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Swiss Transportation Safety Investigation Board STSB

Final Report No. 2290 by the Swiss Transportation Safety Investigation Board (STSB)

Concerning the accident involving the aircraft Maule MX-7-235, HB-KDF,

on 18th July 2015

Münster airfield (LSPU) / VS

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Ursachen

Der Unfall ist auf einen Kontrollverlust während eines Durchstartmanövers mit unzweckmässiger Konfiguration des Flugzeuges zurückzuführen.

Die Untersuchung hat folgenden Faktor ermittelt, der die Entstehung und den Verlauf des Unfalls zwar nicht beeinflusst hat, der aber dennoch ein Sicherheitsrisiko *(factor to risk)* darstellt:

- im oberen Bereich der Kabine waren die Steuerseile der Querrudersteuerung neben zwei Umlenkrollen geführt.

General information on this report

This report contains the Swiss Transportation Safety Investigation Board's (STSB) conclusions on the circumstances around and causes of the accident under investigation.

In accordance with article 3.1 of the 10th edition of annexe 13, effective from 18th November 2010, to the Convention on International Civil Aviation of 7th December 1944 and article 24 of the Federal Aviation Act, the sole purpose of an aircraft accident or serious incident investigation is to prevent further accidents or serious incidents from occurring. Legal assessment of the circumstances and causes of aircraft accidents and serious incidents is expressly excluded from the aircraft accident investigation. It is therefore not the purpose of this report to establish blame or to determine liability.

Should this report be used for purposes other than those of accident prevention, this statement should be given due consideration.

The German version of this report constitutes the original and is therefore definitive.

All information, unless otherwise indicated, relates to the time of the accident.

All of the times mentioned in this report, unless otherwise indicated, are given in local time (LT). For the region of Switzerland, Central European Summer Time (CEST) was the local time at the time of the accident. The relationship between LT, CEST and coordinated universal time (UTC) is:
LT = CEST = UTC + 2 h

Final Report

Aircraft type	Maule MX-7-235	HB-KDF
Operator	Winterthur Gliding Club, 8400 Winterthur, Switzerland	
Owner	Winterthur Gliding Club, 8400 Winterthur, Switzerland	

Pilot	Swiss citizen, born 1959			
Licence	Private pilot licence aeroplane (PPL(A)), according to the European Aviation Safety Agency (EASA), issued by the Federal Office of Civil Aviation (FOCA)			
Flying hours	**Total**	1571 h	**During the last 90 days**	20 h
	On the accident type	353 h	**During the last 90 days**	5 h

Location	Münster airfield (LSPU) / VS		
Coordinates	663175 / 148305	**Altitude**	1,342 m AMSL
Date and time	18th July 2015, 10:57		

Type of operation	Visual flight rules (VFR), private
Flight phase	Go-around
Type of accident	Loss of control

Injuries to persons

Injuries	Crew members	Passengers	Total no. of occupants	Third parties
Fatal	0	0	0	0
Serious	0	1	1	0
Minor	1	2	3	0
None	0	0	0	n/a
Total	1	3	4	0

Damage to aircraft	Destroyed
Third-party damage	Minor damage to the ground

1 Factual information

1.1 Background and history of the flight

1.1.1 General

The following description of the background and history of the flight is based on the statements made by the pilot and eyewitnesses, as well as recordings by the Sky-Map flight software on the pilot's tablet computer and by the EDM 700 engine data monitoring system.

1.1.2 Background

The Winterthur Gliding Club frequently used the aircraft Maule HB-KDF as a tow-plane during the Münster gliding camp. The pilot had participated in the gliding camp for many years. He usually acted as a tow pilot for two weeks, and this was also the plan for 2015.

As the pilot had not flown this aircraft type since the 2014 gliding camp, he completed a training flight including a few landings in the Maule with another pilot on 2nd July 2015. They were accompanied by a pilot from the Winterthur Gliding Club who acted as a safety pilot. There is no evidence that go-around manoeuvres were practised during this training flight.

That year, he had been in Münster since 11th July 2015 and carried out the tow flights together with another pilot from the club.

The accident flight was a local sightseeing flight over the Alps with three passengers on board.

1.1.3 History of the flight

The Maule MX-7-235 aircraft, registered as HB-KDF, took off from runway 05 at Münster airfield (LSPU). At this time, there was a light wind of around 5 kt blowing down the valley.

After a local flight of one and a half hour, the aircraft entered left downwind for an approach to runway 23. The pilot noticed a strong wind that had developed during the flight. He decided to carry out the approach with the flaps fully extended. During the flare, approximately half a metre above the runway, the aircraft was caught by a strong gust of wind. This lifted the left wing and the aircraft drifted towards the right runway edge.

The pilot then applied full throttle and initiated a go-around. According to the pilot, the aircraft was turned further to the right during this phase (see illustration 1). He tried to counteract the turn, but did not succeed. The pilot retracted the flaps by one notch. He did not manage to retract them fully. When the aircraft heading was almost perpendicular to the course of the valley, the tailwind component increased. The aircraft continued to turn further up the valley. The maximum altitude estimated by the pilot was approximately 80 metres above ground. The pilot realised that a collision with the upward-sloping terrain could no longer be avoided and tried to soften the impact as far as possible. In the final moment before impact, he turned off the battery master switch.

The aircraft's right wing impacted the ground first; the aircraft then rolled over and ended up lying on its side.

The pilot and the two passengers in the rear seats suffered minor injuries and were able to exit the wreckage without help. The front-right passenger had to be extracted from the wreckage by the rescue crew. Fire did not break out.

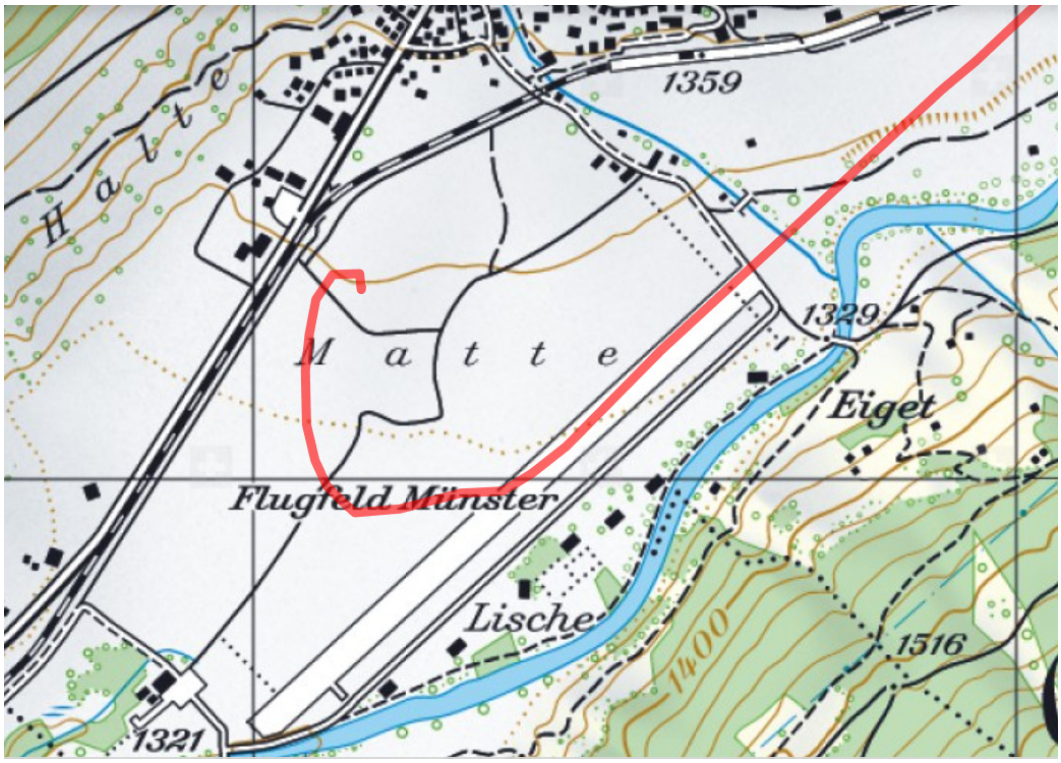

Illustration 1: The last phase of HB-KDF's flight path (red), as recorded by the Sky-Map software on the pilot's tablet (base map reproduced with permission from the Swiss Federal Office of Topography Swisstopo (JA150149)).

1.2 Meteorological information

1.2.1 General weather conditions

The Alpine region was in a wide-open warm sector with a south-westerly upper air flow. A convergence line extended from the Massif Central over the Jura Mountains and southern Germany as far as Poland.

1.2.2 Weather at the time and location of the accident

Two thunderstorms formed along this convergence on early Saturday morning and drifted in a north-easterly direction, causing rainfall. The highest rainfall – up to 40 mm – was measured along the southern foot of the Jura Mountains.

The second area of rainfall was oriented north-south and extended from Central Valais to the Vosges mountain range at 11:00. The turbulence in the area surrounding Münster airfield was caused by a combination of several factors. The onset of rainfall in the west and north-west of the Goms region played a critical role. This caused an increase in turbulence across the valley and subsequently created an airstream opposite to the original wind direction at ground level in the Goms region.

Weather	cloudy and dry
Cloud	8/8 altostratus at approx. 4,500 m AMSL
Visibility	60 km
Wind	Strong gusty wind blowing up the valley with peak gust speeds of up to 30 kt

Temperature / dew point	18° C / 9° C	
Atmospheric pressure QNH	1023 hPa	
Hazards	Gusts of wind	

1.2.3 Astronomical information

Position of the sun	Azimuth: 115°	Elevation: 49°
Light conditions	Daytime	

1.2.4 Weather according to observations of eyewitnesses

According to statements made by other club members, the sky was cloudy at the time of the accident. Visibility, however, was good and there was no rainfall. There was a quite strong gusty wind blowing up the valley. Because of these unusual wind conditions, the other club members were watching the approach of the HB-KDF more closely.

1.3 Information on the aircraft

1.3.1 General

Specification	Four-seater, single-engine high wing aircraft with fixed main landing gear and tailwheel
Manufacturer	Maule Air Inc., Moultrie, Georgia, USA
Year of manufacture	1992
Engine	Lycoming IO-540-W1A5D Air-cooled, four-cylinder horizontally opposed engine, serial number L-28075-48A, year of manufacture 1992, continuous power 175 kW (235 HP) at 2,400 rpm
Operating hours	Airframe: 3304 h (TSN[1]) Engine: 3224 h (TSN)
Max. permissible take-off mass	1134 kg
Mass and centre of gravity	Both mass and centre of gravity were within the permissible limits of the aircraft flight manual (AFM)
Technical restrictions	None
Fuel quality at the time of the accident	According to the analysis, the fuel conformed to the specifications for aviation fuel AVGAS 100LL
Fuel quantity	The fuel quantity on landing was 77 litres
Airworthiness review certificate	Issued by FOCA on 5th September 2014
Type of use	Private VFR[2] by day and night, glider towing flights

[1] TSN: time since new

[2] VFR: visual flight rules

1.3.2 Aircraft maintenance

Maintenance work was carried out by a certified company.

The last 100-hour inspection was completed and certified on 18th December 2014 at 3203:56 airframe operating hours. According to work report 1411-480 P4, the left and right aileron control cables were replaced and adjusted at the front and the wing during this inspection.

The last 50-hour inspection was completed and certified on 21st May 2015 at 3251:16 airframe operating hours.

1.3.3 Information on operating the flaps

The aircraft flight manual (AFM) provides the following information regarding the operation of the flaps:

"*3.3 Normal Flight Operations:*

A. Flap Settings

The following flap settings are available:

Flap configuration	*Flap handle position*	*Flap position*
Cruise	*Handle full down*	*-7°*
Flaps up	*First notch*	*0°*
Take-off	*Second notch*	*24°*
Landing	*Third notch*	*40°*
Landing	*Fourth notch*	*48°*

B. Recommended Flap Settings:

Flap settings are given in number of notches above the fully retracted position, which is handle full down (normal -7°).

[…]

Normal take-off – second notch (24°)

Normal climb – first notch (0°)

Best angle of climb – second notch (24°)

Cruise – fully retracted (-7° / no notches or 0° / 1st notch)

Landing – normally fourth notch (48° / full flaps) – other positions optional"

The AFM contains the following chapter regarding crosswind landings:

"F. Crosswind Landings and Takeoffs:

Maximum demonstrated crosswind component is 12 kt (14 MPH) and flap extension should be limited to 0° (one notch) or -7° (handle full down) with such crosswind or higher. 12 kt (14 mph) is the maximum demonstrated for certification of the airplane and is not considered limiting with flaps at 0°."

The go-around procedure is not described in the AFM.

A go-around with the flaps fully extended is challenging as the increase in engine power causes a strong pitch-up moment, which has to be compensated by pushing forward strongly on the elevator control, to prevent the aircraft from transitioning into an extreme climb. If this manoeuvre is carried out using both hands, it is necessary to change hands when retracting the flaps, and the control yoke has to be operated using the left hand only.

During the training flight on 2nd July 2015, the two pilots also discussed the use of the flaps with the safety pilot, who is said to have stated that he almost always lands the HB-KDF with fully extended flaps. As a result of this statement, the pilot chose this position during the accident flight, even though he was aware of the prevailing strong winds.

1.4 Information on people concerned

1.4.1 Accompanying pilot

The pilot who accompanied the two tow pilots during their training flights in Winterthur was not a certified flight instructor. He was, however, very familiar with the aircraft and local conditions on the airfield. The decision was therefore made that he would accompany every pilot on a short flight as a safety pilot, with the main goal to perform a few landings. The Winterthur Gliding Club requires its tow pilots to perform three landings with the Maule aircraft model at the beginning of the season.

The safety pilot confirmed that he usually landed with fully extended flaps. He was, however, fully aware of the challenges created by crosswind landings and stated that in this case, the aircraft should be landed with retracted flaps. He also stated that a go-around with fully extended flaps was a very challenging manoeuvre because the aircraft had a strong tendency to pitch-up in this situation. This required a lot of force and the control yoke would have to be pushed forward using both hands.

1.5 Information on the wreckage, the impact and the accident site

1.5.1 Accident site and impact

The accident site was located approximately 350 metres north-east of the middle of the runway. The first impact marks were 42 metres before the final position of the wreckage.

1.5.2 Wreckage

Illustration 2: Final position of wreckage

Observations made on the wreckage include:

- Lap and shoulder belts were worn. The shoulder belt mechanism of the front-left seat did not withstand the impact forces and was torn out from the tubular structure of the fuselage front-section. This injured the pilot's ear.
- Both wings were partially separated from the fuselage and laid on top of each other next to the upper side of the fuselage. The flap of the right wing was found in a position of approximately 24°. The flap of the left wing was found at 0°. Marks on the fuselage show that this position had changed during impact.
- The flap control lever was found in the -7° position. This may have been moved into this position when the occupants were rescued.
- The elevator trim indicator was in the 'nose-down' position.
- The position of the fuel tank selector could not be determined due to the degree of damage.
- One propeller blade had dug itself into the ground and another was bent. The third propeller blade showed only minor damage.
- The ignition switch was turned off.
- The electrical switches on the instrument panel, including the battery master switch, were switched off.
- The power, propeller speed and mixture control levers were all pushed forward.
- The emergency locator transmitter (ELT) was in the 'armed' position and had been activated by the impact.
- In the upper section of the cabin, the aileron control cables were routed outside of two pulleys.

1.6 Examination of the aileron control system

1.6.1 Layout of the cable routing

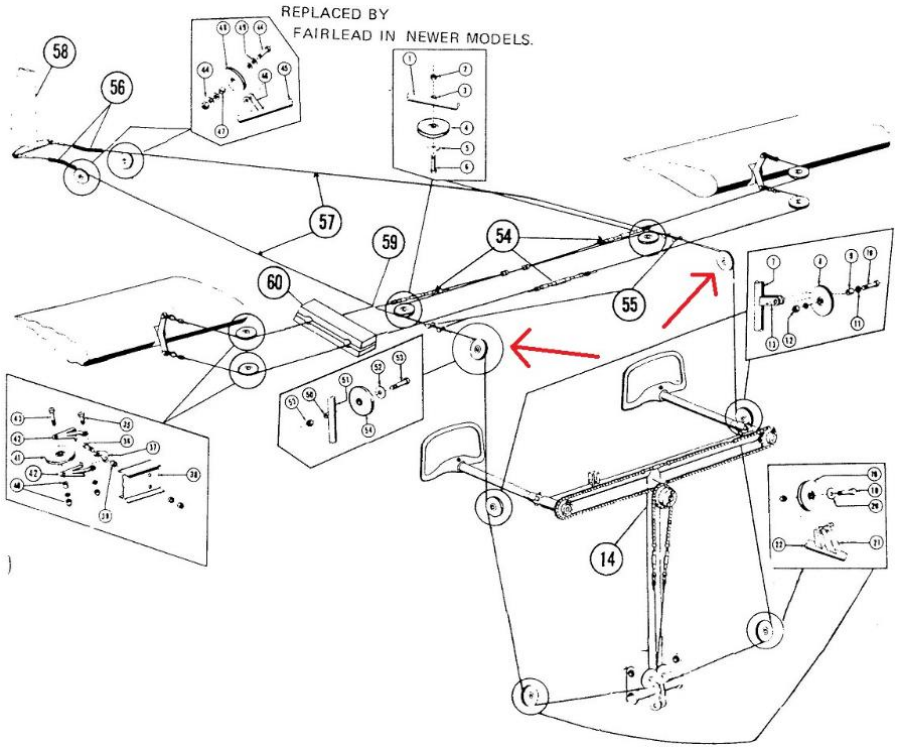

Illustration 3: Diagram showing the cable routing. The red arrows indicate the two pulleys where the control cables were incorrectly routed.

The control cables are moved by the two control yokes using a chain-mechanism. In the rear section of the cabin roof, the two control cables are spliced together and connected to the control cables which lead to the ailerons. Up to the splice, the two control cables are guided on the left- and right-hand side within the cabin via five pulleys each.

1.6.2 Defects found in the cable routing

After the accident, it was established that the control cables were not routed to run in the groove of the pulley, but between the pulleys (see Illustration 3, illustration 4 and illustration 5) and the fuselage's tubular structure. Abrasion marks on the spacer discs of both pulleys showed that the aileron control cable had been running outside of the pulley's groove for a prolonged period of operation.

Illustration 4: Control cable outside the front top-left pulley's groove

Illustration 5: Control cable outside the front top-right pulley's groove

During the last approximately 100 flying hours, the yoke movements moved the control cables over the two tube sleeves, on which the pulleys were mounted. The diameter of these sleeves was approximately 20 mm. A 2-mm-deep groove could be found on both tube sleeves. Both control cables were severely deformed, worn and exhibited wire breaks at this point (see illustration 6 and illustration 7).

Illustration 6: Damaged control cable where in contact with the front top-left pulley

Illustration 7: Damaged control cable where in contact with the front top-right pulley

1.6.3 Replacement of the aileron control cables by the maintenance company

According to statements made by the maintenance company, they replaced the control cables during the 100-hour inspection on 18th December 2014. The company agrees that the defect found is a result of this maintenance work.

Replacing the control cables in the Maule MX-7-235 aircraft is a complex and challenging job, since the access is very limited. The new cable was fed in, using a feeding tape. As not all pulleys are visible, correct routing of the cable into the respective pulley has to be checked by touch.

After feeding in the cables, the rope thimbles were spliced and the turnbuckles were fitted. Free movement of the cable was checked continuously. After all cables had been installed, the cable tension was adjusted (rigging) and the correct function of the ailerons was verified. According to the standard procedure after cable replacement, the cable tension was rigged a little tighter, i.e. set to the upper tolerance limit.

1.6.4 Operation of the aircraft after cable replacement

After the subsequent test flight, the operator's technical pilot accepted the aircraft as operational. However, he noticed a slightly increased resistance of the aileron control. In consultation with the maintenance company, this was accepted as normal cable tension after cable replacement if set to the upper tolerance limit.

The aircraft was subsequently flown for 50 hours without any complaints regarding the function of the ailerons. The pilots criticised the slightly increased aileron control forces, which caused the maintenance company to decrease the cable tension to the middle of the permissible tolerance during the next 50-hour inspection. After this, no further comments were made by the pilots regarding the control forces of the ailerons.

Another tow pilot, who had flown the HB-KDF in the days leading up to the accident in Münster, did not notice any anomalies in the aircraft's controllability.

1.7 Data recording system

The aircraft was equipped with an EDM 700 engine data monitoring system.

It was possible to download the engine data up until the accident from the EDM. No anomalies regarding engine parameters were found in the data. Notably, the engine parameters when the accident flight took off were almost identical to the values recorded during the subsequent go-around.

From this, it can be concluded that normal engine power was also available during the go-around.

In the final 2 seconds before impact, the EDM recorded a decrease in rpm speed and exhaust gas temperature. This indicates that the pilot reduced the engine power or switched off the engine when the crash-landing was unavoidable.

2 Analysis

2.1 Technical aspects

2.1.1 General

Apart from the aileron control cables being incorrectly routed, there is no evidence of any technical faults which could have caused or influenced the accident.

2.1.2 Routing of the aileron control cables

It is safe to assume that the full aileron deflection was was available.

The HB-KDF had been flown for approximately 100 hours with incorrectly routed aileron control cables. The pilots noticed a slight increase in friction, however this did not seem to affect controllability of the aircraft.

2.2 History of the flight and flight tactics

On downwind the pilot noticed a strong wind that had developed during the flight. He decided on an approach to runway 23 with the flaps fully extended. According to the pilot, this decision was made based on his experience during the earlier training flight.

Before the approach to Münster airfield, it began to rain in the west and north-west of the Goms region.

Some of the rain which falls into a dry air mass evaporates and cools the air. The intensity of the rainfall and the cooling lead to differences in density within a small area. These differences encourage turbulence in the valley's airmass. As a result, the gustiness increases. Combined with the complex topography, this represents a wind field that varies in three dimensions.

This can result in a considerable movement of air in a vertical and lateral direction, which differs significantly from an average wind field.

By fully extending the flaps to a position of 48°, the aircraft can be flown at a lower speed. However, the large surface of the aircraft's flaps makes it considerably more sensitive to wind gusts and the reduced speed before touchdown significantly reduces the effect of the ailerons.

The AFM therefore recommends landing with a flap position of 0° or -7° in cross-winds.

Shortly before touchdown, the aircraft was caught by a strong wind gust . This lifted the left wing and the aircraft drifted towards the right runway edge. The pilot therefore decided on a go-around, which was appropriate in this situation.

A go-around is a challenging flight manoeuvre in a Maule MX-7. Due to its high engine power, significant moments develop in the aircraft's yaw and pitch axes. The moment in the pitch axis is intensified when the flaps are fully extended. Maintaining a stable climb-attitude became challenging due to the large force that had to be pushed on the elevator control. This was further accentuated by the fact that it was necessary to change hands to retract the flaps. There is no evidence that go-around manoeuvres were practised during the training flight on 2nd July 2015. It can therefore be said that, at the time, the pilot had little training in the execution of go-around manoeuvres in this aircraft type.

Due to the reduced airspeed during the flare, the effect of the ailerons during the go-around was also limited. This contributed to the pilot not being able to keep the aircraft flying straight ahead in a stable manner.

These factors led to loss of control of the aircraft.

From the damage on the three propeller blades, it can be concluded that the engine was no longer providing any, or very little power on impact. This reduction in power has also been recorded in the EDM. The reduction in engine power and switching off the battery master switch shortly before impact had a favourable effect on the outcome of the crash-landing. It probably also contributed to the fact that fire did not break out.

The pilot predominantly carried out tow flights in this aircraft, during which he was the only person on board. He rarely carried out passenger flights and landings with a relatively heavyaircraft with an aft center of gravity. The higher total mass of the aircraft made the go-around more difficult.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft had the required permissions for VFR-traffic, including tow flights.
- Both mass and centre of gravity were within the allowable limits of the flight manual.
- During the last 100-hour inspection, the left and right aileron control cables were replaced and adjusted at the front and the wing.
- In the upper section of the cabin, the aileron control cables were routed outside of two pulleys.
- There is no evidence that the controllability of the aircraft was impaired.
- Data from the EDM 700 engine data monitoring system indicates that normal engine power was available for the go-around.
- The shoulder belt mechanism on the front-left seat did not withstand the stress of the impact and was torn out from the tubular structure of the fuselage's front. This injured the pilot's ear.

3.1.2 Human and operational aspectsThe pilot was in possession of the required licences for the flight.

- The aircraft took off from runway 05 at Münster airfield. At this time, there was a light wind of around 5 kt blowing down the valley.
- After a local flight of one and a half hour flight, the HB-KDF made a left downwind approach to runway 23 at Münster airfield.
- The pilot noticed a strong wind that had developed during the flight and decided on an approach with the flaps fully extended.
- The AFM recommends a flap position of 0° or -7° in crosswinds.
- During the flare, approximately half a metre above the runway, the aircraft was caught by a strong wind gust and drifted towards the right-runway-edge.
- The pilot applied full throttle and initiated a go-around. The aircraft was turned further to the right during this phase and the pilot tried to counteract the turn, but did not succeed.
- The pilot retracted the flaps by one notch. He did not manage to retract them fully.
- Due to the low airspeed, the effect of the ailerons was also limited during the go-around. This contributed to the pilot not being able to keep the aircraft flying straight ahead in a stable manner. These factors lead to loss of control of the aircraft.
- The reduction in engine power and switching off the battery master switch shortly before impact had a favourable effect on the outcome of the crash-landing.
- The pilot and the two passengers in the rear seats suffered minor injuries and were able to exit the wreckage unassisted. The front-right passenger, who was seriously injured, had to be extracted from the wreckage by the rescue crew.
- Fire did not break out.

- The pilot flew this aircraft type mostly for tow flights, but rarely with a high total mass or a centre of gravity in the rear section.
- During the training flight on 2nd July 2015, the use of the flaps was discussed with the safety pilot, who is said to have stated that he almost always landed the HB-KDF with flaps fully extended.
- There is no evidence that go-around manoeuvres were practised during the training flight on 2nd July 2015.

3.1.3 General conditions

- At the time of the accident, a strong gusty wind was blowing up the valley.

3.2 Causes

The accident was caused by loss of control during a go-around with inadequate aircraft configuration.

Although it did not influence the development of the accident, the following factor to risk was identified during the investigation:

- In the upper section of the cabin, the aileron control cables were routed outside of two pulleys.

4 Safety recommendations, safety advices and measures taken since the accident

4.1 Safety recommendations

None

4.2 Safety advices

None

4.3 Measures taken since the accident

None

This final report was approved by the Board of the Swiss Transportation Safety Investigation Board STSB (Art. 10 lit. h of the Ordinance on the Safety Investigation of Transportation Incidents of 17 December 2014.

Bern, 22 January 2018 Swiss Transportation Safety Investigation Board