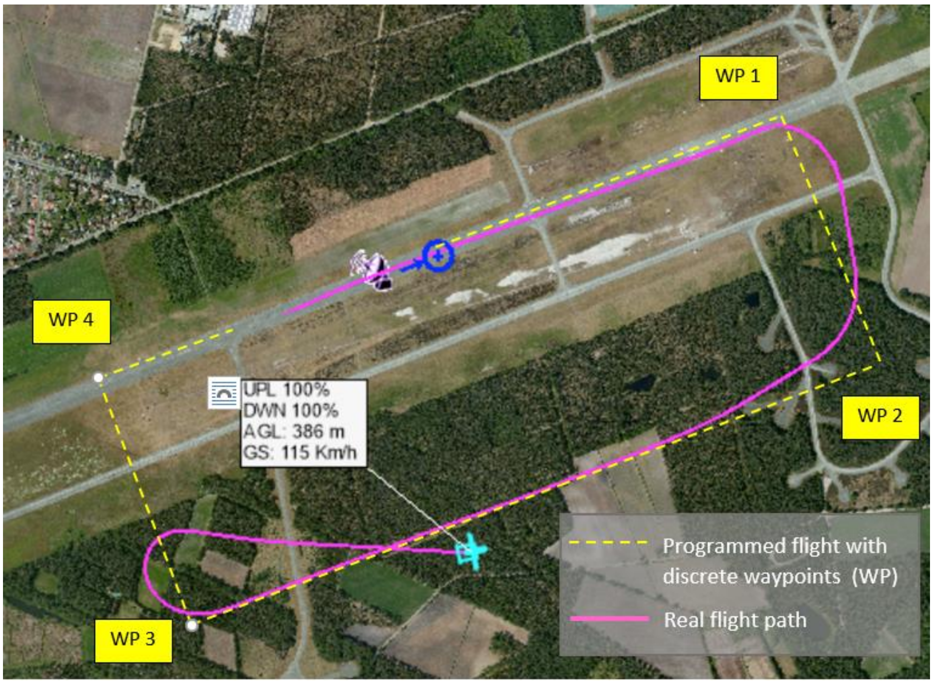


Figure 1 : Flight Path

The internal[1] pilot ordered the autopilot to switch to the HOLD mode, which means that the aircraft maintains a specific altitude following a circular pattern around the location where this mode is engaged. The UAV responded to the command and started to fly a hold pattern around waypoint 3. It was further decided by the crew that in a next step, the UAV would be landed by switching to LAND mode.

Shortly after, the system notified a complete loss of communication. At that time it had become impossible to manually take over the controls. The VITO crew immediately notified ATC of the event.

When this (LUL - a long loss of communication) occurs, the autopilot switches automatically to the SAFE mode. In this mode the autopilot first flies the aircraft to a pre-defined safety altitude before switching to LAND mode, allowing the UAV to land.

The aircraft, still visible by the ground crew, seemed to follow the pre-set procedure and started an approach for the landing. However, the landing flight phase was several times interrupted and the UAV was seen flying away, before coming back. Finally, around 14:15, the UAV took a south-westerly heading (199°), climbing and it disappeared from sight.

The operators alerted the ATCC of Semmerzake about the loss of control. Thanks to the transponder mode S, the aircraft could be tracked by ATC.

The drone flew at 4000ft, a track that brought it from Weelde through the CTR/TMA of EBBR and overhead EBCI towards France.

[1] See 1.6 Aircraft information for the definition of the internal and external pilot

ATC started diverting traffic and informed the civilian and military ATCs of the aerodromes on the flight path of the UAV to allow for necessary action in order to prevent collision or mishap. The only noticeable incident during the flight was a loss of separation with an airliner departing from RWY07 at EBBR (Separation 4.5 NM, 800ft).

The Belgian Defense sent out several aircraft to intercept the UAV. The pilots reported the UAV was flying straight, although it was going up, then down, in - what they thought was - a ‘phugoid’ movement.

Note: A phugoid is a dynamic flight mode where the aircraft makes a sequence of oscillations in altitude. The general principle is that as speed increases, lift increases causing the aircraft to pitch up and climb. The climb then slows the aircraft reducing the lift and causing the aircraft to pitch down.

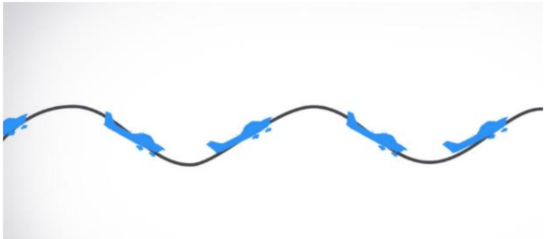


Figure 2 : Phugoid movement

Beyond the border, the French Armée de l’Air took over the interception.

After the UAV engine stopped rotating, the UAV began to descend. The UAV finally crash landed in a field near Dizy-le-Gros (department of Aisne in the region of Nord-Pas-de-Calais-Picardie), about 110 nm southwest of EBWE.

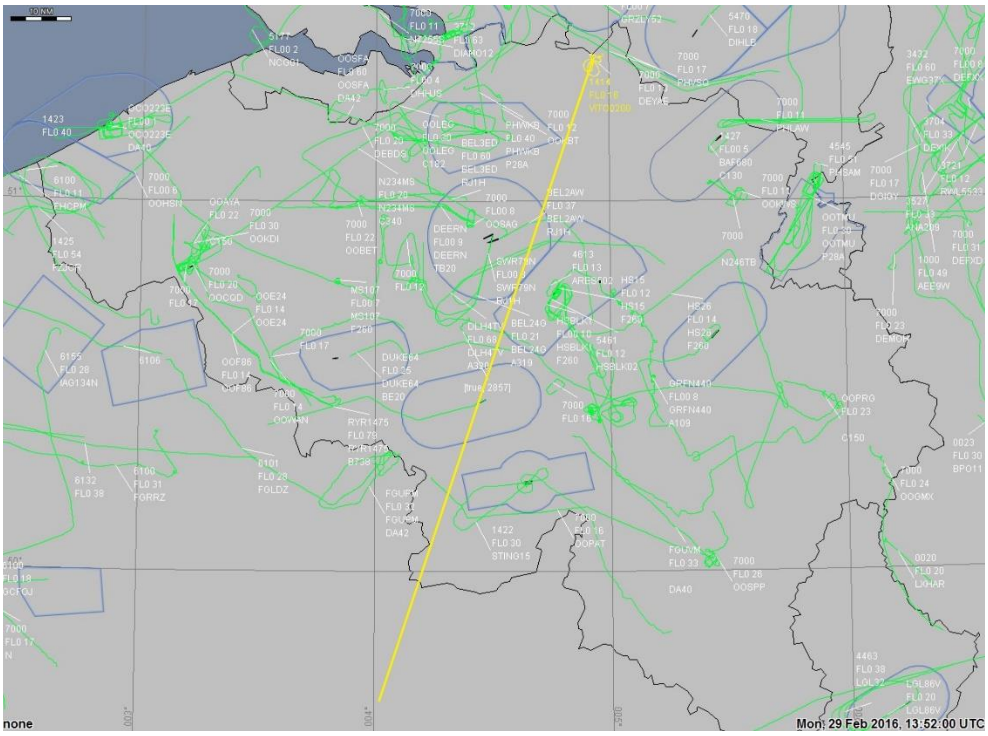


Figure 3 : Complete flight track

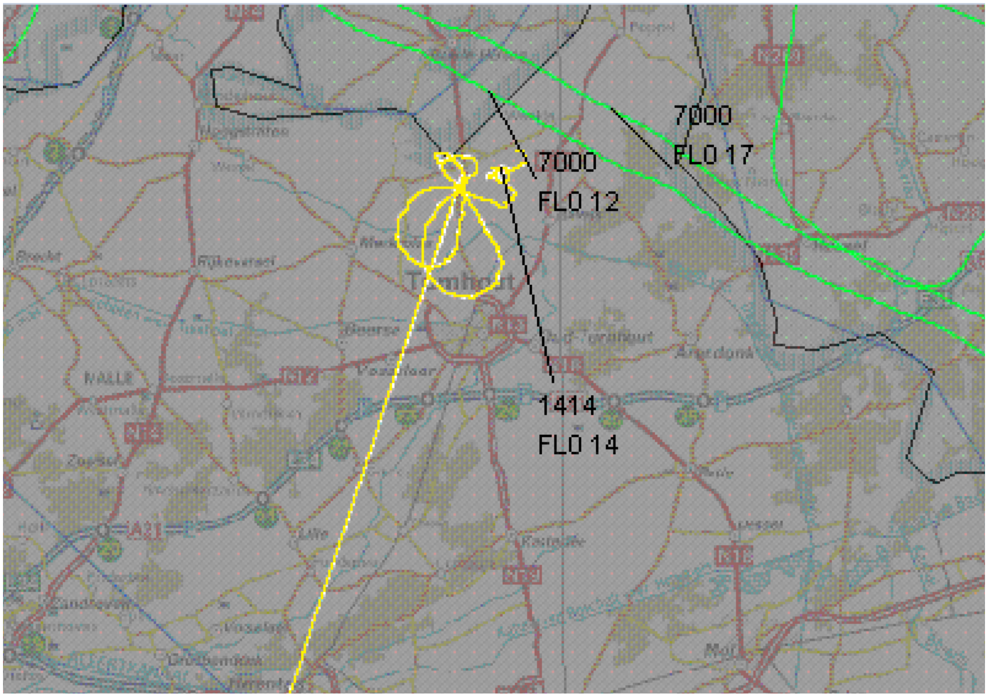


Figure 4 : First part of the flight track

1.2 Injuries to persons.

No person was injured.

1.3 Damage to aircraft.

The UAV sustained major damage to its undercarriage and tail.

1.4 Other damage.

None.

1.5 Personnel information

Pilot (external):

Sex:	Male
Age:	43 years old
Nationality:	Belgian
License:	Holder of a Private Pilot Licence, issued on 26 November 2014 Rating: SEP (Land).
Medical certificate:	Class 2
Experience:	Wide experience flying aero-models aircraft. (flying since his 16 years) Total flight hours with the Oculus (A and B) : 25 FH

1.6 Aircraft information.

The Oculus B UAV is a fixed wing, unmanned aerial vehicle (UAV) that operates as an aircraft and is capable of automatic take-off, flight plan execution and automatic landing according to a previously-loaded flight plan and can be controlled up to a range of 50 km.

Manufacturer: UAVN
UAVN is a privately-owned, Spanish company which has been developing flight control systems, autopilots and ground control stations since 2004. Over 50 000 hours flying time have been logged by UAVN and its customer using its products since that time.

UAVN has been certified in accordance with ISO 9001 since 2009 for the design, manufacturing and technical assistance of avionics for manned and unmanned aircraft, and is registered by the Spanish (civil) Aviation Authority (Agencia Estatal de Seguridad Aérea or AESA) as a qualified operator of UAVs.

UAVN designed the fixed wing Atlantic UAV based upon an original Slovak design airframe (Called Cruiser UAV) on which UAVN fitted their own autopilot, antennas and interface electronics. UAVN manufactured this product up to 2013 and thereafter the manufacturing of the Atlantic was transferred to another company; Sistemas de Control Remoto, SL (SCR).

VITO Oculus UAV particularities
In March 2013, VITO ordered two UAVs from UAV Navigation (UAVN). It was decided to use the base of the Atlantic UAV design modified to suit VITO's requirements (doubled ailerons and flaps, transponder, etc). This new design was designated "Oculus", and the two units delivered were named Oculus A and Oculus B.

UAVN made the design and subcontracted the manufacturing to SCR.

According to VITO, these changes did not occur smoothly. The integration of the transponder required an additional port not originally available on the autopilot. A software solution was developed in order to open up another communication port in the autopilot in order to connect the transponder into the setup.

The radio control frequency was discussed, and it was decided to use a radio in the 2,4 GHz frequency band instead of the original (as installed in the ATLANTIC – 900MHz). However, when BIPT came to inspect the system after the crash, they found that the system was actually working on 2,312 GHz, a frequency reserved for the public broadcasting organization RTBF.

The systems were delivered and conditionally accepted by VITO after a successful demonstration of the Oculus performances on May 7th 2015 in Weelde.

This occurred after UAVN modified the software in order to improve the precision of the landing system, because, during the previous acceptance campaigns (4 acceptance campaigns in Belgium and one in Spain (Jan 2015, ATLAS UAV test range)), several malfunctions such as hard landings and landings besides the runway, malfunctioning of the transponder, etc. were observed. As a consequence UAVN was required to perform corrective actions.

During this period, the future VITO pilots received a 3-weeks training at UAVN in order to get the adequate skill flying their Oculus.

Airframe

Empty weight (fuselage and wings, without fuel and payload):	45 kg
Total fuel capacity:	12 liters
Maximum Take-off weight:	55 kg
Wingspan:	3,8 m

Engine
The engine is a 2 cylinder 2-stroke 120 cc gasoline engine manufactured by DA. The engine can deliver 12 hp at 6500 rpm.

Performances
Cruise speed: 110 km/h
Fuel Flow: 2 l/h (cruise)
Vne: 180 km/h
Vno: 170 km/h
Maximum operating altitude: 11 811ft AMSL (3600 m)

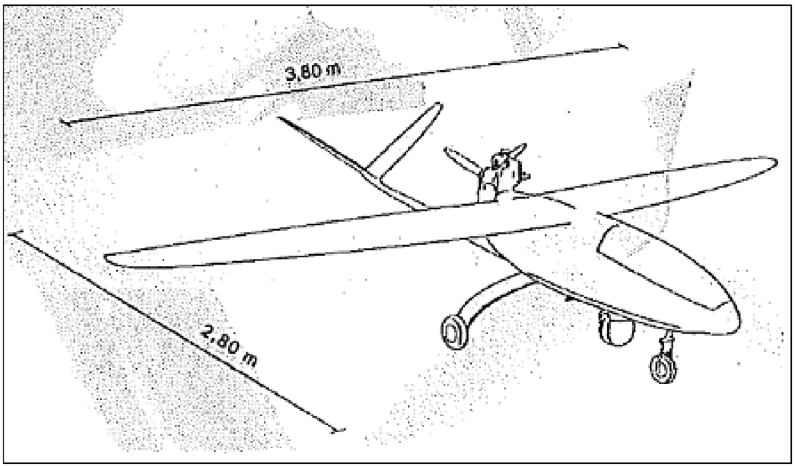


Figure 5 : Dimensions

Flight Control System
The Flight Control System (FCS) used in the Oculus consists of the following main elements (all developed and manufactured by UAVN, unless otherwise stated):

Onboard:
- AP04M autopilot.
- TELEM06 datalink (UHF).

Ground Control Station (GCS), including:
- Tracking antenna, including TELEM06 datalink (UHF).
- GCASE (contains a battery and the necessary electronics to connect the laptop to the antenna, as well as to steer the tracking antenna).
- Ruggedized Dell laptop.
- Visionair mission planning and control software.
- JY02 Joystick (for backup manual operation if required).

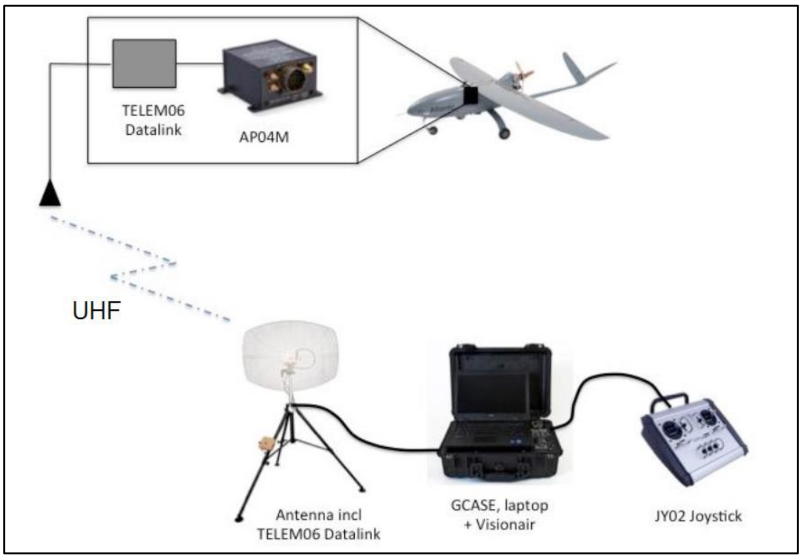


Figure 6 : Schematic of the flight control system

Figure 7 : Oculus UAV

The AP04M autopilot is a fully integrated autopilot with manual override and payload control capabilities (remote camera operation,..). A datalink allows communication from and to the Ground Control Computer.

Operators
The flight control system requires two UAV operators as follows:

Internal pilot
- Operates the GCS computer (Visionair software)
- Normally located inside a van (which is the case with the operations by VITO) or shelter
- No direct line of sight with UAV

External pilot
- Operates the UAV in MANUAL mode if required via joystick
- Normally located at edge of landing strip, with eyes on the UAV

Warnings

The autopilot of the UAV generates warnings when encountering problems and sends it to the Ground Control console. However, the warnings are only recorded by the ground control station and not in the autopilot itself.

Name	Abbreviation	Description
Long Uplink Loss	LUL	Communication interrupted over 5 seconds (time can be modified)
Short Uplink Loss	SUL	Only whilst in MANUAL HOT mode, communication interrupted over 1 second (cannot be modified)

Extract from the UAVN Atlantic POH manual

Systems and Equipment Limits (check lists for flight preparation)

- LUL (Long Uplink Loss)
  1. CHECK UAV / GTRACK / GCASE antenna and cabling connections
  2. CHECK UAV / GTRACK /GCASE power supply

  LUL Alarm OFF → GO

  ....

  LUL Alarm still ON → NO GO

- SUL (Short Uplink Loss)
  1. CHECK UAV / GTRACK / GCASE antenna and cabling connections
  2. CHECK UAV / GTRACK / GCASE power supply

  SUL Alarm OFF → GO

  ....

  SUL Alarm still ON → NO GO

Emergency procedures:

➢ LUL (Long Uplink Loss) Automatic switch to SAFE mode and landing.

IMPORTANT: AP04M can be configured to ignore the LUL alarm. In this case, UAV will continue its mission and will not land automatically. TAKE EXTREME CARE! See AP04M Manual for more information.

1. CHECK GCS connections
2. CHECK GTRACK power supply
3. CONNECT external power supply (if required)
4. LUL alarm OFF ⟶ Continue mission
5. LUL alarm ON ⟶ FOLLOW landing procedures

➢ SUL (Short Uplink Loss) Automatic switch to SAFE mode and landing.

IMPORTANT: AP04M can be configured to ignore SUL alarm. If so, the ATLANTIC UAV will continue it´s mission and will not land automatically. TAKE EXTREME CARE! See AP04M Manual for more information.

1. CHECK ALL GCS connections
2. CHECK GTRACK power supply
3. CONNECT external power supply (if required)
4. SUL alarm OFF ⟶ Continue mission
5. SUL alarm ON ⟶ FOLLOW landing procedures

Safety Features.
The UAV features several systems to ensure safety in case a fault would occur.

- SAFE mode: Automatically triggered when either:
  - A not-to-exceed flight time is reached (called BINGO time), or
  - When the communication between the UAV and the ground station is interrupted (Long Uplink Loss - LUL).

  In these cases, the UAV is flown with engine at full throttle, at maximum speed (close to V_{NE}), to a pre-determined safety altitude (in this case it was set at 1001ft). When the altitude is reached, the mode automatically switches to LAND and the UAV flies to a specified geographical point (on Runway 07 of EBWE) for eventual landing.

  If the AP has entered LAND from BINGO time, and the landing has been aborted, It will not enter into LAND mode again from SAFE unless the operator resets BINGO time.

- Parachute: the Oculus is equipped with a parachute to allow retrieval of the UAV in case of emergency. The operation of the parachute must be decided by the operator before the flight or manually triggered in flight. The modes include
  - Manual deployment, requiring uplink communication.
  - Automatic deployment in case of loss of communication
  - Automatic deployment in case of engine failure

  The use of the parachute does not exclude possible damage during landing.

1.7 Meteorological conditions.

<u>From the meteo observations in EBAW:</u>

Wind: 30 degrees, 10knots
Temperature: 7°C
Visibility CAVOK
QNH: 1024 hPa
No significant changes foreseen

<u>From the GAMET</u>

Surface windspeed : 07-14KT

Wind /Temperature: 1000 FT 040/20KT PS00
2000 FT 060/20KT MS01
5000 FT 040/25KT MS04
10000 FT 360/20KT MS10

1.8 Aids to navigation

The UAV is controlled through a ground station emitter, an on-board receptor, an autopilot and a GPS antenna.

The flight plan is usually entered in the autopilot on ground, based on a series of way-points and altitude reference. The flight plan can be modified in flight through the ground station and the on-board radio.

Radar

Owing to the installation of a transponder, the UAV was easily detected by secondary radars.

1. First phase;
   Take-off and loss of control in the vicinity of the airfield

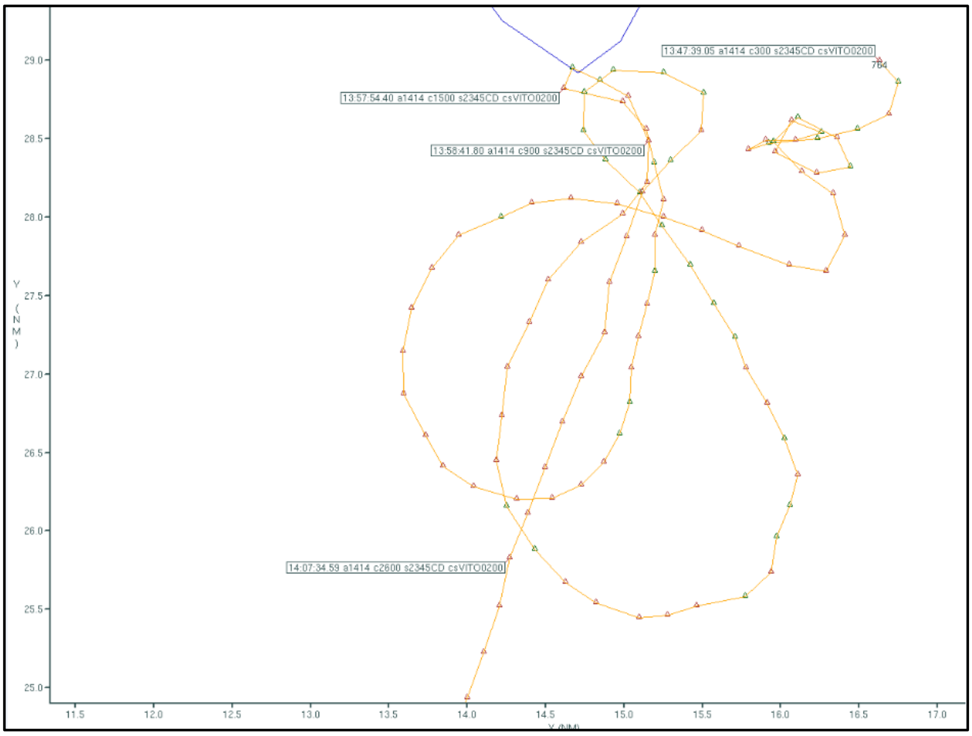
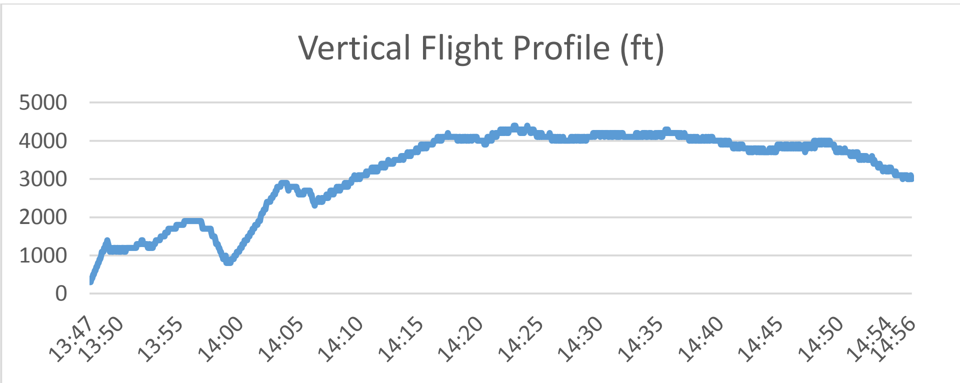


Figure 8 : Radar track of the first phase

2. Second phase:
   From 14:07, out of TSA and climb from 2300 ft to 4100 ft in 10 minutes – 180 ft/min. Thereafter, straight flight of 23 minutes at 4100 ft with slight variations, up to 14:39:24. Flight at 199 degrees up to 15:02 in the vicinity of Vervins, France.

   The UAV flew during 55:21 minutes at a ground speed of 183 km/h. Taking into account the wind at 5000 ft (40 degrees, 25 kts), the drone flew at an approximate airspeed of 140 km/h – 75,6 kts.

   The airplane went down somewhat, then climbed back to 4000 ft up to 14:49, before going down at 140 ft/min. Crash landing at about 15:02.



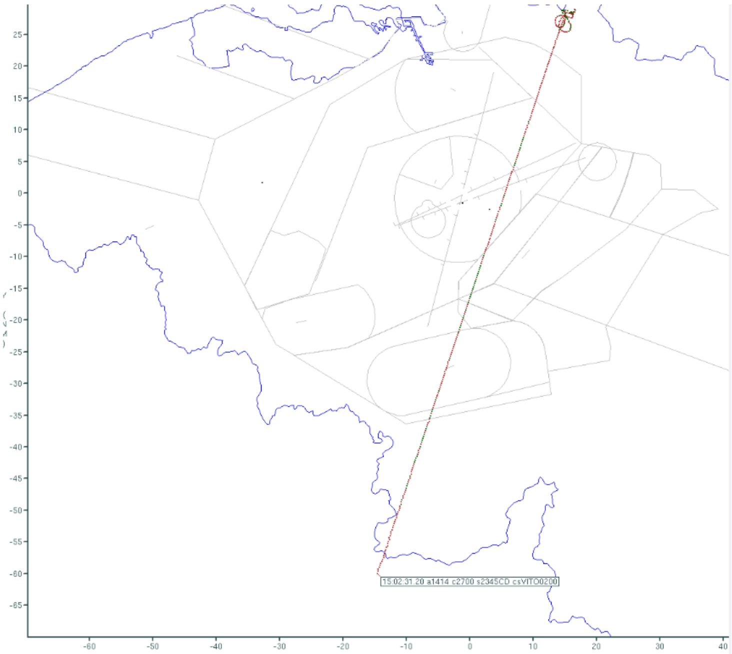


Figure 9 : Radar track – complete flight

1.9 Communication.

The ground station is equipped with a radio tuned to EBWE radio. Another handheld radio was tuned to “Brussels Info” frequency.

The operators used also a mobile phone to alert the ATCC of Semmerzake.

1.10 Aerodrome information.

The Weelde airfield – EBWE – is a military airfield operated by civilian clubs outside military activity. The airfield is operated during daytime hours and its use is subject to prior permission from the operator.

The military airfield is equipped with a 2 980 m long x 45 m wide concrete runway, oriented 070°/ 250°. For civilian use, the runway is reduced to a length of 799 m and a width of 18 m.
Elevation is 33 m above mean sea level.
Threshold 07: N051° 23’ 42’’ – E004° 57’ 37’’
Threshold 25: N051° 23’ 51’’ – E004° 58’ 15’’

Basic information is given by radio: "Weelde Radio" - 119.600 MHz - Information only, no ATC.

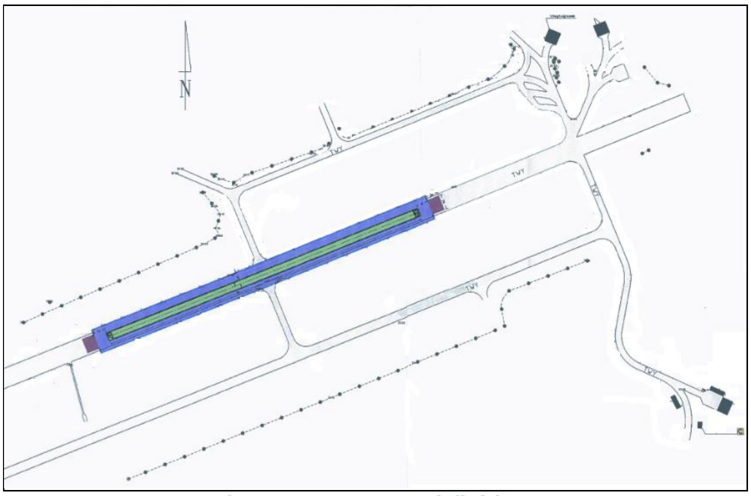


Figure 10 : EBWE Airfield

1.11 Flight recorders.

No flight recorder is required to be carried on board, and none was installed.
Only the data sent by the UAV to the ground station were recorded meaning that few flight data were available for the investigation.

1.12 Wreckage and impact information.

On-site inspection.

The UAV was found by the French Gendarmerie in a field, North of the village of Dizy-le-Gros, Aisne, France at coordinates 49° 38,752’ N, 004° 01,224’ E. The engine was not running, but the navigation lights were still on.

The impact traces show the UAV impacted the ground first on the left side. The distance between the first impact trace and the resting position of the UAV is 39,65m.

Figure 11 : Crash site

The UAV was first inspected on 9 March 2016. The undercarriage was ripped off. The pitot tube was bent. The left winglet was found bent inwards and there was some impact damage on the stabilizer.
Besides that, the UAV was in general good condition.

Figure 12: Damage to UAV

The UAV was released from custody on 5 April 2016. Additional findings were made by AAIU(Be) upon conditioning the drone for the return voyage:

- There was an undetermined quantity of fuel remaining in the tank.
- The carburetor butterfly valve was in full open position.
- The servos of the V-tail controls were blocked.
- The ignition cables were found worn by chafing on the cylinder fins.
- The V-tail planes were difficult to remove, probably due to a chock at impact with the landing gear.

Inspection of the UAV system.

The UAV was returned to VITO and an inspection of the system occurred on 14 April 2016. The inspection took place at the VITO facility, Mol Belgium. Present were:

- VITO's pilots and management
- UAV Navigation,
- The French State Aviation Investigation Authority (BEAD_Air) (observer)
- The Belgian Military Safety Investigation Authority (ASD)

The inspection occurred on the base of the checklist prepared by UAV Navigation and approved by AAIU(Belgium).

The fuel tank of the UAV was emptied, and 5,5 liters of fuel were recovered.

The Ground Control station, consisting of the directional antenna and the Ground control Case was deployed. No obvious defect was found. The antenna was calibrated.

The UAV was powered and the loss of communication was confirmed with both (directional and non-directional) antenna.

When the UAV parachute cover was opened to gain access to the UAV radio box, it was found that the cable between the radio and the antenna was disconnected.

Figure 13: Disconnected antenna

The antenna cable was removed from the Oculus A – the sister ship – and installed in Oculus B. This could determine that the radio still did not work after installation of the serviceable antenna cable. Thereafter, the radio from the Oculus A was installed in the Oculus B allowing the communication between the UAV autopilot and the ground station to be re-established. The replacement of both the radio and the antenna cable was thus necessary to restore the communication system. The radio failure was determined by UAVN engineer as being very likely created by the antenna cable disconnection. The disconnection of the antenna causes the radio to emit continuously at full power, eventually causing its failure.

The on-board computer sent correct data to the ground station (pitch, roll angle, low rpm warning (engine stopped), Bingo time reached, UAV on ground.

The GPS was powered and the system reflected a correct satellite reception. The actual geographical position of the UAV was reflected accurately (N 51° 13.1011' E 5° 4.7772'). The altitude computed by the GPS was -12.26 m.

The flight plan, as introduced the day of the accident was downloaded from the UAV, and reflected the flight plan stored in the ground station. The take-off, landing and holding position were also correctly reflected.

The setting of 1 hour as Bingo time (maximum mission time) was read.
The Configuration of system and FP options page showed that the following safety options were NOT selected:

- Safe mode > Parachute
- Enable FW parachute landing
- Engine Fail > Parachute
- Low Altitude > Parachute
- Enable Parachute release.

The maximum deflection value for the flight control surfaces and engine throttle were checked, without any anomaly found.

The setting of the Long Uplink Loss warning (LOS Timeout) was 5 seconds (which is considered a normal setting). After 5 seconds of continuous loss of communication, the LUL warning is generated.

The loss of communication fault was intentionally reproduced and the autopilot reacted as follows:

- When in AUTO mode (normal working), the autopilot reverts in SAFE mode,
- When in LAND mode, the autopilot reverts to the SAFE mode.

Inspection of the autopilot.

The autopilot computer was sent to UAV Navigation for testing under the supervision of the Spanish Safety Investigation Authority CIAIAC.

The autopilot was connected to a PC that, using specific software, tested the behavior of the different sensors (accelerometers, GPS …). According to the data registered they were all in working conditions. The unit was then disassembled and the different components were inspected. No condition was found that could have caused a failure of the autopilot.

The tests of the autopilot included:

- A 15-minutes vibration test to guarantee mechanical integrity; no damage or unwanted mechanical behavior was observed.
- The unit is subjected to an environment test, a series of cycles at temperature ranging from -40°C to +80°C for 4 hours; no damage to the autopilot was observed after the test.
- The unit was submitted to a ‘full acceptance protocol”; all sensors passed all tests and are within range.

Communication test

The crew stated that during preflight, they simulated an interruption of the communication between the ground station and the aircraft by standing in front of the aircraft.

A reconstruction was made on the Weelde airfield on 16 June 2016 with the second Oculus UAV. It was not possible to interrupt the communication between the ground antenna and the UAV,

- With a person standing between the ground station and the UAV,
- With a car standing between the ground station and the UAV,
- With the ground station dish antenna directed in the opposite direction of the UAV.

It was therefore concluded that the communication interruptions during the preflight check on the day of the accident was the indication that the antenna connection was already faulty.

The procedure to stand in front of the UAV in an attempt to simulate a communication breakdown is not documented in UAVN’s manuals.
The crew reported this procedure was taught during training, but this allegation is contested by UAVN (see “Comments on the report by UAVN” in annex).

1.13 Medical and pathological information.

Not applicable

1.14 Fire.

There was no fire.

1.15 Survival aspects.

Not applicable

1.16 Tests and research.

Not applicable

1.17 Organisation and Management Information.

VITO is a Belgian Company providing innovative technological solutions and offers scientifically-based advice and support to encourage sustainable development and to reinforce the economic and social structures in Flanders (from VITO website).

VITO expects the Oculus to be used for research into various applications, including environmental and air quality monitoring, as well as aerial surveillance. To this end, the UAVs will be fitted with a series of sensors, such as hyperspectral sensors, high definition video cameras and other equipment.

VITO hopes to use the UAVs within the framework of the European projects AIRBEAM (AIRBorne information for Emergency situation Awareness and Monitoring) and LUMEN (Light UAS in non-segregated airspace for Maritime and Environmental surveillance).

1.18 Additional information.

Similar Events

In Belgium, the number of incidents involving drone is growing in the last five years. Antwerp Airport reported 2 air misses in 2013 and 2014 during aircraft landing. Although the notification to the police was done rapidly, the perpetrators were not identified.

In 2015, 10 incidents involving drones were reported. It included:

- 2 emergency landings of drones, due to a technical failure or the intrusion of an aircraft in the protected zone where the drone was flying.
- 2 drones spotted by aircraft in flight
- 5 drones spotted by aircraft landing at various airport
- 1 drone spotted above a sensitive area.

In 2016, other than this event, two others were notified, involving a drone crashing in a backyard, and a flight over a sensitive area.

In most of the cases, the identification of the involved drone was impossible.

European action

Responding to a call from the EASA Executive Director in April 2016, representatives of the National Aviation Authorities of Finland, France and United Kingdom joined with EASA specialists to form a Task Force to examine thoroughly the risk to manned aircraft from the operation of UAVs (mainly in the “Open” category) and to consider how best to manage the risk.

The Task Force assessed the current understanding of the risk, collated the actions of manufacturers, users and authorities to manage the risk, identified emerging best practice and looked at future options.

A first report was published on 2 September 2016 (Study and Recommendations regarding Unmanned Aircraft System Geo-Limitations).
The report includes a series of recommendations.

Drone Regulation
At the time of the accident, no Regulation pertaining to UAV was enforced in Belgium. As a result, all UAV flights were forbidden to the exception of those specifically authorized by the Civil Aviation Authority.

An authorization was given to VITO in 2013 for a period of 1 year, renewed twice, last in February 1st 2015. VITO applied in January 2016 for the extension of the authorization. The extension was not yet formally approved at the time of the accident.

The authorization included the following conditions (translation of the actual document);
1. The flights can only take place between 01 February 2015 and 01 February 2016.
2. The UAV may only fly in the zone defined in the dedicated TSA, activated by NOTAM.
3. The UAV may only fly outside controlled airspace.
4. The UAV may only fly between sunrise and sunset.
5. The UAV may not fly above 4500 ft AMSL
6. The UAVs shall remain in the authorized zone defined in item 2 here above.
7. The UAV may only perform flights for scientific purposes.
8. The images recorded by the UAVs may not be used for commercial purposes.
9. The radio communications must occur in accordance with BIPT requirements.
10. The pilot / operator will have received sufficient training in order to be able to use the UAV correctly.
11. The UAVs must be provided with operational safety provisions in conformity with the dispositions of the technical and safety file in case of:
    a. Control failure due to failure of servo
    b. Fatal error (autopilot failure)
    c. Loss of engine power
    d. Low battery voltage
    e. Loss of GPS signal
    f. Radio control link failure
    g. Ground Control Station communication failure.
12. The UAVs take off and land will occur always on the zone defined on the detail map.
13. When needed, a RPA observer in direct contact with the pilot may be used, with a maximum of 2 observers.
14. The UAV must always remain in sight of the pilot or the observer(s).

On 10 April 2016, a Royal Decree on the use of remotely piloted unmanned systems in the Belgian airspace was published. It entered into force on 25 April 2016.
The Regulation focuses, among others on,
- The registration of the aircraft.
- The qualification (licensing) of the pilot.
- A flight demonstration including the emergency situations (provided it does not endangers the UAV).
- The preparation of a risk study (art.68) to highlight the potential dangers to aviation safety and persons on ground before the operation starts. If “moderate” or “high” risks are identified, an approval by the BCAA is required before the start of the operations.
- An operations manual is required.
- The reporting of incidents and accidents.

The regulation does not provide technical requirements for the UAV.

2 Analysis.

2.1 Authorization

The operation of the UAV was authorized through a dedicated authorization, issued by the Belgian CAA (DGTA – DGLV), however overdue at the time of the accident.

Out of the 14 conditions set on the document,

- 11 are operational conditions,
- 1 concerns the pilot's training.
- 2 are technical conditions.

Operational conditions.
The conditions 2, 3, 5, 6 and 12 are somewhat redundant and are related to the zone allocated for the flight of the UAV, defined by a NOTAM.

Conditions 1,4,8,13,14 are dealing with general operational restrictions.

The authorization document is incomplete, as it introduces a restriction in relation to the nature of the activity (scientific purpose). It does not include the necessary training and test flights, which was the nature of the flight of 29th February. .

Training conditions.
The condition pertaining to the pilot's training is quite generic, and does not reflect the actual competence of the pilot.

Technical conditions.
BIPT was not aware of the use of the Oculus UAVs by VITO and no specific authorization was issued. Nevertheless, the use of the 2,4 GHz band (2400,0 MHz – 2483,5 MHz), otherwise used for many other purposes (mobile telephone, etc..) is free but subjected to radio wave output power limitations. It was later found that the frequency used was not the intended frequency and the output power exceeded the limit set for 2,4 GHz band use.

The other technical condition was that the UAVs must be provided with operational safety provisions in conformity with the dispositions of the technical and safety file in case of equipment failure.

The POH (Pilot's Operating Handbook) provides instructions related to a series of warnings that might be activated during ground test on;

A. Various servo's,
B. Internal autopilot failure,
C. Engine rpm below threshold,
D. System voltage at a critical (low) level and UAV volt low,
E. No accurate GPS reception
F. Uplink communication losses (long and short)
g. Laptop failure.

For each of the warnings, the POH defines a procedure for trouble-shooting, ending by a GO / NO GO decision.

The POH provides instructions related to a series of emergency situations that may occur in flight.

a. Failure of several servo's.
b. Internal autopilot failure.
c. Engine failure.
d. UAV Volt critical (Voltage at a critical value).
e. GPS failure.
f. Uplink communication losses.
g. Laptop failure.

For each emergency situation, a procedure is provided to the operator, in most cases this procedure ends with the mention "=> Emergency landing procedure".

The POH does not describe further the emergency landing procedure. However, another document titled Standard Operating Procedure, in the form of a flow chart titled "emergency procedures", featured a block "emergency landing" with the instruction "FW: Deploy parachute". This flow chart was not found in the POH.

The authorization delivered by the BCAA refers to the Operations Handbook for this aircraft, but does not formally requires all flight to be performed in accordance with it.

2.2 The pre-flight

The pre-flight check occurred in accordance with a check-list, designed by the manufacturer. The required NOTAM was activated by the crew.

Among others, the crew decided not to select the parachute safety. There are several options, such as automatic activation upon a Long Uplink Loss of communication or engine failure. The crew stated they took the decision based on the following elements and on the instructions received during training:

- Activation of the parachute would mean possible damage to the UAV.
- The safety level provided by the automatic landing upon a loss of communication and the manual control was considered sufficient.
- It was a short flight.

The fuel tank was filled (11,9 liters).

The BINGO time (period of time after which the UAV automatically returns to land) was set to 60 minutes and was not reset after the ground tests. This had for consequence that the remaining flight time was only 20 minutes.

The flight log recorded 2 LUL warnings at 13:22:11 and 13:29:01. The crew stated they intentionally provoked a Long Uplink Loss of communication during the pre-flight by standing in front of the UAV, masking the antenna. However, it was demonstrated during the investigation that this interruption could not be have been caused by standing in front of the UAV but was rather a symptom that the antenna connection was already faulty.

2.3 The Flight.

The analysis of the flight was made from the data recovered from the Ground Control Station, combined with the radar information. Some data were sent from the UAV to the GCS after the first communication interruption (LUL), meaning that communication was interrupted and restored a few times during the initial phase of event.

The UAV took off at 13:46:45 from Runway 07 of EBWE. During the initial climb, the system reports 4 Short Uplink Losses (SUL) warning. The crew decided to interrupt the planned flight and instructed the UAV to circle around a pre-determined point (HOLD mode). The UAV reverted course, and entered a counterclockwise turn, executed perfectly.

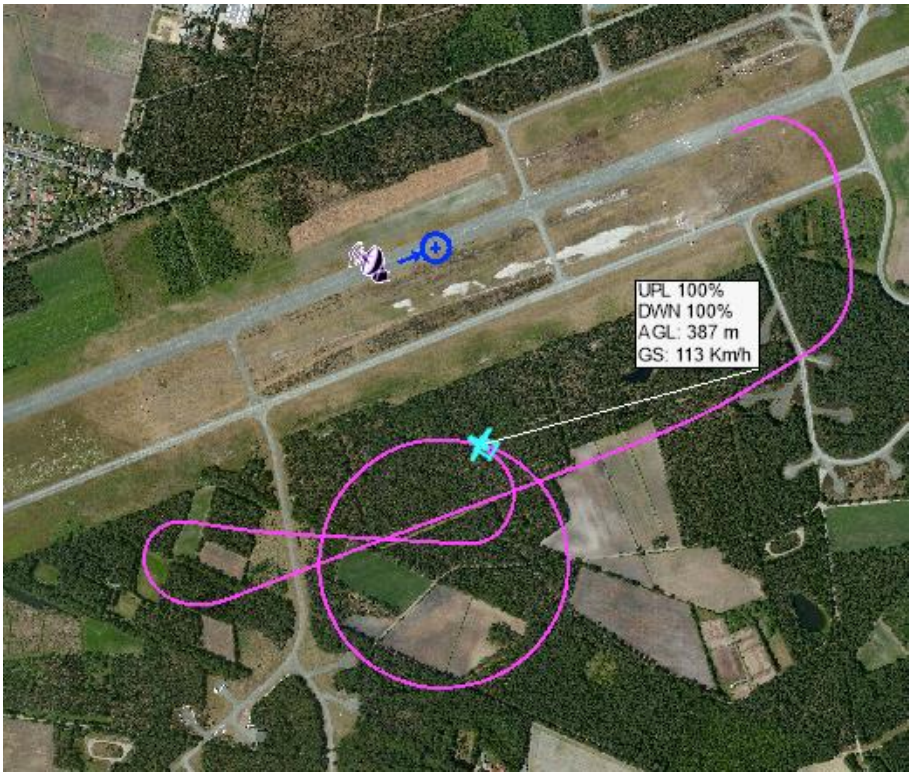


Figure 14 : Initial flight evolution

When the UAV was about to complete 1 ½ turn, the system reported a Long Uplink Loss (LUL). The UAV was flying at an altitude of 1500ft.

Moments after the failure, the UAV seemed to react to the SAFE mode, automatically triggered upon a LUL warning; it flew in direction of the landing area. However, although the UAV was flying above the safety altitude (1001 ft set during flight preparation), the altitude did not decrease, and even increased.

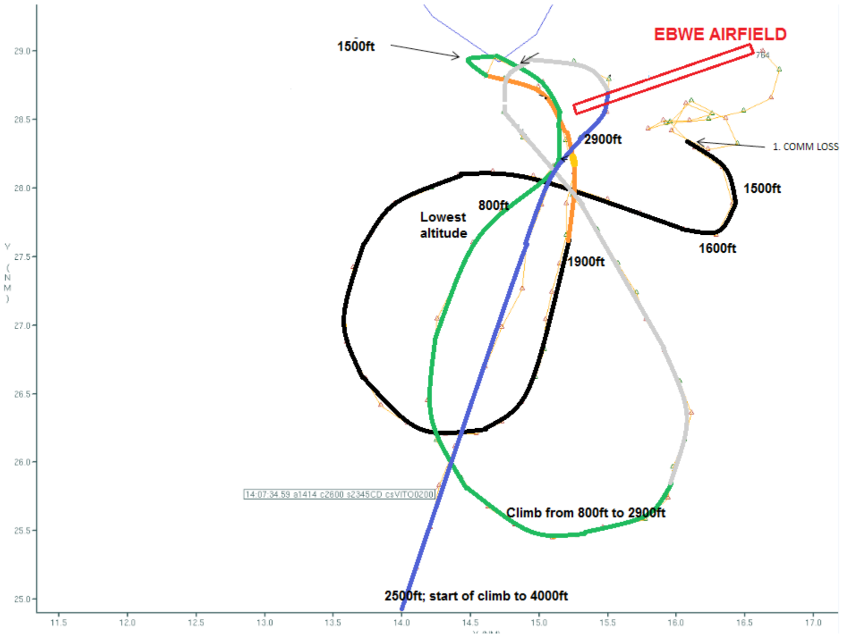


Figure 15 : UAV flight in the vicinity of EBWE

The flight deviated then from the expected pattern, and the UAV started a wide loop to the west, away from the intended landing point (black track on Figure 15 : UAV flight in the vicinity of EBWE)

During the loop, the altitude of the UAV increased to 1900ft.

The altitude decreased when the UAV reached the runway threshold, which is a normal behavior. Data were available in the GCS, indicating that communication were restored.

The UAV then initiated a clockwise loop, but the movement was then changed to an increase of altitude, away from the landing point. This reaction was caused by an interruption of communication

Figure 16 : UAV flight during loss of control (based on radar data)

From the lowest altitude reached, the UAV started to climb and entered a counterclockwise loop (green track on Figure 15), eventually coming back above the runway threshold at an altitude of 2900ft. The UAV then started a descent.
When the UAV passed 2400ft (grey track on Figure 15), Bingo time was reached, inhibiting the LAND instruction. When this happens, the AP enters automatically in SAFE and

subsequently in LAND mode. However, when the landing is afterwards aborted (by the operator or due to a further loss of communication), the UAV will go in SAFE mode (full power, climbing) and will not enter into LAND mode again unless the BINGO time is reset. This explains why the UAV started climbing upon reaching BINGO time and continued its flight without changing its heading, holding it steady at 199 degrees..

During this event, the crew of the OCULUS attempted to restore the communication by manually pointing the antenna towards the direction of the aircraft, based on indications received over the phone by the Military ATCC.

2.4 Antenna connection

On the OCULUS UAV, the radio is connected to the antenna by a co-axial cable. Each end of the cable is fitted with a connector.

The disconnected antenna was found during the inspection of the OCULUS UAV on April 14, 2016.

Figure 17: cable as found.

Figure 18: cable with protective sleeve and connector.

Figure 19; rubber protective sleeve removed.

The rubber protective sleeve was removed and showed that crimping of the brass sleeve occurred mostly on the far end (cable end of the connector).

Figure 20 : connector and cable in situation showing the crimped sleeve covering a small part of the connector center.

The braid was found short so that only a small portion of the extremities of the braid was pressed between connector and sleeve.

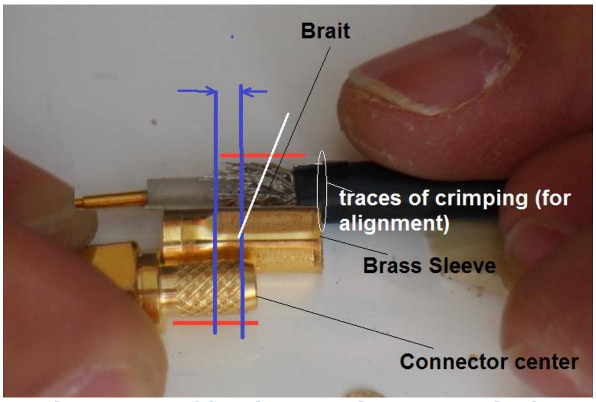


Figure 21 : cable, sleeve and connector body.

Normally, for a coax connector, the braid should be inserted up to the edge of the connector before the crimping sleeve be inserted, to ensure that the braid be pressed between the sleeve and the connector center.

Another connection showed a correct crimping pattern (done by another tool - sleeve crimped close to the connector body – lower connection in the picture hereunder);

Figure 22 : comparison with another connection

2.5 Safety equipment.

Transponder

Crucial during the incident, the UAV was equipped with a transponder. This allowed the UAV to be visible on radar, and therefore allowed to clear the flight path of the UAV.
The clearing of the flight path is only valid for controlled airspace. However, in non-controlled airspace, this possibility does not exist, as the separation between aircraft must be assured by each pilot. The relatively small size of the UAV makes its visual detection quite difficult.

The installation of the transponder was the subject of early discussions between VITO and the BCAA, however, this requirement was not reflected on the authorization issued later by BCAA.

Parachute.

The emergency parachute was present and operational on the UAV, but was not activated. As outlined in chapter 2.1., the POH does not include a detailed procedure on how to appropriately operate the parachute.

The deployment of the parachute on the manual mode requires communication from the ground control console to the UAV. However, the command can be actioned on the console even when communication are interrupted. In this scenario, the signal of parachute deployment would be sent in priority as soon as communication are re-established, even for a short period of time.

In this case, as the signal was shortly re-established a few times during the first part of the flight, there had been a possibility to command the deployment of the parachute.

Software: Automatic landing mode

The automatic landing mode is automatically activated when a given malfunction is sensed by the autopilot.

During the development of the Oculus UAV, the software was modified against the original software of the Atlantic, amongst others, to allow for the incorporation of a transponder. It was also further altered in Weelde, after delivery, during the different adjustments performed to improve the automatic precision landing capabilities.

During these modifications, an undetected logic fault was introduced causing the autopilot to switch from LAND to SAFE mode when subsequent communication failure occurred.

2.6 The loss of control

The failed antenna cable caused the loss of communication, the AP automatically entered in the SAFE mode, which is normal. However, the SAFE mode activation combined with the software anomaly, resulted in a continuous switching from LAND to SAFE, interrupting at least two times the landing process.

A little later on, once the BINGO time was reached, the AP entered again into SAFE mode (SAFE mode from BINGO). When a SAFE mode is triggered by an elapsed BINGO time and a landing sequence is aborted (manually, or as in this case through the software anomaly), the AP inhibits the possibility to enter in a new automatic landing sequence (LAND mode), unless the operator resets BINGO time. This particularity is intentionally designed to allow the operator to interrupt an automatic landing sequence after the BINGO time elapsed and fly the aircraft manually.

From that time, the UAV flew in an uninterrupted SAFE mode, continuously climbing with 100% throttle at an airspeed close to the $V_{NE,}$ continuously adjusting the pitch and without changing heading. As the UAV reached about 4000 ft, the maximum altitude possible in that configuration was reached, creating the phugoid movement spotted by the intercepting aircraft.

The UAV kept on flying on a 199 degrees heading at 4000 ft, until the engine stopped operating. The cause of the engine failure was not determined, one hypothesis would be that it overheated and seized. At that time, the autopilot decreases attitude to maintain the airspeed (stall protection), gliding down. The autopilot controlled the aircraft until touching down (crash landing) in a field outside Dizy-le-Gros in France.

2.7 Drone Regulation.

The accident happened before the entry into force of the Royal Decree of 15 April 2016.

The regulation shows different requirements than those foreseen on the Authorization that was given for the Oculus operation.
However, the following can be said:

- The pilot was not licensed, as it was not required at the time, but had sufficient knowledge and experience. (since the accident, the pilot obtained a license of RPAS operator and examiner). The new regulation would not have brought additional safety measures.

- The Oculus of the accident was equipped with a transponder which allowed its tracking by ATC and possible detection by other aircraft. This is not foreseen as such in the Regulation, unless the need for a transponder be identified during the risk analysis.

- Risk analysis. The risk analysis pertaining to the use of the Atlantic UAV was performed during design by UAVN. This led to the safety measures and devices such as the emergency landing procedure, the parachute, etc.. The Oculus featured an additional safety feature; the transponder, sign that the specific risks of the use of the Oculus were analyzed.

- The Oculus were provided with a Pilot Operating Handbook, made for the Atlantic UAV, and deemed to be used for the Oculus.

- The original design of UAVN – the Atlantic UAV – was flight tested to demonstrate the emergency procedures. The Oculus were based upon that design and even further modified after the failed acceptance test flights. However, there was no in-flight demonstration of the emergency procedures (except for activating the holding pattern) performed for the Oculus.
  The software flaw was introduced during these modifications and a run of the in-flight demonstration of the UAV emergency procedures would have allowed the early detection of the flaw in the logic in a controlled environment.
  The current Regulation does not address this specific issue, i.e. the need to perform a new in-flight demonstration of emergency procedures after modification of a proven design.

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3 Conclusions.

3.1 Findings.

- Due to a faulty workmanship, i.e. inadequate crimping of the antenna connector, the radio antenna cable of the UAV disconnected from the radio.
- The communication between the ground station and the UAV was already partially defective on the ground during pre-flight check. The procedure described in the POH was not applied by the crew.
- The communication between the ground station and the UAV was interrupted in flight causing the AP to trigger emergency procedures.
- The maximum flight time (BINGO) was set to one hour, but due to the time necessary for the pre-flight, the actual remaining flight time at take-off was 20 minutes.
- When reaching the BINGO time, if a landing is aborted, the AP returns to SAFE mode and does not allow to re-enter the LAND mode again (unless the BINGO time is extended). This is on purpose designed in order to allow full manual control.
- The autopilot software included a logic flaw, causing the autopilot to incorrectly revert to the SAFE mode from the LAND mode when an interruption of communication occurs. The undetected software logic flaw was introduced during one of the modifications performed by UAVN.
- The possible automatic deployment of the parachute was not selected by the crew during pre-flight.
- The crew did not try to manually operate the parachute.
- The aircraft was equipped with a transponder, allowing its flight to be tracked by ATC.
- The engine stopped operating for an unknown cause.
- A procedure in the POH exists to check a.o. the UAV antenna and cabling connections in case of a short and/or long uplink loss during pre-flight.
- As it was believed by the operator that the communication losses during pre-flight were self-induced, cable connections were not checked.

3.2 Causes.

The accident was caused by a series of interruption of the communication between the ground station and the aircraft due to the disconnection of an antenna cable inside the aircraft, causing the autopilot to initiate the automatic landing procedure. A flaw in the autopilot logic software caused the aircraft to interrupt the automatic landing sequence and to continue flying in a 200 degrees heading after the Bingo Time was reached.

Contributing factors.

Operational factors

- The interruptions of communication between the ground station and the aircraft that occurred during pre-flight was not identified by the crew (the crew stated they considered it as a positive check) as a potential serious problem.
- Not all safety features were selected before the flight; the use of the automatic parachute was not selected before the flight.
- The manual parachute deployment was not commanded when the crew realised that the SAFE mode did not work as expected.

Technical factors

- The autopilot was not originally designed for the incorporation of a transponder, requiring the development of a software solution in order to open up another communications port in the autopilot to connect the transponder into the setup.
- The acceptance procedure after the different modifications to the autopilot software was insufficient to identify the change in the logic.

4 Safety actions and recommendations.

4.1 Safety action

UAVN confirmed they have revised its software validation process to include a check for AP software logic failures under specific communication loss conditions.

AAIU(Be) supports this safety action.

4.2 Safety issue: BINGO time logic

Recommendation BE-2017-0004:

It is recommended that UAVN reviews the BINGO time logic, as it features an inherent danger of losing control of the UAV should a communication problem arises after the landing is interrupted and the BINGO time elapsed.

4.3 Safety issue: Safety measures not selected

Safety features were present, such as the use of the parachute, however its use is optional, and must be activated during pre-flight.

Recommendation BE-2017-0005:

It is recommended that UAVN reviews the design of safety features to ensure that essential safeties are selected ‘on’ by default and requiring an action from the operator to be de-activated.

4.4 Safety issue: Modification to existing proven design

Recommendation BE-2017-0006:

It is recommended that BCAA reviews the requirements for in-flight demonstration in order to extend this requirement when a modification is applied to an UAV of a proven design.

4.5 Safety issue: Selection of safety measures

Recommendation BE-2017-0007:

It is recommended to BCAA, when issuing Type 1a UAV operations authorization, to require that all applicable safety measures identified in the Flight Manual are selected ‘on’ for each flight.

5 Annexes

This report was circulated amongst the concerned authorities / organisations, as par EU Regulation EU 996/2010 Article 16.4. and ICAO Annex 13 Article 6.3. All comments were analysed and the report was amended accordingly. Some comments by UAVN and VITO did not led to changes to the report and are reproduced hereunder, only the chapter references are updated for clarity.

5.1. Comments on the report by UAVN

Referring to the act of standing between the UAV and GCS antennas to provoke a communications failure “The crew reported this procedure was taught during training. “ This assertion is not true. No such procedure to provoke a communications failure is taught by UAVN, and any competent UAV operator would recognize that this is not a reliable way of provoking one. In fact this method, which VITO stated it had used during pre-flight checks on the day of the accident, was proved during the investigation on 14 Apr 2016 to be completely invalid and therefore that VITO’s claim was misleading. The communications failure is arguably the principle contributory factor to the incident; therefore the crew’s decision to ignore the two LUL communications failures during pre-flight checks represent a serious operator failure.

5.2. Comments on the report by VITO

Pg.9 Contributing factors:
Bullet 2: ‘Not all safety features…
Comment: “We would like to highlight that the safety features selected were fully in line with the recommendations provided by the Manufacturer during the training.
Therefore we would like to suggest to replace ‘Not all safety features… ‘ by ‘All applicable safety features, in line with the instructions of the manufacturer were selected’.”

Pg. 36 Section 2.5 Safety Equipment:
“Clarification: VITO was never told/instructed that in case of a communication failure the parachute deployment signal would be sent in priority whenever the communication would be re-established.”

Pg.39 Section 3.1 Findings Bullet 8
‘The crew did not try to manually operate the parachute’.
“We think some clarification might be useful here: The crew did indeed not do this as it was explained by that the opening of the parachute required communication with the aircraft which was not the case anymore. The details about sending the signal by priority in case of reestablishment of the contact was not instructed during the training of the VITO crew.”

Pg. 39 Section 3.2 Causes Bullet 2:
‘Not all safety features…’
“As indicated earlier in this document, the crew DID select all RELEVANT safety feature in line with the training and instructions received by UAV Navigation and the POH.”

AAIU-2016-AII-01

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