Air Accident Investigation Unit (Belgium)
Federal Public Service
Mobility and Transport
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Safety Investigation Report

Ref. AAIU-2022-07-02-01
Issue date: 08 June 2023
Status: Final

Scope: Extended

As per ICAO Annex 13 and EU regulation EU 996/2010, decisions regarding whether to conduct a civil aviation safety investigation, and the extent of an investigation, are based on many factors, including the level of safety benefit expected to be drawn from such an investigation.
For this occurrence, an extended investigation was performed concluded with a thorough analysis covering several aspects of the operation.

SYNOPSYS

Occurrence class	Accident	
Occurrence category	Glider towing related events (GTOW) Loss of control - inflight (LOC-I) Fire/smoke (post-impact) (F-POST)	
Date and time[1]	02 July 2022 13:00 UTC	
Location	Field bordering aerodrome of Maubray (EBTY)	
Aircraft	Piper PA25-235 Pawnee	Schleicher Ka 6E
Aircraft category	Fixed wing - Small aeroplane (MTOW ≤ 5700 kg)	Fixed wing - Sailplane - Non-powered
Location of departure	Aerodrome of Maybray (EBTY)	Aerodrome of Maybray (EBTY)
Planned destination	idem	idem
Type of operation	Non-commercial - Specialised - Local	Non-commercial - Local
Phase of flight	Takeoff	Takeoff
Injuries	Minor	None
Aircraft damage	Destroyed	No damage

What happened

On July 2, 2022, about 13 UTC, a Piper PA-25-235 airplane was destroyed when it impacted terrain during initial climb after take-off from the Tournai-Maubray airfield, Belgium. The airline transport pilot suffered only minor injuries and could escape from the wreckage before it caught fire and was totally destroyed. The aircraft was towing a Schleicher KA 6E sailplane at the time. The sailplane pilot stated that during the initial climb, the tug aircraft disappeared from his sight and he released the tow cable. The sailplane could return to the airfield for a safe landing.

[1] All time data in this report are indicated in UTC, unless otherwise specified

What the AAIU(Be) found as safety topics

Systemic	Organisational	Management – Policy/procedure – operator – risk analysis
Systemic	Technical	Aircraft systems – Equipment/furnishing – tow line weak links
Systemic	Operational	None found
	Human	Action – Delayed action – pilot Info processing – identification/recognition - pilot
	Environmental	None found

AAIU(Be) comments

As stated under chapter 1.17.1 of this report, according the regulation it is the individual pilot-in-command that is responsible to conduct a thorough risk assessment of the operation and develop checklists. However, as aeroclubs are organisations gathering persons -who are principally pilots - sharing the same interest, the AAIU(Be) believes it is the organisation's task to take, as a peer, a leading role in the performance of such a risk assessment and the use of standardized checklists.

Safety message/safety action

Therefore as a safety message;

> The AAIU(Be) reminds all organisations and their pilots performing glider towing, in line with the regulation, to conduct a thorough risk assessment of the operation. Further, before each flight, the concerned pilots (tug aircraft and sailplane pilot) needs to hold a briefing, on the base of the developed checklists, on all the safety aspects of the operation with the combination tug aircraft / sailplane considered, including revised emergency procedures to cope with any unforeseen situations arising from changes introduced – like in this case, a new tug aircraft type.

1. FACTUAL INFORMATION

1.1 History of the flight

The history of the flight is based on the witness declarations of the accident, the radar records of the flight, and the data of the portable GPS used on board by the crew.

The tug airplane of the Aero-club was out of order for a few weeks and the aero-club was looking for a temporary replacement.
The Piper Pawnee was leased from a company specialised in panel towing based in the Netherlands.
Several pilots of the aero-club went to Saint-Hubert (EBSH) to familiarize themselves on the Piper Pawnee. The training consisted of a theoretical part followed by flight exercises, including stalls and touch and goes.
The pilot went then to the Netherlands to bring the airplane to EBTY on the 25th of June.

The tug airplane was used for aerotow on the 25, 26 June and 1 July for a total of 28 flights. All flights were performed by other pilots, at the exception of the first aerotow on the 25 June, which was performed by the pilot involved.

On 2nd of July, the aerotow was performed by the pilot; he already performed 8 aerotows when he positioned the airplane for the towing of the Ka 6E sailplane. These included mostly the twins ASH25, DG1000 and the ASK13 of the club. The pilot also performed the aerotow of a K-6CR, another K-6 of a private owner (note; the version without the all-moving tailplane).

Before the first flight of the day, the tug pilot checked the rear-view mirror with the help of other pilots. The tug aircraft pilot stated that he always checks the rear-view mirror at the start of the take-off roll and shortly thereafter, to make sure the sailplane is aloft behind the aircraft. During the initial climb, the tug aircraft pilot keeps his attention forwards to ensure a correct trajectory and stabilization it in case of turbulences.

For the sailplane pilot, it was his first flight of the day. The sailplane was brought to the start line.
The tow cable was attached to both tug airplane and sailplane. On the sailplane, it was attached to the ventral position on a Tost hook. On the tug airplane, it was attached to a Schweitzer hook on the tail wheel structure.

The tug aircraft pilot stated that during the pre-flight check, he insisted about the difference in engine power between the PA-25 and the Robin DR400 used so far for the aerotow. He pointed out that the acceleration was higher but the airspeeds were identical. The climb angle would be different, but the fundamental task for the sailplane pilot would remain the same (keeping the tug airplane in the reference position). The aerotow speed was determined by the tug aircraft pilot at 70 mph (112 km/h). The pilot used the check-list developed from the POH and the training in EBSH. The sailplane pilot used the standard ‘CRIS’ check-list (see also chapter 1.17.2 of this report).

The airplane and sailplane took off from EBTY at 13:00. The sailplane lifted off first at ¾ of the runway, followed by the tug airplane.
The sailplane pilot soon noticed he was flying higher than the tug airplane and wanted to correct the attitude by initiating a descent and pushed slightly on the stick. The sailplane pilot stated that after that, he lost the tug airplane from sight. He then decided to release the tow cable.

The tug airplane pilot took off as usual. The lift-off occurred when the airplane passed the hangars. The airplane was reaching the runway end (threshold) when the pilot felt the vertical force applied by the sailplane on the tail. The pilot reached for the release handle but sensed the sailplane releasing the tow cable as well. The pilot states that the airplane was 'vertical' when the cable was released.
The tug airplane pilot then realized he was at 200 ft height, diving towards the trees bordering the runway end. He tried to recover and seeing the inevitable crash, succeeded in putting the airplane as good as horizontal, in order to limit the impact forces.

The tug airplane impacted a corn field and skidded sideways for a distance of 20 m before coming to a stop. The pilot opened the RH door and escaped the airplane that started burning.
The sailplane, after the release of the tow cable, turned to the right, to come back on the runway. The landing was uneventful.

1.2 Injuries to persons

Table 1: List of injuries

Injuries	Crew	Passenger	Others	Total
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	1	-	-	1
None	1	-	-	1
Total	2	-	-	2

The tug airplane pilot suffered minor injuries.
The sailplane pilot is unhurt.

1.3 Damage to aircraft

The tug airplane was totally consumed in the subsequent fire.

1.4 Other damage

The corn field suffered damage limited to the crash scene area, due to the airplane and subsequent fire and also the subsequent fire brigade intervention.

1.5 Pilot information

1.5.1 Tug airplane pilot

Table 2 : General pilot data

Nationality	Belgian	Age	31
License	Private Pilot Licence (PPL), first issued in 2010 Commercial Pilot Licence (CPL), first issued in 2011 Airline Transport Pilot Licence for aeroplane (ATPL(A)), first issued in 2015		
Ratings	B737 SEP(Land) Sailplane towing, first issued in August 2020 TRI (MPA)		
Medical	Class 1		

Table 3 : Flying experience pilot

Total time as pilot:	5000 FH
Total time as PIC on SEP (Land) :	500 FH
Total on type:	10 FH

The pilot started aerotowing in 2012 in France, at the Sailplane aeroclub of Maubeuge for a year. He held a Belgian rating for sailplane towing in August 2020 and was active in the sailplane aeroclubs of Maubray and Cerfontaine since.

1.5.2 Sailplane Pilot

Table 3 : General pilot data

Nationality	Belgian	Age	67
License	Sailplane Pilot Licence SPL first issued in 2002, The pilot started sailplane flying in 1994		
Ratings/Limitations	Winch, Aerotow		

Table 4 : Flying experience pilot

Total time as pilot:	570 flights / 290 FH
Recent experience 2022 up to accident date:	22 flights / 7 FH Last flights on the previous week on ASK-13
Total on Ka 6E:	22 flights / 10 FH all with aerotow start Last flight with the Ka 6E on 11 June.
Type flown ASK-7 ASK-8 Ka 6 CR ASK-13 ASK-21 Twin Astir Jeans AS Nord 2000 M200	 77 flights / 20 FH 220 flights / 210 FH 2 flights / 1 FH 110 flights / 55 FH 22 flights / 8 FH 15 flights / 26 FH 6 flights / 6 FH 1 flight / 1 FH 2 flights / 3 FH

For the sailplane pilot, it was the first flight of the day and the first time he performed an aerotow with the Piper Pawnee on a Schleicher Ka 6E. His only other flight with the Ka6E in 2022 was performed in June.
He stated his experience on aerotow is not extensive, although all the flights made on the Ka 6E started with an aerotow.

1.6 Aircraft information

1.6.1 Tug airplane

The PA-25 Pawnee is an agricultural aircraft produced by Piper Aircraft between 1959 and 1981. It remains a widely used aircraft in agricultural spraying and is also used as a tow plane, or tug, for launching sailplane or for towing banners.

On April 15, 1988, Piper Aircraft, Inc. officially sold the PA-25 series aircraft to Latino Americana de Aviación S.A in Argentina.

The fuselage frame is constructed of steel tubes, welded to form a rigid structure. Highly stressed members are made of 4130 Chrome- Moly steel, others are of 1025 steel.

Fuel System: A total of 38.5 US gallons is carried in two aluminum fuel tanks, one in each wing.

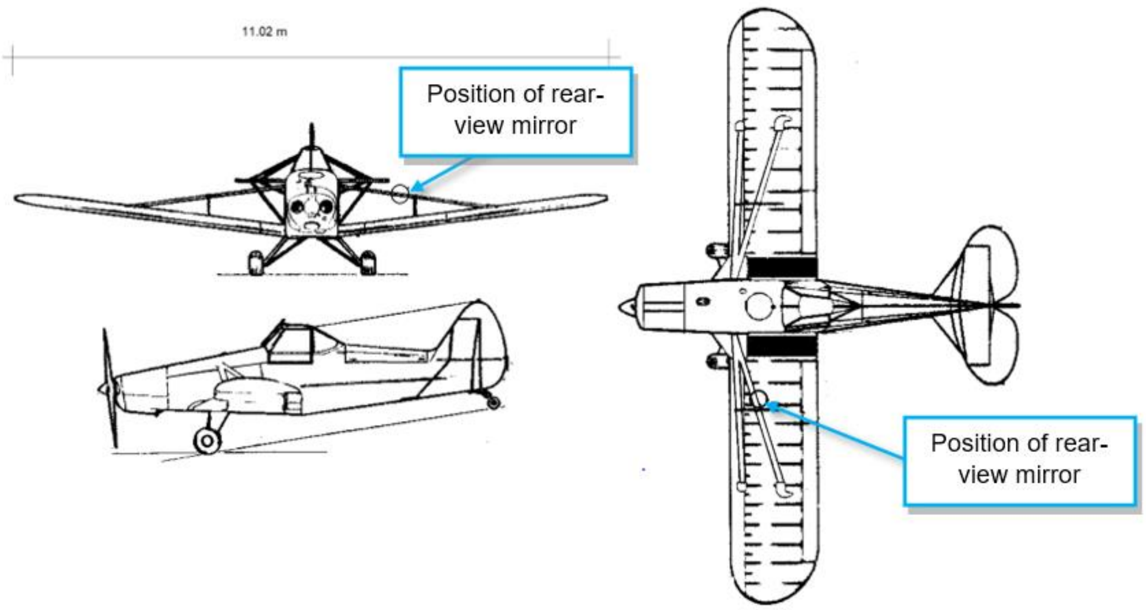

Figure 1: Piper PA-25 Pawnee 3-view drawing

General characteristics

- **Crew:** One
- **Length:** 24 ft 9 in (7.55 m)
- **Wingspan:** 36 ft 2 in (11.02 m)
- **Height:** 7 ft 2 in (2.19 m)
- **Wing area:** 183 ft^2 (17.0 m^2)
- **Empty:** 1,457 lb (662 kg)
- **Loaded:** 2,900 lb (1,317 kg)
- **Maximum takeoff:** 2,900 lb (1,317 kg)
- **Powerplant:** 1 x Lycoming O-540-B2B5, 235 hp (175 kW)

Performance

- **Maximum speed:** 107 kts or 124 mph
- **Range:** 500 km
- **Service ceiling:** 13,000 ft
- **Rate of climb:** 630 ft/min (192 m/min)(at MTOW)

The airplane was registered in the United Kingdom; the Certificate of Registration was issued to the Dutch Operator in May 2016. The aircraft had a Certificate of Airworthiness issued by the UK CAA in April 2008. The Airworthiness Review Certificate was renewed in May 2022.

The airplane was equipped with a rear-view mirror, mounted on the LH wing mast.

1.6.2 Sailplane

The Schleicher Ka 6 is a single-seat sailplane designed by Rudolf Kaiser, built by Alexander Schleicher GmbH & Co, Germany and is constructed of Spruce and plywood with fabric covering. The design initially featured a conventional tailplane and elevator which was later replaced by an all-moving tailplane in the -Pe and Ka 6E variants. Variants built before the -CR and -BR used a main skid as the principal undercarriage, with later variants including the Ka 6E using a wheel as the main undercarriage with no nose skid. Other modifications for the Ka 6E include a more aerodynamic fuselage with glassfibre nose and wingroot fairings, longer canopy, and modified aluminium airbrakes.

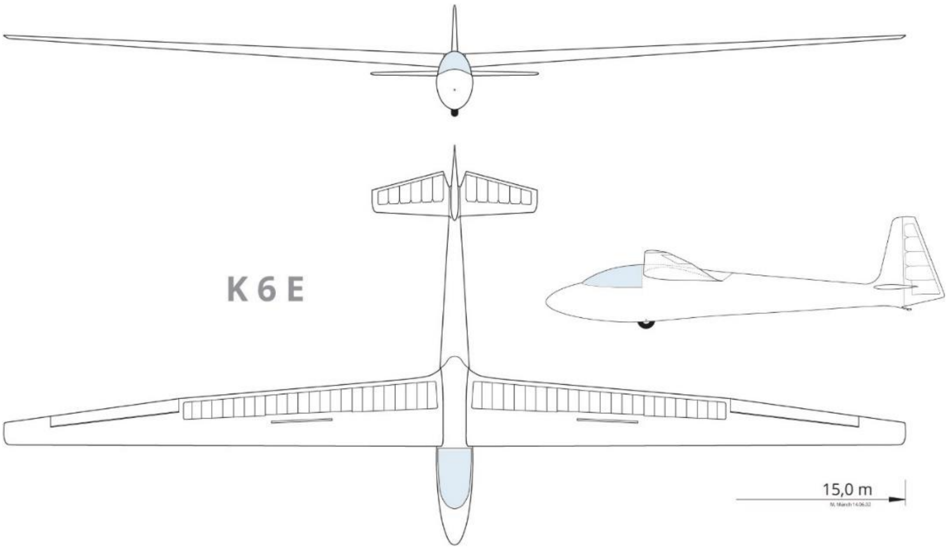

Figure 2: Ka6e Sailplane 3-view drawing

General characteristics

- **Crew:** One
- **Length:** 6.66 m
- **Wingspan:** 15 m
- **Height:** 1.6 m
- **Aspect ratio:** 18.1
- **Maximum speed for aerotow:** 140 km/h
- **Maximum Take-off weight:** 300 kg
- **Built year:** 1967
- **Total FH:** 1977 FH
- **Empty weight**: 212 kg

    - **Min. weight on seat:** 60kg
    - **Max. weight on seat:** 88kg

The sailplane had its Airworthiness Review Certificate renewed in March 2022 and was valid until 23 March 2023. The sailplane accumulated a 260 flights and 216 FH between 2009 and 2022. In the period 2021-2022, it accumulated 10:37 FH /11 flights .

Weight and balance:

The pilot weights 62 kg and uses a ballast weight of 10 kg placed on the seat.

1.6.3 Equipment for aerotow

1.6.3.1 Tug airplane

The modification of an airplane for the purpose of glider aerotow operations is approved by the UK CAA through the issue of an Airworthiness Approval Note (AAN). The actual document was not found in the burned wreckage, nor at the UK CAA. Nevertheless, the aircraft's Flight Manual should have incorporated a Supplement worded as follows;

> **Installation of Schweizer Glider Tow Hook Model 3415D**
>
> When Schweizer glider towing equipment, Model 3415D, is installed (Modification No BAS/PA25/004), the aircraft may be used for towing gliders, subject to compliance with the following conditions:
>
> i) The weight of the towed glider shall not exceed 1260 lb (570 kg).
> ii) The breaking strength of the towing cable (or weak link, if employed) shall not exceed 1200 lb (545 kg).
> iii) The aircraft must not be flown at airspeed indicator readings in excess of the maximum speed at which the towed glider is permitted to be flown during aerotow.
> iv) The aircraft must not be flown at any airspeed indicator reading less than 55 knots (63 mph) when towing a glider.
> v) The aircraft must not tow more than one glider at any one time.
> vi) The aircraft shall not fly for the purpose of Public Transport when towing a glider

The CAA Supplement 4 Issue 5 to the Piper PA25-235 FAA approved Airplane Flight Manual, a possible alternative to the AAN, gives similar requirements.

1.6.3.2 Glider

The Flight Manual of the Ka 6e states;

> Sollbruchstelle im Schleppseil (*Weak link in the tow rope*):
> (…)
>
> bei Flugzeugschlepp(*for aerotow*):
> max. 450 kp
> min. 300 kp
>
> Hinweise zum Flugzeugschlepp: GröBte Schleppgeschwindigkeit 140 km/h. Flugzeugschlepp an der Schwerpunktkupplung ist zulässig bei Verwendung von Textilseilen (Höchstlänge 100 m). Kupplung voll durchziehen. Vor jedem Start Einrasten der Haube und BK prüfen.
>
> *Notes for Aerotow: Maximum towing speed 140 km/h. Aerotow at the center of gravity coupling is permitted when using textile ropes (maximum length 100 m). fully depress the clutch. Before each start, check that the canopy and BK are locked in place*.

Note: "kp" means Kilogramme-force, i.e. 9.81 m/s^2

1.6.3.3 Tow cable

The tow cable used by the aeroclub was a 40m-long Nylon cable with Tost connections on either end.

There are no specific regulatory requirements related to the tow cable, except that the BGA – Aerotowing Guidance Notes Part 1 (2nd Edition - 2008) states the following:

– 14. **Daily inspection and defects**:
(….) Generally, the longer the rope the safer it is for the tug pilot, however in practical terms 180 feet is a reasonable compromise. (…)

- 35.2 **Factors which apply to all rope systems**
(…) An aerotow rope needs to be between 55m and 60m (180ft – 200ft) (…)

Note: The Belgian Authorization document, issued by BCAA for Belgian-registered PA25 aircraft operating aerotow states that the length of the tow cable should be between 30 and 50m long.

1.6.3.4 Weak link

The tow cable was not equipped with weak links at any extremities (tow aircraft and glider). The aeroclub stated the following;

"*We considered that the tow cable has an "auto-breaking" function at a value of 1000 daN, value found in the POH of the Robin DR-400 (the airplane type used for aerotow by the club, that was unavailable at the time of the accident). There was no value available for the Piper Pawnee.*

On the glider side, we determined, on the base of several incidents in the past, that the risk of a premature opening of the weak link at take-off on Runway 29 (note; in this case, the take-off occurred from Runway 11) was too high. Therefore, we decided not to install any. The risk of an overload of the glider being towed is practically non-existent and in any case less likely than an untimely opening. The value of the weak links supposed to protect the towed gliders are indeed much lower, between 300 and 500 kg depending on the glider."

1.7 Meteorological conditions

METAR of Lille Airport LFQQ. (28.5 km to the East)

LFQQ 021330Z AUTO 22008KT 180V280 CAVOK 24/10 Q1019 NOSIG
LFQQ 021300Z AUTO 19010KT 160V220 CAVOK 23/09 Q1019 NOSIG

- **Time:** 13:00 UTC
- **Wind direction:** 190°, variable between 160 and 220 degrees
- **Wind speed:** 10kt
- **Temperature:** 23°C
- **Dew point:** 9°C
- **Pressure:** 1019 hPa
- **Visibility:** CAVOK, meaning visibility +10 km (and no clouds below 5000 ft AGL)

LFQQ 021230Z AUTO 21009KT 170V260 CAVOK 24/09 Q1020 NOSIG

1.8 Aids to navigation

Not applicable.

1.9 Communication

Not recorded

1.10 Aerodrome information

Maubray airfield (EBTY) is a private airfield located near the town of Tournai, Belgium.

It features a bi-directional grass runway Runway 11/29 of 640m long and 18m wide

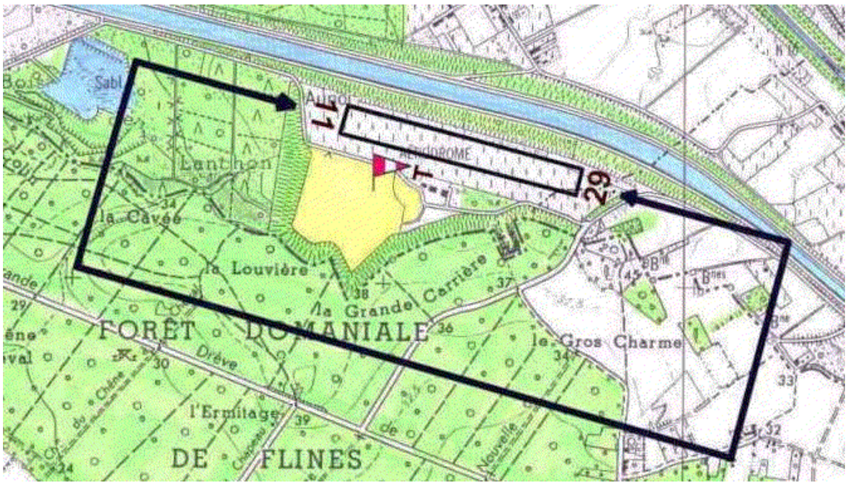

Figure 3: EBTY Airfield

1.11 Flight recorders

Both aircraft were not equipped with FDR/CVR, nor was it required.
The on-board devices of the tug airplane were totally destroyed by fire.
The sailplane was equipped with a FLARM, which records flight data (position, height and time) every second on an .IGC format.
The file records were retrieved for the investigation. It shows the whole flight of the sailplane.

1.12 Wreckage and impact information

Investigators were deployed on site. The first inspection of the aircraft determined the following:

Crash location: 50°31'48.79"N
3°30'15.22"E

Impact direction: 94°
Heading of aircraft wreckage: 147°
So aircraft was in angle of about 55° with the final path.

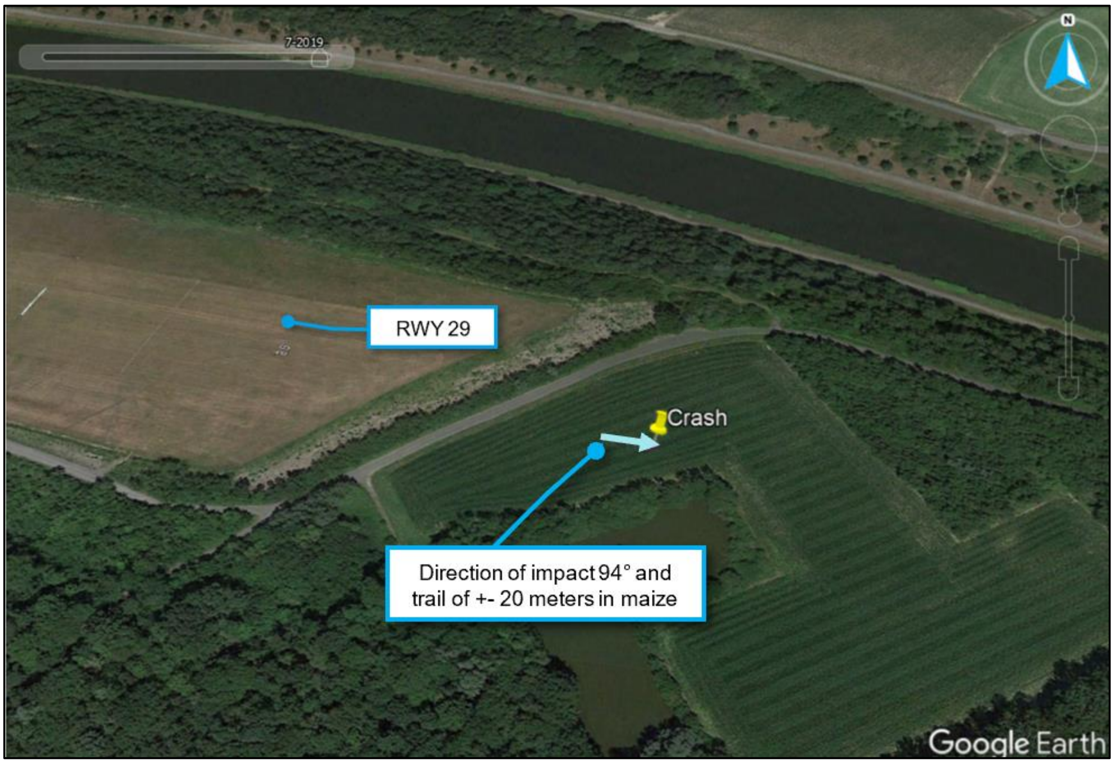

Figure 4: Crash area

Figure 5: The wreckage of the tug airplane

<u>Findings on the wreckage:</u>

- Fabric was consumed by post-crash fire, but structure was overall good intact. All flight controls were still present, any in-flight break-up excluded.
- Flap handle down (so flaps up position). Cable to LH flap was ruptured (overstress), rod of RH flap to the flap horn was found broken (also overstress).
- Rudder cables were still intact and connected with pedals, rudder was free to move
- Aileron cables and pulleys still intact and connected with stick
- Elevator cables still intact and connected with stick
- Trim handle in cockpit disconnected. Not possible to determine the elevator trim setting. Cable and spring were still attached to the elevator however.
- Mixture setting full rich
- Throttle: half power
- Propeller blades and spinner had no signs of high power during impact
- Schweizer (tow) hook open and cable released.

The tow cable itself was found at the beginning of the trail in the corn field.

1.13 Medical and pathological information

The pilot of the tug airplane suffered a broken nose due to the forces at impact, although he was strapped in his seat with a five-point harness. The pilot stated the harness was very helpful.

1.14 Fire

A fire started very soon after the impact. The pilot stated he noticed the flames at the right wing when he exited the airplane. At some point, he wanted to go back to the airplane to get some personal belongings but he saw that fire was then raging on both sides of the airplane.

At the RH wing it was clear that there were 2 sources of fire; one originating from the wing fuel tank and one originating from the engine compartment. The wing support struts showed no fire damage. Also the flap was only half burned from inner to outer while the aileron (which lies more outboard) was completely burned at the upper side; showing that the radiation came from 2 directions.

In a study (Reference A-87-99), the NTSB has reviewed all 102 accidents in the period 1983 - 1987 with PA-25 Pawnee to determine the relationship of post-crash fire and fatalities, Out of the total, 30 % involved post-crash fire. The safety concluded with a safety recommendation regarding the fuselage-mounted fiberglass fuel tank (not installed on the tug aircraft).

The aviation-safety.net website shows for the years 2018 - 2021 a total of 101 reports of accidents with PA-25 Pawnee, of which 10 involve a post-crash fire.

1.15 Survival aspects

The pilot of the tug airplane suffered only minor injuries at impact, although he was strapped in his seat with a five-point harness. The pilot stated the harness was very helpful.

The shoulder harness is equipped with an inertia reel. It has a manual control to lock or unlock the harness in any position as well as an automatic locking device which will lock the reel automatically in any position upon application of more than 2 +/- 0.5 G inertia load on the reel.

In the wreckage, the safety belts were not found. However, the connection cables were still attached to the structure. So no signs of impact failure (rather consumed by the fire).

The construction of the fuselage provides an adequate resistance to impact. The cabin frames were still standing, even after the fire. However, the cabin lay-out is such that the pilot has to exit the aircraft through the window, which in case of emergency or crash exiting the cockpit in an emergency might be difficult.

Figure 6: PA-25 Cockpit

1.16 Tests and research

None

1.17 Organizational and management information

1.17.1 Regulations

As stated above, the concerned tow aircraft was registered in the UK and thus to be operated under the UK law. However, the basic regulation (EU) 2018/1139 of the European Parliament and of the Council was retained and amended in the UK domestic law under European (Withdrawal) Act 2018.

Basics

Annex V the Basic of Regulation (EU) 2018/1139 specifies;

1.2. A flight must be performed in such a way that the operating procedures specified in the Flight Manual or, where required the Operations Manual, for the preparation and execution of the flight are followed.

Air Operations

The operation of glider towing is covered by the EU Regulation (EU) 965/2012 (Air Operations) and may be conducted in accordance with Annex VII (Part-NCO, Non-commercial operations with other-than complex motor-powered aircraft) of that regulation if :

- it involves, of course, operations with other-than complex motor-powered aircraft[2], and
- it is performed by a training organisation having its principal place of business in a Member State and being referred to in Article 10a of Regulation (EU) No 1178/2011,
- or it is performed by an organisation created with the aim of promoting aerial sport or leisure aviation, on the condition that the aircraft is operated by the organisation on the basis of ownership or dry lease, that the flight does not generate profits distributed outside of the organisation, and that whenever non-members of the organisation are involved, such flights represent only a marginal activity of the organisation.

An ‘*organisation created with the aim of promoting aerial sport or leisure aviation’* is further defined in the regulation as ‘a non-profit organisation, established under applicable national law for the sole purpose of gathering persons sharing the same interest in general aviation to fly for pleasure or to conduct parachute jumping. The organisation should have aircraft available.’
In Belgium, the so-called ‘aeroclubs’ are to be considered as such organisations.

In addition to the general requirements of Part-NCO, glider towing operations need to comply with the specific requirements (NCO.SPEC) of the Subpart E of this regulation.

[2] other-than complex motor-powered aircraft’ means for an aeroplane that is not a plane:
- with a maximum certificated take-off mass exceeding 5700 kg, or
- certificated for a maximum passenger seating configuration of more than nineteen, or
- certificated for operation with a minimum crew of at least two pilots, or
- equipped with (a) turbojet engine(s) or more than one turboprop engine

NCO.SPEC.105 requires the pilot-in-command to conduct a risk assessment of the operation in order to set up a checklist detailing the operational tasks and taking into account any mitigating actions deemed necessary to alleviate the potential dangers. The Regulation shows examples of template forms for risk assessment, hazards identification and listing mitigating measures, assisting in the development of checklists.

The responsibilities and authorities of the pilot-in-command are further detailed in Subpart A, rule NCO.GEN.105. Under Part-NCO no requirements or responsibilities are required for the aeroclubs/organisations.

1.17.2 The operator: Royal Tournai Air Club

The Tournai Air Club was founded in 1964 and is at the Maubray airfield (EBTY), close to the French-Belgian Border. Its activity is now focused on gliding activities, for which a tug aircraft and 2 winches (340 and 360 HP) are available.
The Tournai Air Club became the Royal Tournai Air Club in 2016. It operates an Approved Training Organisation for the qualification of glider pilots.

The fleet of gliders of the club includes the following glider types; one ASK13, for the basic training, one Twin Astir II for advance training, one Ka8b for beginners pilots, three Grob Astir, 1 Cirrus StaASW19B. The club uses also a 180HP Robin DR 400 for the aerotow.

Procedures and checklists

For the aerotow, the aeroclub did not develop a specific documented procedure. The training on aerotow for the glider pilots is based upon the “Memento de l’instructeur de pilote de planeur” (issued by the French Federation FFVP, edition 2/2020). Daily and ad-hoc safety briefings are also based on this publication.

A checklist was developed to cover both launching technique (aerotow and winch launch), highlighting what is specific for which technique. This checklist, in French and Dutch language, is generic for all type of gliders and uses mnemonics.

Extract (for aerotow):

CRIS

C	▪ **Controls**, free and correct, airbrakes checked. ▪ Trim set for take-off ▪ Balance: ballast if necessary ▪ Hat and sunglasses
R	▪ **Radio** ON and frequency set (squelch test). ▪ **Rigging** of seats and rudder pedals
I	▪ **Instruments** - Variometer(s) zeroed and ON - Altimeter QNH or QFE - Airspeed indicator zeroed - Compass QFU - Ball and wool thread - O2 open and tested
S	▪ **Safety** - Pilot strapped - Parachute adjusted - No loose objects - Canopy latched - Brake test (cable stretched) - Air brakes closed and latched
▪ **Preparation in case of Towing incidents** • Wind direction ? • Decision altitude ? • Critical speeds ?	

1.18 Additional information

1.18.1 British Gliding Association

From the British Gliding Association – Aerotowing Guidance Notes (2nd Edition June 2008)

41. TUG UPSETS

Tug upsets occur when the glider pilot gets too high and lifts the tug's tail uncontrollably. This tends not to happen from a pilot flying consistently high on tow, but rather from a pilot in difficulties a little low, perhaps in the slipstream, who suddenly 'winches' up behind the tug. This creates so much lift, and hence drag on the glider that the tug is not only tipped, but loses its forward momentum as well. From time to time over the years, tug upsets have occurred at low level from which the tug has been unable to recover, usually with fatal results. A glider pilot's aerotow training emphasises that correct position behind the tug is essential and that he must release if he is getting too high. However, tug pilots must be vigilant during the early stages of the launch for any tendency of the tug to be pitched nose down. At all times monitor the tug's attitude and if a significant backpressure is required to prevent any nose-down pitch – release immediately. Be aware that tug upsets can happen rapidly with little warning.

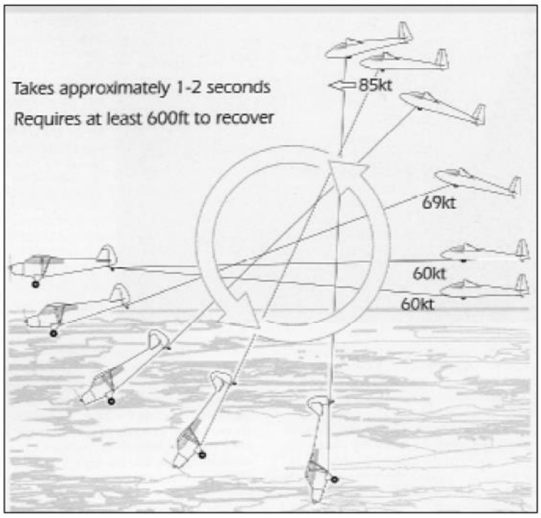

Figure 7: Typical sequence of glider 'winch launching' behind the tug. Glider speeds are based on a constant tug speed of 60 kts

There are a number of factors that increase the possibility of a tug upset:

- A glider that is to be towed from a belly hook
- Gliders with high-set wings relative to the towing hook
- Gliders with a low wing loading, usually older or vintage types
- The presence of turbulent conditions, especially if associated with a strong wind gradient
- Glider pilots with low hours and/or aero-tow experience

- Lightweight pilots
- The use of short tow ropes will exacerbate the problem

This list is not exhaustive.

A typical sequence is shown in the illustration on the previous page, with a simplified rope load/angle plot in the illustration below. In reality the situation is worse than shown because the glider zoom climbs behind the tug, its total energy increases (simultaneous increase in height and speed). This energy can only come from the momentum of the tug and therefore its speed will rapidly decay. This means that just when a high download is required to be generated by the tailplane/elevator to retain control and break the weak link on the rope, the capability to do so is vastly reduced by the decay in airspeed. This may result in the tailplane, and possibly the wing, stalling. Typically, 600 feet or more may be required to recover from an upset.

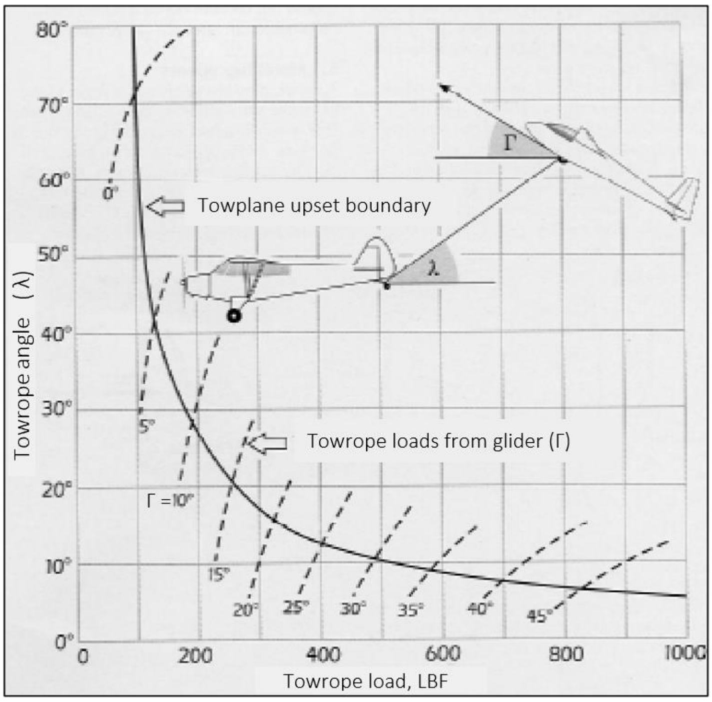

Figure 8

The solid line corresponds to the vertical component of the tow rope load which will upset the tug, and the dashed lines represent the loads applied by the glider calculated as if tow ropes were extremely long. For typical ropes, the loads are greater than shown – much greater for steep flight paths. The tug will therefore be upset at small rope angles by rather gentler manoeuvres than this diagram suggests. The rope weak links will protect the tug at the right side of the diagram while rope release is the only solution at the left side

Also it is important to avoid a hasty transition from level acceleration to climb, as this will result in the glider becoming low relative to the tug. This can tempt the glider pilot to make a rapid recovery, with obvious potential for over correction.

From the British Gliding Association Instructor's Manual (Section 4 page 17-6/7);

TUG UPSET ACCIDENTS

These are serious, and have caused the deaths of a number of tug pilots. If the glider is allowed to climb rapidly behind the tug, it can very quickly become impossible to prevent it accelerating upwards in a slingshot action (rather like a winch launch), and tipping the tug over into a vertical dive.

Once that has happened only height can save the tug pilot from disaster. Downward displacement of the glider to a position below the slipstream is quite acceptable, but upward displacements are much more critical.

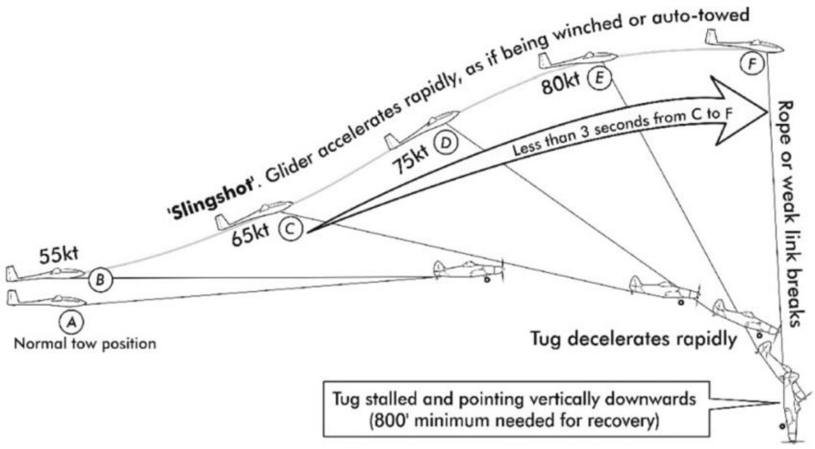

Figure 9

Typical sequence of glider 'winch launch behind the tug. Glider speeds are based on a constant tug speed of 60 kt

The glider pilot must release immediately if:

- *the glider is going high and the tendency cannot be controlled, or*
- *the pilot loses sight of the tug*

Factors which can combine to create a tug-upset accident are:

- *a light pilot flying close to the minimum cockpit weight*
- *an inexperienced pilot - particularly wire launch pilots with little recent aerotow experience*
- *glider with a belly or CG hook*
- *an all-flying tailplane, or a glider with very light elevator forces*
- *short rope*
- *turbulent conditions*.

1.18.2 Similar Accidents

Source: BFU
Investigation report BFU20-0660-3X; (free translation)

In the last 10 years, the BFU investigated 16 aerotow accidents in Germany. Of these, 4 accidents were fatal (with a total of 5 individual fatally injured) , 5 ended up with serious injuries, one with minor injuries and 6 without injury. The accidents occurred during take-off or initial climb. The tow plane was usually being forced into an uncontrollable flight attitude while the glider was able to continue flying or landed in a controlled manner after releasing the tow cable. A contributing factor to these accidents was that the glider went above or under the towing aircraft.

A study[3] by the Luftfahrt-Bundesamt (LBA) on aerotow events in the period 1971-1998 showed that the majority of aerotow accidents occurred during the initial climb (67%). The most dangerous flight conditions were met when the glider went above the towing aircraft (63%) and during flight path oscillations (27%). Sufficient time and at least 100 m ground clearance is required to release a towing aircraft and recover control over the aircraft.
Such accident were most critical for the towing pilot, as in only 9% of the towing accidents he remained uninjured.

The federal commission for gliding in the German Aero Club e.V. (DAeC) described in the basic training handbook for gliding (Chapter 6.2.2 Aircraft tow) the following:

> After take-off, the glider will usually take off earlier than the towed aircraft. As long as the towing aircraft has not taken off, you may not lift off. Never lift the tail of the tow aircraft! stay as close to the ground as possible until the towing aircraft has taken off.
> A start in aerotow requires high concentration. In turbulent weather you don't have time to look around. Keep the tow plane constant in the eye and always correct deviations as early as possible and as smooth as possible.
> In particular at the beginning of take-off, as long as the towing aircraft is still close to the ground, it is dangerous to close the side window, put away the chart, chase a fly in the cockpit...
> Not observing the tow aircraft increases the risk losing the correct position behind the tow plane. If the tow vehicle climbs in front of you, climb straight up with it. If the tow aircraft in front of you goes down, follow it down.

[3] LBA (1999). Schleppen von Segelflugzeugen durch Luftfahrzeuge nach JAR 22 und JAR 23, Grundlagen zur Erfüllung der Lufttüchtigkeitsforderungen (L-5/97). 23. Segelflugsymposium, Braunschweig

2. ANALYSIS

2.1 The flight

From the testimonies of pilots and the data from the FLARM, we can conclude:

- The tug airplane and the sailplane held an airspeed of 64 kt, which was the speed agreed upon during pre-flight (112 km/h + small component of headwind)

- The height graph (Figure 10) shows a small reduction of climb (almost levelling off) at 43 m, which could correspond to the statement of the sailplane pilot realizing he was flying too high and, as a reaction, pushed the stick forward. The tug pilot stated he sensed a upward force on the stabilizer upon reaching the runway end.

- From the runway end, the sailplane is climbing up to a height of 100 -110 m before the tow cable is released, which is compatible with the cable length of 40 m and the statement of the tug pilot stating he was flying at 61 m (200 ft) high when he released the tow cable.

- The graph shows an increase of ground speed from 64 kt to the maximum ground speed of 76 kt - 142k m/h, reached in 3 seconds time. This value and rate of increase is indicative of the sling shot effect described in Chapter 1.18 of this report).

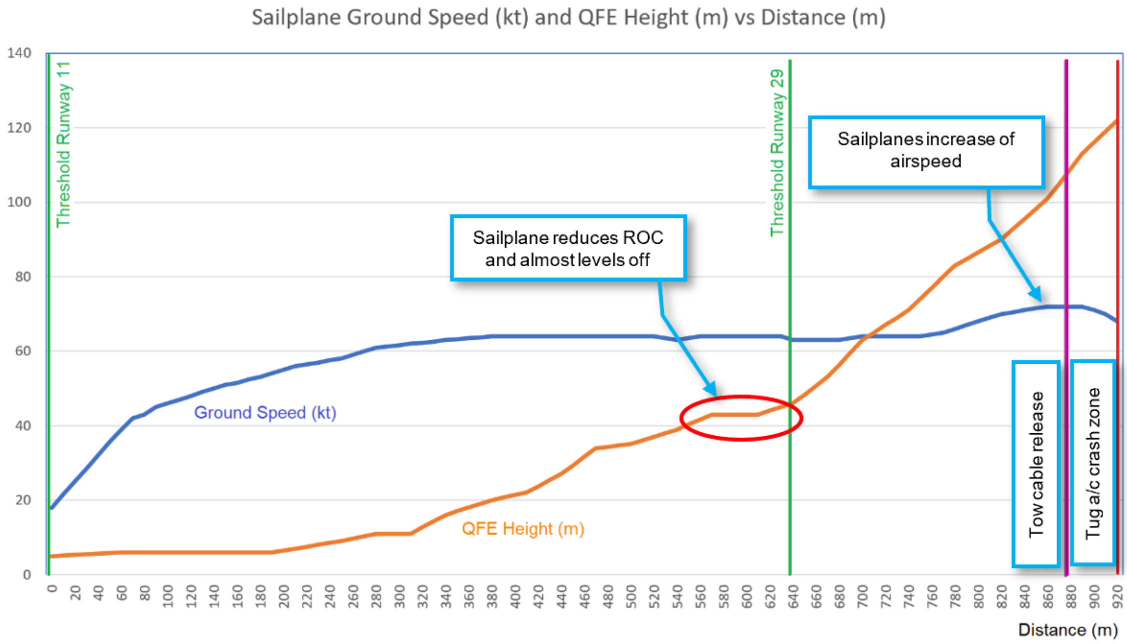

Figure 10 : FLARM data of the sailplane

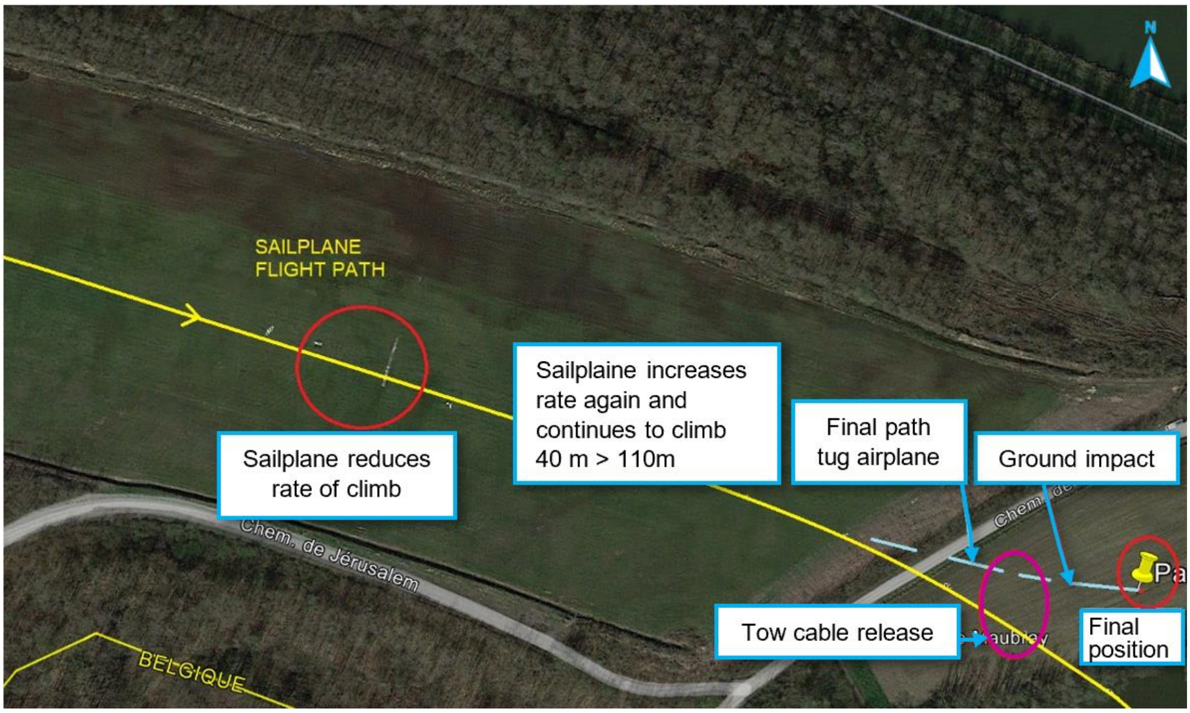

Figure 11 : reconstructed flight paths

The respective position of the 2 aircraft evolves very rapidly and the sailplane pilot did not constantly hold the tug airplane in sight. It resulted in a late detection of the problem. His first reaction was to correct the situation by pushing on the stick, but this did not have immediate effect. The sailplane pilot stated that, at that moment, he lost sight of the tug aircraft, sign that the problem increased.

Realizing the danger, the sailplane pilot released the towing cable, much at the same moment the pilot of tug aircraft did it. The sailplane deviated to the right, even before the release of the tow cable. This means that the cable, being attached at the tail behind the center of gravity, may have forced the tug airplane to yaw and change heading to the left, before the crash, as the trace of the ground impact direction shows.

The release of the towing cable occurred too late to prevent the tug aircraft from tipping down. There was insufficient height available to allow the recovery.

2.2 Aircraft and equipment

Both aircraft were airworthy and adequately equipped for the aerotow.

2.2.1 Weak link

Noteworthy is the absence of weak links on the tow cable, although the Flight Manuals require the separation of the tow cable from the aircraft at a rated load factor. The aeroclub stated that this function was ensured by the cable itself, although the breaking load factor was not precisely known. The aeroclub further stated that the risk analysis performed determined that the presence of a weak link for the glider would have caused more trouble than actual protection (chapter 1.6.3).

The reference documentation (chapter 1.18.1) and further studies[4] show that a tow airplane upset can occur while the load on the tow cable remain below the break-up value of the weak link (typ. 4000 N / 890 lbf). The weak link will only provide protection against very steep glider attitudes (Γ angle above 45 degrees) at low tow cable angle (λ angle below 10 degrees), the situation shown at the right side of the diagram in Figure 8. of chapter 1.18.1. In this last case, a weak link would be effective as a safety barrier.

In the other case – a high tow cable (λ) angle combined with a glider attitude of 0-40 degrees of Γ angle, the only action to prevent the tow aircraft upset is the early release of the tow cable by the pilots.

Witnesses on ground and the glider pilot did not report that the glider took a very steep pitch-up attitude during the critical phase. The data of the FLARM and the witnesses show that the sailplane climbed rapidly above the height at which the tow aircraft was flying, as reported by the tow aircraft pilot. This would generate a high tow cable angle.

Nevertheless, with the data available, the investigation could not compute the value of the load on the tow cable, thus could not conclude whether a weak link would have released the cable earlier than the action of the pilots. For that purpose, recorded flight data from the tug aircraft would have been required.

2.2.2 Mirror

It's impossible and even not desired for the tug pilot to constantly monitoring the rear-view mirror. Moreover the mirror's position is approx. 1 meter away from the cockpit, so impossible to include this in a quick instrument scan by the pilot. He really has to turn his head to the left for this.

[4] Glider/Tow-plane Upsets by Frank Irving. Imperial College of Science and Technology, England. Presented at the XIX OSTIV Congress, Rieti, Italy (1986)

2.3 Tug upset contributing factors

From the BGA reference documentation, factors which can combine to create a tug-upset accident are:

- *a light pilot flying close to the minimum cockpit weight*

The pilot has a weight of 62kg, but uses a ballast weight of 10kg to compensate.

- *an inexperienced pilot - particularly wire launch pilots with little recent aerotow experience.*

The sailplane pilot has a mixed experience, wire and aerotow. However his last flight on aerotow with this type of sailplane was performed 2 months before. He was unfamiliar with the new type of tug aircraft.

- *short rope*

The tow cable was 40 m long, in compliance with the Belgian CAA specifications found for Belgian-registered tug aircraft. The BGA and the reference documentation recommend a cable length of 55-60m .

The length of the tow cable in itself is not a critical factor, except that for the same vertical deviation, the angle of the tow cable between the tug aircraft and the sailplane will be greater when the cable is shorter. Therefore, the reaction time required to correct the deviations will also be shorter. Compared to a 40-meter tow cable, using a 60-meter cable would take the glider one and a half times (cable ratio 3:2) longer to travel the same (vertical) distance. Considering the time frame for the so-called slingshot phenomenon to takes effect, a 40-60m cable length difference would translate in a reaction time difference of 2-3 seconds versus 3-5 seconds.

- *turbulent conditions*

The wind was not turbulent but it was cross (190 degrees for a runway oriented 110 degrees), requiring lateral control of the sailplane.

- *glider with a belly or CG hook / Gliders with high-set wings relative to the towing hook*

The sailplane is not equipped with a nose hook and the cable was attached to the CG hook. This will induce a natural tendency of nose-up attitude and for the sailplane to move up.

A CG hook, as compared to a nose hook, makes a crosswind take-off more difficult since the glider can weathervane into the wind more easily. In addition, a CG hook makes the glider more susceptible to kiting on take-off, especially if the CG is near the aft limit. This can present a serious danger to the towplane during the aerotow[5].

- *an all-flying tailplane, or a glider with very light elevator forces*

The Schleicher Ka-6E is equipped with an all-moving elevator.
An all-moving elevator (also known as a constant-chord elevator) in a sailplane has the disadvantage of decreased pitch stability.

2.4 Why this flight went wrong ?

The type of sailplane used and the condition of operation, as seen hereabove, were combining most of the contributing factors potentially leading to the phenomenon of tug upset. On the other end, both pilot were qualified and had experience on aerotow.

One factor did change with respect to the previous flights; the tug aircraft type changed, from a 180 HP – 600kg Robin DR400 to the 235 HP 662kg PA-25 Pawnee. As outlined by the tug aircraft pilot, during the pre-flight briefing, the major difference between the two aircraft would be the steeper angle of climb, the higher rate of climb and the initial acceleration. In addition, should the sailplane fly in the propeller wake, the flow induced by the PA-25 propeller would be more important than the one of the Robin DR400 and, combined with the all-moving elevator, have an influence on the controllability of the sailplane.

The pre-flight briefing did outline these differences and the importance of the key safety factor during the take-off and initial climb to keep a constant eye on the tug airplane, to keep it in the same relative position in order to be able to respond immediately to changes in pitch attitude and course. The briefing did not address the emergency procedures to apply in case of problem.

During take-off, the new situation caught the sailplane pilot off-guard, giving him little time to anticipate. He applied corrections during the take-off, but these corrections were insufficient to prevent the kiting of the glider behind the tug aircraft, owing to the critical aspects of the K6-E and the speed at which the event evolved. Once the kiting movement was initiated, the only action remaining possible was to release the tow cable, which was not done early enough to prevent the tug upset.

As the pilot of the tug airplane rightly stated;
“This event occurred very fast ; there is very little time to think and act. It is therefore very important to know the memory items. A pre-flight briefing before each flight is very important in order to be able to recognize the situation and act immediately.”

[5] Federal Aviation Administration's Glider Flying Handbook, FAA-H-8083-13A, section "CG Hooks"

3. CONCLUSIONS

3.1 General findings

- The tug aircraft was airworthy
- The pilot of the tug aircraft was licenced and qualified for the flight
- All damage to the tug aircraft was due to the impact, no pre-impact failure found that could declare the ineffectiveness of the elevator and subsequent dive
- The sailplane was airworthy
- The pilot of the sailplane was licenced and qualified for the flight
- The tow cable was 40 m long
- The tow cable was not equipped with weak links
- The sailplane's POH defines specifications (min – max values) for weak links.
- The regulation requires the use of check lists prior to each flight, based on a risk assessment.

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3.2 Findings as to causes and contributing factors

- The sailplane pilot's lack of situational awareness allowed the situation to develop and his corrective actions were unsuccessful. (direct causal factor)

- The tow cable was released by both the tow plane and the sailplane, nearly simultaneously, however too late to avoid the tug aircraft to be upset. (contributing factor to the outcome)

- The attention of the tug airplane pilot is divided between flying the aircraft and reacting upon his feeling of the actions of the towed sailplane. To the contrary of the sailplane pilot, he cannot maintain a constant monitoring of the sailplane position. (contributing factor)

The sailplane type and the conditions of the aerotow makes the risk for tug upset higher with the Ka 6E than with other sailplane types. (contributing factor)

3.3 Finding as to risks

- The tow cable was not equipped with weak links rated to the values defined in the aircraft's POH. A weak link is essential to provide a protection against very steep glider attitudes at low rope angles.

4. SAFETY ACTIONS AND RECOMMENDATIONS

As stated under chapter 1.17.1 of this report, according to the regulation it is the individual pilot-in-command that is responsible to conduct a thorough risk assessment of the operation and develop checklists. However, as aeroclubs are organisations gathering persons -who are principally pilots - sharing the same interest, the AAIU(Be) believes it is the organisation's task to take, as a peer, a leading role in the performance of such a risk assessment and the establishment of standardized checklists.

Therefore;

Safety message: risk assessment and management in aerotow operations

The AAIU(Be) reminds all organisations and their pilots performing glider towing, in line with the regulation, to conduct a thorough risk assessment of the operation. Further, before each flight, the concerned pilots (tug aircraft and sailplane pilot) need to hold a briefing, on the basis of the developed checklists, on all the safety aspects of the operation with the combination tug aircraft / sailplane considered, including revised emergency procedures to cope with any unforeseen situations arising from changes introduced – like in this case, a new tug aircraft type.

ABOUT THIS REPORT

General	
What?	Safety investigation reports are a technical document that reflects the views of the investigation team on the circumstances that led to the accident or serious incident and is conducted in accordance with Annex 13 to the Convention on International Civil Aviation and Regulation (EU) No 996/2010.
Objective	**The sole objective of safety investigations is the determination of the causes, and to define safety recommendations in order to prevent future accidents and incidents. It is not the purpose of this investigation to apportion blame or liability.** In particular, Article 17-3 of Regulation (EU) 996/2010 stipulates that the safety recommendations made in this report do not constitute any suspicion of guilt or responsibility.
Investigation authority	The Air Accident Investigation Unit of Belgium (AAIU(Be) for the rest of this publication). It is the Belgian permanent national civil aviation safety investigation authority as defined in Article 4 of Regulation (EU) No 996/2010 and established in accordance with the Royal Decree of 8 December 1998. This unit is part of the Federal Public Service Mobility and Transport and is functionally independent from the Belgian Civil Aviation Authority and other interested parties.
This investigation	
Investigation initiation	AAIU(Be) was notified of the occurrence by the airfield commander at 13.30 UTC on the date of the accident. Two investigators deployed and arrived at 16.00 UTC at the crash scene to start the investigation
Scope	**Extended** As per ICAO Annex 13 and EU regulation EU 996/2010, decisions regarding whether to conduct a civil aviation safety investigation, and the extent of an investigation, are based on many factors, including the level of safety benefit expected to be drawn from such an investigation. For this occurrence, an extended investigation was performed concluded with a thorough analysis covering several aspects of the operation.
Other parties involved	The AAIB UK for the State of Registry, the Argentinian SIA for the State of design of the PA-25 aircraft, the German BfU for the State of Design of the sailplane and the Belgian General Directorate for Air Transport.
	AAIU(Be) would like to thank the mentioned parties above and all other entities and individuals that have contributed to this safety investigation.