DUTCH SAFETY BOARD

Crashed after banner pick-up, Piper PA-25-235 Pawnee

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The Hague, May 2021

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Cover photo: De Haan

The Dutch Safety Board

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N.B. This report is published in English, a summary is available in the Dutch language. If there is a difference in interpretation between the Dutch and English version, the English text will previal.

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SUMMARY

On 31 May 2018 just before 11.00 hours local time, a Piper PA-25-235 Pawnee took off from Breda International Airport (Seppe) for a banner towing flight. Within the local circuit, the pilot positioned the aeroplane to pick up the banner. Shortly after the pick-up, the aeroplane lost airspeed and started to descend. Just outside the airport boundary, it fell over its right wing and impacted the ground in an almost vertical attitude. The pilot was fatally injured. The aeroplane was destroyed by the crash and subsequent fire.

This accident was the operator's fourth incident or accident in a period of five years. Therefore, the Dutch Safety Board investigated a broad range of factors and system elements in this accident. The investigation answers three questions. What was the cause of the crash? How did the operator's safety management contribute to safe operations? And what systemic factors were related to the accident?

The following conclusions were drawn. First, the aeroplane stalled and crashed because it was equipped with an improper propeller for banner towing operations. As the aeroplane was flying slowly and the engine did not have enough power to produce sufficient rpm, the propeller could not produce enough thrust for the aeroplane to safely accelerate and climb after the pick-up of the banner. Furthermore, the aeroplane was flown above its maximum take-off weight, which worsened the thrust deficient situation. In this unsafe situation, the experienced pilot had no options to seize back control of the aeroplane.

Second, the operator's safety management was characterized by a neglect of safety risks in maintenance and flying operations. Safety responsibilities were delegated to the maintenance organisation, the on-demand hired engineer and the pilots. Furthermore, the operator did not foster an environment where safety was an integral part of maintenance and flying operations. In this environment it was possible that: 1) an improper propeller was fitted on the aeroplane; 2) the limitations of the aeroplane and propeller were not sufficiently known to the operator and pilots; 3) the aeroplane was used for banner towing for more than six years while not having a supplemental type certificate for banner towing operations and without having authorized banner towing limitations; 4) there was no assessment of operational performance of the aeroplane after the installation of the fuselage fuel tank and the installation of the 4-blade propeller; and 5) the pilot's survivability in case of a crash and post-crash fire was reduced by the installation of an additional fuselage fuel tank. These shortcomings signify that the certification and operational limitations of aeroplanes are not just obligatory requirements that can be taken for granted, but they are essential for ensuring safe operations and the wellbeing of personnel.

Third, the Human Environment and Transport Inspectorate (ILT) did not perform active oversight on the operator from the moment it was founded in 2008 until the day of the accident. The long history of safety deficiencies of the operator would have justified an

active role of the inspectorate. This history of unnoticed deficiencies, signifies the importance of active oversight in the general aviation sector to identify and reduce the safety risks for specialized operations and third parties.

In an earlier investigation, the Dutch Safety Board noticed a reluctance to report unsafe situations in the general aviation sector.[1] This investigation, unfortunately, provides further proof of this lack of reporting of unsafe situations. No occurrence reports were submitted to ILT, despite the operators' history of safety deficiencies and the serious concerns in the sector associated with this operator. The Dutch Safety Board emphasizes the importance to report unsafe situations to ILT. In this way every person involved can contribute to the safety of aviation. This also requires an active role and a responsive attitude of ILT in supervising and monitoring the sector.

1 Dutch Safety Board, *Fatal aircraft accident in low flying area Gouda*, 22 May 2018.

RECOMMENDATIONS

Specialized operations (SPO) inherently have an increased level of risk for operators, pilots and third parties. SPO operations such as banner towing, are governed by Regulation (EU) No 965/2012 and (EU) No 379/2014. These SPO regulations aim to increase the operators' level of safety and provide the member states with guidelines for effective oversight. The regulation on SPO has been in place since 1 July 2014 and became effective on 21 April 2017.

The Dutch Safety Board noticed a reluctance to report unsafe situations in the general aviation sector in this investigation and in an earlier investigation. To improve the reporting of unsafe situations within aviation companies and to the Aviation Occurrence Analysis Agency (ABL) of the Human Environment and Transport Inspectorate (ILT), every person involved in the general aviation sector is called upon to report unsafe situations and so to contribute to aviation safety.

To promptly increase and ascertain the level of safety in the SPO sector, the Dutch Safety Board makes the following recommendations.

To CNE Air:

1. Implement a fit for purpose safety management system to ensure that maintenance and operational hazards are known and that risks are managed. Make sure that the responsibility for safety management is appropriately appointed within the company. Finally, foster communication within the company and with people who work with the company, such as hired pilots and technicians, about operational safety matters.

To the Minister of Infrastructure and Water Management:

1. Improve the level of safety in the sector of Specialised Operations (SPO) and the safety of third parties by setting up and implementing an effective oversight program. The oversight program should include flight, ground and ramp inspections.

2. Strengthen the current ILT oversight capacity on SPO operators to match the array of oversight activities as demanded by European regulation. At a minimum, the goal must be to have all SPO operators entered in the oversight program and adequately inspected before March 2022.

To Specialised Operations Operators:

1. Specialised Operations (SPO) operators are urged to apply pertinent lessons from this accident to improve the safety of their operations.

J.R.V.A. Dijsselbloem
Chairman Dutch Safety Board

C.A.J.F. Verheij
Secretary Director

ABBREVIATIONS

CAA	Civil Aviation Authority
CAMO	Continuing Airworthiness Management Organization
CMPA	Complex motor-powered aircraft
CPL	Commercial Pilot Licence
EASA	European Union Aviation Safety Agency
EHSE	Breda International Airport (Seppe)
EHWO	Woensdrecht Air Base
FAA	Federal Aviation Administration
IAS	Indicated airspeed
ILT	Human Environment and Transport Inspectorate
In	Inch
IR	Instrument Rating
Kg	Kilogram
KIAS	Knots indicated airspeed
Km/h	Kilometres per hour
KNMI	Royal Netherlands Meteorological Institute
Knot (kts)	1 nautical mile per hour (1 kts = 1852 metres per hour)
LAPL	Light Aircraft Pilot License
METAR	Meteorological Aerodrome Report
Mph	1 mile per hour (1 mph = 1609 meters per hour)
NM	Nautical mile
NTSB	National Transportation Safety Board
PPL(A)	Private Pilot Licence (Aeroplanes)
Rpm	Revolutions per minute
SEP	Single Engine Piston
TAF	Terminal Aerodrome Forecast
QNH	Reference for barometric pressure
UTC	Coordinated Universal Time

GENERAL OVERVIEW

Identification number:	2018045
Classification:	Accident
Date, time of occurrence:	31 May 2018, 10.58 hours[2]
Location of occurrence:	Breda International Airport, the Netherlands (EHSE), formerly known as Seppe Airfield
Registration:	SE-KHF
Aircraft type:	Piper PA-25-235 Pawnee D
Aircraft category:	Single engine piston (SEP)
Type of flight:	Commercial banner towing
Phase of operation:	Climb out after picking up of banner
Damage to aircraft:	Destroyed
Flight crew:	One
Passengers:	None
Injuries:	Pilot, fatally injured
Other damage:	None
Light conditions:	Daylight

2 All times in this report are local times (UTC + 2).

1 INTRODUCTION

On 31 May 2018 just before 11.00 hours, a Piper PA-25-235 Pawnee crashed at Breda International Airport (Seppe), after it had picked up an advertisement banner for a banner towing flight. Banner towing operations are considered "specialized operations"[3] (SPO) with an increased risk. During banner towing, the aeroplane momentarily flies close to the ground while performing an abnormal manoeuvre to pick-up the advertisement banner with a specialized hook on a tow line. These operations form a risk for the pilot and for third parties. In earlier investigations into similar accidents, the Dutch Safety Board identified increased risks with banner towing operations.[4]

The operator of the banner towing flight, performed these operations for about ten years. In this period, the operator was involved in several incidents. Besides the fact that the investigation of this aviation accident is required by law, the risk involved with this type of operation and the operator's incident record were reasons for the Dutch Safety Board to investigate this accident.

The purpose of this accident investigation is to determine the contributing factors to the crash, to identify the relevant elements of the system wherein the accident took place and to draw lessons that can improve aviation safety. The questions for this investigation are:

- What was the cause of the accident?
- How did the operator's safety management contribute to safe operations?
- What systemic factors were related to the accident?

This investigation follows the ICAO Annex 13, Standards and Recommended Practices, for aircraft accident investigation. The investigation consisted of interviews, examination of the aeroplane's wreckage, a banner towing test flight and analyses of surveillance camera video images. For the analyses of the aeroplane's flight path, surveillance camera video images were used. The images were taken by three different cameras. The frame rate was 1 per 2 seconds, this was considered adequate for analysis. These video images show the aeroplane's flight path from the moment the aeroplane approached the banner pick-up location until the moment the aeroplane was outside the airfield boundary where the aeroplane crashed.

3 EASA, *Specialised Operations (SPO)*, Specialized operations means operations with aeroplanes such as aerial photography and agriculture.

4 Dutch *Safety Board, Crashed after pick up of a banner, Reims F172N, Teuge Airport, 2 June 2011; Collision in the air, Comco Ikarus C42B, Cessna 172N, Stadskanaal, 22 April 2006; Landed after engine quit, Christen A-1, Rotterdam Airport, 2004; Loss of flight control during pick up of banner, Aviat A-1 Husky, Rotterdam Airport, 2003; Emergency landing due to shortage of fuel, Aviat A-1 "Husky", 's-Gravendeel, 2002.*

In Chapter 2 the information gathered in this investigation is structured according to the ICAO Annex 13 report format. In Chapter 3 the analysis of the accident is described in three main themes: the accident, safety management factors and systemic factors. In Chapter 4 the findings and conclusions from the previous chapter are combined and listed. Chapter 5 offers recommendations. The appendices provide additional information and are particularly useful for operators in the general aviation sector.

2 FACTUAL INFORMATION

2.1 History of the flight

On 31 May 2018 the operator had an assignment for a banner towing flight near the town of Almere in the Netherlands. The planned take-off time was 10.00 hours and the planned duration of the flight was approximately four hours.

2.1.1 Flight preparation

The pilot of the aeroplane (SE-KHF) made preparations for the flight. He checked the weather[5] and informed the airport manager of his planned banner towing flight. The banner was prepared by the ground crew for pick up at the pick-up location of the airport. During the flight preparation, a thunderstorm front passed the airport which caused the take-off time to be delayed to 11.00 hours. After the thunderstorm front had passed, the flight preparations were resumed. The pilot discussed the location and duration of the banner flight with the owner of the company.

2.1.2 Take-off and circuit

SE-KHF taxied to runway 25 from where it took off at 10.56 hours. The pilot was in radio contact with Seppe Radio (120.655 MHz); the supporting ground crew was on this frequency as well. On downwind for the pick-up, the pilot released the tow hook, after being reminded to release it by the ground crew. He continued for a left hand circuit according to local procedures. Next, he approached the pick-up location for the banner.

Figure 1: Banner pick-up accident flight. (Source: De Haan)

5 The source of the weather information is unknown, only the fact that he checked the weather is confirmed by witnesses.

2.1.3 The accident

At 10.58 hours the aeroplane picked up the banner (see Figure 1). During the pick-up, the banner deployed normally. After the pitch up manoeuvre and levelling off, the aeroplane almost immediately began to lose altitude with a wings level and a nose high attitude. This is illustrated by the compilation of video stills in Figure 2. The aeroplane had its flaps in the up position during the pick-up manoeuvre. This is the normal flap setting for the pick-up manoeuvre and climb out. The aeroplane continued to fly in a descending flight path veering slightly to the left, passing over a residence bordering the airport at approximately 100 feet (see Figure 3).

Figure 2: Video compilation of the moment of the banner pick-up and the descending flight path. (Source: Breda International Airport, modified by the Dutch Safety Board)

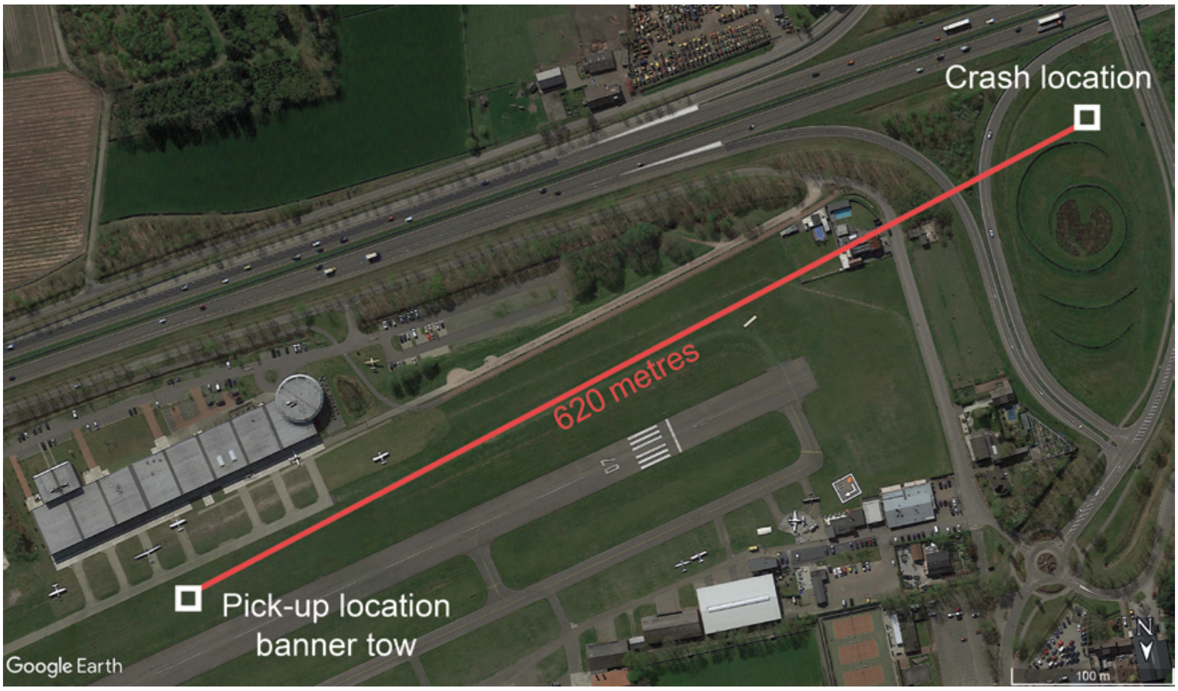


Figure 3: The grass strip, banner pick-up point and the crash location at Breda International Airport. (Source: Google Earth)

At approximately 100 metres west of the residence and slightly left of the grass strip's extended centreline, the pilot released the banner. Immediately after that, the aeroplane rolled over its right wing and crashed with an almost vertical nose down attitude just outside the airport boundary on the grassy slope of a highway ramp area. The released banner fell in the yard of the residence.

2.1.4 First response

The fire crew was dispatched by the airport manager, who witnessed the accident. By the time the fire crew arrived at the crash location, the aeroplane was on fire. Because of the intensity of the fire, rescue activities could not be performed.

Figure 4: Wreckage of SE-KHF. (Source: Dutch Aviation Police)

2.2 Injuries and damages

The pilot suffered fatal injuries. The aeroplane was destroyed as a result of the crash and subsequent fire (see Figure 4).

2.3 Personnel information

The pilot was a 62 year old male. He held an EU Commercial Pilot Licence (CPL) with the following ratings: IR, Banner Towing, Sailplane Towing and SEP valid until 30 June 2019. The first issue of his CPL was on 7 February 2010. He also held ratings for flight instruction for Aerobatic, Banner Towing, Night, LAPL, PPL, CPL, and Sailplane towing. These ratings were valid until 31 December 2018. The medical class certificate 1 was valid until 28 September 2018. Hence, the pilot had a valid pilot licence and a valid medical certificate at the time of the accident.

The pilot had 5,137 flight hours as pilot in command. In the five days before the accident, he had flown 3 hours and 40 minutes. According to the aeroplane's logbook, the pilot's last flight in SE-KHF before the accident was on 21 May 2018. The pilot was considered experienced with the Piper Pawnee. He had 830 flight hours banner towing on various types of aeroplanes and possessed an instructor rating for banner towing.

The pilot worked independently and was hired by the operator for the flight. The pilot worked for the operator frequently. Besides, the pilot owned an aviation company which conducted commercial special operations.

2.4 Aircraft information

The Piper PA-25-235 Pawnee is a single engine piston, single-seat, low wing aeroplane. It has a fixed landing gear with a tailwheel (see Figure 5). The aircraft has a steel tube fuselage with fabric covering. The wings and tail are also fabric covered. The Piper Pawnee was originally designed and used for agricultural purposes. As of the 1980s, it also came in use as a towing aeroplane for gliders and advertisement banners.

2.4.1 General information

The aeroplane was registered in Sweden as SE-KHF since 23 January 1989. On 19 March 2012, the aeroplane was purchased by the Dutch operator from a Swedish owner. The operator used the aircraft primarily for banner/glider towing in the Netherlands. Before 1989, the aeroplane was flown by different owners in the United Kingdom and the United States of America.

2.4.2 Aeroplane type certificate and airworthiness

SE-KHF had a certificate of airworthiness valid until 21 May 2019. The SE-KHF's Aircraft Flight Manual (7 February 1974) was based on type certificate TC-2A8 (FAA). To the aircraft flight manual, the following three supplements were added:

1. No S 3/79[6], concerning glider towing operations;
2. No M 4/79, concerning the use of alternate propellers;
3. EASA Minor Change Approval 10056774, concerning the installation of an additional fuel tank.

According to supplement No S 3/79 rev. 4, SE-KHF was certified for the towing of glider aeroplanes; this supplement does not refer to an authorization for banner towing as is discussed in Paragraph 2.4.5. The relevance of No M 4/79 is discussed in Paragraph 2.4.7 and the EASA minor change approval is discussed in Paragraph 2.4.9.

6 Swedish Transport Agency: Civil Aviation and Maritime, *SE-KHF, Supplemental Type Certificate No S 3/79 Revision 4*, 4 November 1992 (originally dated 30 October 1979).

2.4.3 Aeroplane technical data

Table 1: Aeroplane technical data.

Manufacturer	Piper Aircraft Corporation
Aircraft type	PA-25-235 Pawnee D
Year built	1977
Serial number	25-7756019
Motor type	Lycoming O-540-B2C5
Serial number	L-16615-40
Propeller type	Hoffmann HO 4/27 HM-185 125
Serial number	77746
Fuel capacity: • Wing tanks • Fuselage tank	38.5 US gal 38 US gal
Maximum take-off weight Normal category Restricted category • Swedish STC 3/79 (glider towing)	2,900 lbs (1,315 kg) 2,205 lbs (1,000 kg)

Figure 5: SE-KHF. (Source: Airport-data.com)

2.4.4 Aeroplane flight time

The total flight time of the aeroplane was 3,887 hours and 15 minutes. From 1 January 2018 until the day of the accident, the aeroplane flew six times, with a total of nearly 10 hours. The first flight in 2018 was on 10 February, followed by the next flight on 19 May 2018. Between 19 May 2018 and the day of the accident flight, the aeroplane had flown three banner towing flights and an out and back flight to an airfield where multiple glider towing flights were performed.

2.4.5 Weight and balance

As described in Paragraph 2.4.2, SE-KHF was not certified for banner towing operations. Therefore, it did not have certified weight and balance limitations for these operations added to the aircraft flight manual. To make an assessment of the aeroplane's operational performance during banner towing, the weight and balance limitations from a similar type aeroplane's flight manual[7] were used in this investigation.

The similar type aeroplane is a PA-25-235C. For this aeroplane, the maximum take-off weight for banner towing (restricted category) with a Hoffmann HO 4/27 HM-185, 115 propeller is 2,010 pounds (912 kilograms). The centre of gravity limits are as indicated in Appendix A.

The estimated take-off weight of SE-KHF was 2,341 pounds (1,065 kilograms), assuming the pilot's weight of 198 pounds (90 kilograms) and full wing and fuselage tanks. For this estimation, the aeroplane's basic empty weight of 1,689 pounds (770 kilograms) was used as derived from the most current weighing report, dated 25 February 2016.

The Swedish CAA issued an addendum dated August 1992 to the aeroplane's flight manual cautioning pilots for the hazards of a narrow centre of gravity envelope. The addendum was written in Swedish and stated amongst others that the centre of gravity was influenced significantly by differences in pilot's weight. It was possible for the centre of gravity to be outside limits in the case of heavy weight pilots. Therefore, pilots should pay extra attention maintaining the correct weight and balance. More information about the weight and balance and specifically the aeroplane's centre of gravity characteristics is provided in Appendix A.

2.4.6 Recommended airspeeds for normal and towing operations

SE-KHF's Aircraft Flight Manual minimum airspeed for normal operations was 61 mph IAS (53 KIAS). In the investigation, the minimum indicated airspeed for banner towing derived from the similar type aeroplane's flight manual was determined to be 67 mph IAS (58 KIAS).[8]

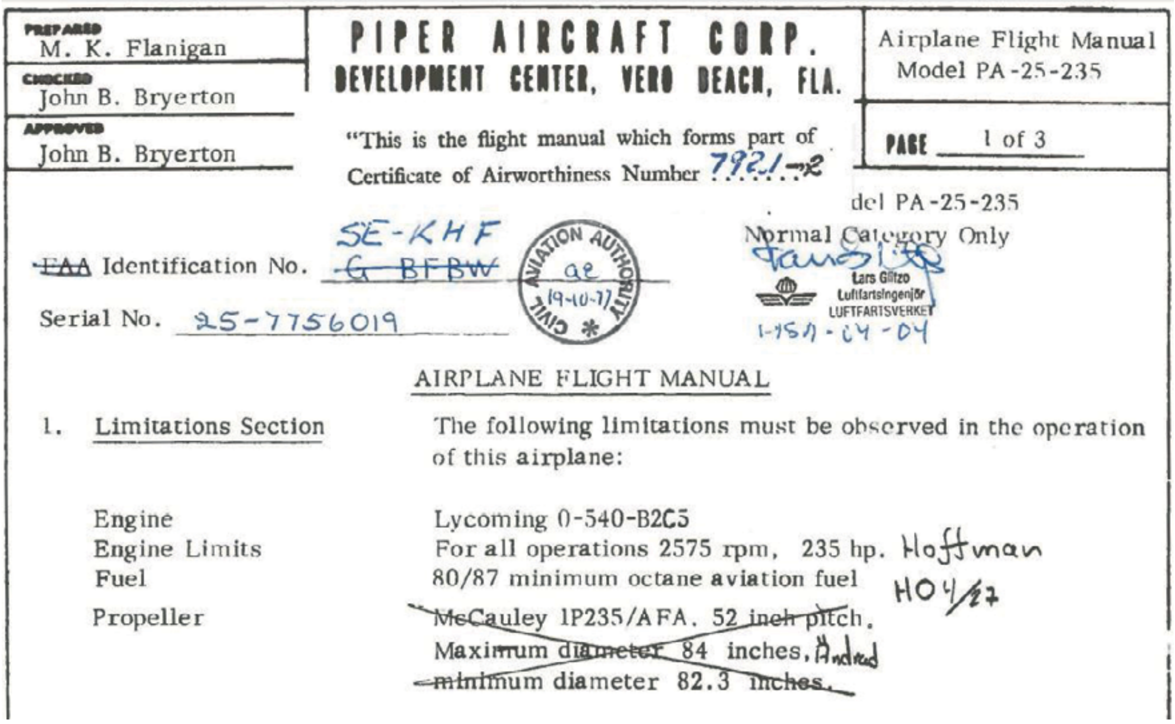
2.4.7 Propeller information

The standard propeller for this aeroplane is a fixed pitch 2-blade McCauley 1A200/FA8453 propeller. On 9 May 2018, this propeller was removed and changed, because it was due for maintenance. As a replacement, a Hoffman fixed pitch, 4-blade propeller with type number HO 4/27B HM-185 125 was installed on the aeroplane. This Hoffmann propeller was in store at the operator's premises; in the past, it had been used primarily for glider towing on a different type of aeroplane. On the day of the accident, SE-KHF was equipped with this Hoffmann 4-blade propeller. The aeroplane had flown five times for banner or glider towing with the Hoffmann 4-blade propeller until the day of the accident.

7 Rijksluchtvaartdienst, *PH-BAT, Flight Manual, Amendments and Supplements*, 13 March 1997.
8 Derived from SE-KHF Aircraft Flight Manual and applicable flight manual supplements from PH-BAT.

The Hoffmann HO 4/27B HM-185[9] propeller series is made of laminated hardwood material with reinforced composite leading edge protection. This propeller is produced in the pitch ranges from 90 up to 180.[10] The pitch number is indicated behind the blade length indication of 185, as the last number in the type identification. The installed Hoffmann propeller on SE-KHF had a pitch of 125.

SE-KHF's airplane flight manual, page 1, Limitations Section, had a hand written annotation stating: "Hoffmann HO 4/27." Below this annotation, the original text referring to a McCauley 1P235/AFA type propeller was crossed out. The page also shows that the limitations mentioned are applicable when the aeroplane is operated in the "normal category" (see Figure 6).


PREPARED M. K. Flanigan
CHECKED John B. Bryerton
APPROVED John B. Bryerton

PIPER AIRCRAFT CORP.
DEVELOPMENT CENTER, VERO BEACH, FLA.

"This is the flight manual which forms part of Certificate of Airworthiness Number 7921-2

Airplane Flight Manual
Model PA-25-235

PAGE 1 of 3

del PA-25-235
Normal Category Only

Lars Giltzo
Luftfartsingenjör
LUFTFARTSVERKET
1-1957-04-04

~~FAA~~ Identification No. SE-KHF ~~G-BFBW~~

Serial No. 25-7756019

AIRPLANE FLIGHT MANUAL

1. Limitations Section

The following limitations must be observed in the operation of this airplane:

Engine	Lycoming 0-540-B2C5
Engine Limits	For all operations 2575 rpm, 235 hp. Hoffman HO 4/27
Fuel	80/87 minimum octane aviation fuel
Propeller	~~McCauley 1P235/AFA. 52 inch pitch. Maximum diameter 84 inches, minimum diameter 82.3 inches.~~ Ändrad

Figure 6: Excerpt from SE-KHF's airplane flight manual with a hand written annotation concerning the authorization of the Hoffmann HO 4/27 propeller. (Source: Dutch Safety Board)

SE-KHF's Modification Type Certificate No M 4/79 Revision 2, dated 28 August 2000 (originally dated 23 April 1979) issued by the Swedish Civil Aviation Authority, certified the use of the Hoffmann HO 4/27B HM 185 propeller with pitch ranges from 105 up to and including 120. This authorization applies to glider towing operations, not to banner towing operations. Furthermore, it stated that the operational limitations from supplemental type certificate M3/79 were applicable.

The Hoffmann 4-blade propeller that was fitted on the aeroplane, was owned by the operator and had an EASA Form-1 authorization release certificate indicating the

9 Hoffmann Propeller GMBH & Co KG, Service Documents, Fixed Pitch, *Operation and Maintenance Manual HO/HO4*, 2002.

10 Skybrary: *Blade Pitch*: Blade pitch, often shortened to pitch, refers to the angle between the propeller blade chord line and the plane of rotation of the propeller, 2017.

propeller was eligible for use on "various" aeroplanes. This certificate was produced by the Hoffmann Company after repair of the propeller in the year 2007.

2.4.8 Banner dimensions

SE-KHF's aeroplane flight manual did not have a supplemental type certificate allowing for banner towing operations; therefore, the aeroplane did not have formal limitations for the maximum allowable dimension of the banner. For the investigation, the banner size limitations from the similar type aeroplane's flight manual were used to assess the effect of such a banner on the performance of the aeroplane. This similar type of aeroplane was authorized for banner towing. The operational limits from this aeroplane stated that the maximum area for banner towing was 135 m^2 with a McCauley 1A200/FA8453 or a Hoffmann HO 4/27 HM-185 (115) propeller.[11]

The banner that was towed during the accident flight consisted of 23 letters and had a surface of approximately 53 m^2. Because of the rain shower that had passed over the airport at the time of the flight preparation, the banner which was already prepared on the grass strip had become wet. To estimate the weight increase of the banner due to the rain, the banner was soaked in water. In the soaked condition, the banner's weight increased from 34.4 to 39.9 kilogram, which equals a 5.5 kilograms weight increase.

2.4.9 Additional fuselage fuel tank

In 2016, an additional fuselage fuel tank was installed in SE-KHF by a certified CAMO maintenance organization. SE-KHF, with its aircraft type indication of PA-25-235D, was originally equipped with fuel tanks only in the wings. The fuselage fuel tank was permitted according to minor change approval 10056774, issued by EASA, dated 17 February 2016. The installation of the fuselage altered the following three properties of the aeroplane. First, it changed the aeroplane's weight and balance as mentioned in Paragraph 2.4.5 and 3.1. Second, it affected the performance of the aeroplane which necessitated an operational assessment. This will be discussed in Paragraph 3.2.3. Third, it changed the pilot's survivability in case of a crash and post-crash fire. Further details are examined in Paragraph 2.9.3 and 3.2.4.

2.5 Meteorological information

The Royal Netherlands Meteorological Institute (KNMI) provided the information regarding the weather at Breda International Airport (Seppe) at the time of the accident. A low-pressure area with several centres on a line from Brittany to southern Germany determined the weather in much of Western Europe. In the continental tropical air mass above the Netherlands, a trough moved northwest across the south of the country. In the vicinity of the trough, moderate to heavy rain showers and thunderstorms occurred.

11 Rijksluchtvaartdienst, *PH-BAT, Flight Manual, Special Purpose Operations Appendix - Banner Towing*, 13 March 1997.

The estimated weather at the time of take-off at Breda International Airport was:
- Wind:
  - Surface 280-330 degrees, 6 to 10 kts, gust 7-14.
  - 500 feet 290 degrees, 10 kts. The wind direction may have varied because of the thunderstorms that moved through the area;
- Visibility (kilometres): 2-4 in heavy rain and 4-10 in medium rain showers;
- Ceiling (feet): few scattered clouds at 700-1,000, overcast at 4,000;
- Temperature (˚C): surface 18, at 500 feet 17;
- Dew point (˚C): surface 18, at 500 feet 17;
- QNH 1015;
- Significant weather: chance of moderate to heavy turbulence near thunderstorms.

Additional weather information is provided in Appendix C.

2.6 Airport information

Breda International Airport (also referred to as Seppe Airfield) has one paved runway (07/25). On the south side of the runway a grass strip is available for grass landings and glider and banner towing activities.

Camera surveillance systems on the airport recorded flight activities 24/7.

2.7 Wreckage and impact information

The aeroplane crashed on a grass area of a curved ramp leading towards the highway south of the airfield (see Figure 3). The impact with the ground was in a near vertical nose down attitude which caused the wooden propeller blades to completely disintegrate. Many parts of the propeller were found at a distance from the impact point on the grass area. The aeroplane structure was buckled at the cockpit area and distorted by the force of the impact. The banner and towline were found on the airfield boundary and the residential area.

The aeroplane was destroyed by the impact of the crash and subsequent fire. Although most of the aeroplane was severely damaged, a technical investigation was performed on the engine, cockpit controls, banner tow release system and the propeller. The following findings were made:

a. The technical state of the engine did not reveal any malfunctions.
b. The cockpit engine controls were found to be in the following positions: throttle – *full power*, mixture – *rich* and carburettor heating - *cold*.
c. The aeroplane was equipped with a towing and tow-release installation. The banner release installation was tested and functioned normally.
d. The wooden propeller blades of the 4-blade propeller were completely fragmented on impact with the ground, only the propeller hub/core was still attached. The fragmentation of the propeller blades showed that the engine was running at high rpm.

2.8 Organizational and management information

2.8.1 Regulatory framework

The activities performed by the operator, such as banner towing, are governed by European Union (EU) and national regulations. The EU regulation for operations is the Air Operations Regulation (EU) No 965/2012 and 379/2014.[12] The EU regulation was adopted by the European Commission on 7 April 2014. It stated amongst others that Member States had to implement the regulation as of 21 April 2017. According to this EU regulation, Specialised operations (SPO) operators are required to submit a declaration to the national competent authority as of April 2017. In the Netherlands, the competent authority is the Human Environment and Transport Inspectorate (ILT). Operators are required to have an approved Operations Manual, which describes their operations. For the maintenance of aeroplanes, regulation (EU) No 1321/2014[13] is applicable, stating requirements for continuous airworthiness and the performance of maintenance tasks.

The national regulation for banner towing operations is the Regulation Towing and Banner Towing *(Regeling slepen en reclamesleepvliegen[14])*. Article 3 of this Dutch regulation states that it is prohibited to perform banner/glider towing operations with an aeroplane that is not certified for banner/glider towing.

2.8.2 The competent authority

ILT, as the competent authority, performs oversight on the general aviation sector in the Netherlands. The ILT oversight program for the SPO organizations was in accordance with EASA regulations[15] developed in 2017. The EASA regulations require that the first oversight cycle on the sector is completed on 21 April 2021. The oversight cycle as mandated by EASA has a duration of 48 months. Furthermore, the regulation requires Member States to provide their designated competent authority with, amongst others, competent and adequate capabilities to perform oversight activities.

ILT performs oversight on SPO organizations that have submitted their declarations. According to ILT, the oversight program is primarily aimed to ensure the safety of third parties (external safety). Further, it intends to create a level playing field for all SPO organizations concerning the adherence to regulations. While executing their oversight program, ILT expects that the sector's (SPO organization's) safety management and safety culture will mature. The SPO oversight program in part contributes to the national State Safety Plan 2015-2019 safety objective for general aviation, which has the goal to contribute to zero fatal accidents caused by equipment or training shortcomings.

In 2018, ILT considered a SPO organization to be in the oversight program when the required declaration was received. After the declaration and operations manual were received, ILT made the planning for auditing, e.g. desk audit or on-site audit. At the time of the investigation, ILT stated that not all operators who were assumed to perform SPO operations in the Netherlands had submitted their declaration. ILT also indicated that at

12 EASA, *(EU) No 965/2012, Easy Access Rules for Air Operations, Annex III Part-ORO and Annex VIII Part-SPO*, 2021.
13 EASA, *(EU) No 1321/2014, Easy Access Rules for Continuing Airworthiness*, 2021.
14 Overheid.NL, *Regeling slepen en reclamesleepvliegen*, 2014.
15 EASA, *(EU) No 965/2012, Easy Access Rules for Air Operations, Annex II Part-ARO*, 2021.

the time of investigation they were unsure which of the operators would continue or cease their SPO operations.

2.8.3 The operator

The operator undertook operations in commercial banner and glider towing, aerial photography and aeroplane rental. These operations are considered commercial SPO according to EU regulations. On 6 April 2017, the operator submitted the required declaration for a SPO organization to the competent authority (ILT) to confirm that it complied with the EU regulations. The required Operations Manual was at that time, however, not yet prepared.

On the subject of continuing airworthiness, the operator was required to have a written contract with a Continuing Airworthiness Management Organisation (CAMO). One of the purposes of a written CAMO contract is to stipulate the responsibilities concerning continuous airworthiness and maintenance tasks between the operator and the CAMO. Furthermore, for the maintenance of the aeroplanes, the operator was required to have the maintenance performed by a certified maintenance organization.[16]

Between late 2012 and December 2017, the operator had most of its continuous airworthiness management and the maintenance work on SE-KHF (and its other aeroplanes) performed by a certified CAMO organization that also provided maintenance services. The two companies did not formalize the airworthiness management with a written CAMO-contract. As of January 2018, the maintenance work on SE-KHF was no longer performed by the certified maintenance organization. Instead, the maintenance work was accomplished by an on demand hired certified maintenance technician.

In March 2018, the operator was requested by ILT to prepare its documentation, i.e., the operations manual for a scheduled desk audit. ILT requested a copy of the Operations Manual for evaluation on 13 June 2018. The Operations Manual was received by ILT on 21 July 2018.

The result of the desk audit performed by ILT was communicated with the operator on 17 August 2018. The following summarized findings were noted:

1. Training in Operating Manual section D was not conform requirements of EU-Regulations.
2. The Safety Management System was not complete. A risk management process was missing. For banner towing operations, there was no documented risk assessment.
3. The contents of the Operating Manual only partly complied with the requirements.

The aeroplanes of the operator were involved in several incidents and accidents in the period 2013 till 2015:

- Crashed after touch and go due to engine failure, PH-SER, Midden Zeeland, May 2013.[17]

16 EASA, *(EU) No 1321/2014, Part-M Organizations*, Certified as referred to by 'Part-M (Subpart F) Organization or a Part 145 Organization, 2021.

17 Dutch Safety Board, *Engine failure after restart*, 20 November 2015.

- Emergency landing after engine failure near Breda, Piper Pawnee, PH-BJX, March 2014.[18]
- Emergency landing after engine failure near Breda, Piper Pawnee, PH-OMA, April 2015 (no incident report available).

2.9 Additional information

2.9.1 Operational flight tests and experiences with the Hoffmann Propeller

The Piper PA-25 is originally equipped with a propeller (McCauley 2 blade propeller) that ensures adequate performance for its crop spraying tasks. This means that the propeller needs to provide relatively high thrust at low air speeds. The Hoffmann HO 4/27B HM-185 propeller was not a standard propeller for the PA-25 and has different performance characteristics than the original propeller. Therefore the Hoffmann propeller was flight tested in the past to validate its safe usage.

The reason for the demand of the Hoffmann 4-blade propeller in general was because it produces less noise hindrance during glider and banner towing operations. Between 1984 and 1993 various test flights were performed in different countries that resulted in approval of the Hoffman 4-blade propeller for glider towing. A description of these test results is provided in Appendix D. Below follows a short description of the flight tests that were specifically performed to validate the safe use for banner towing.

In 1997 flight tests for banner towing with a PA-25-235C and a HO 4/27 BHM-185 (115) propeller were performed in the Netherlands. The test report of these flight tests was not available, however, operational limitations were determined and approved by the Dutch Civil Aviation Authority. These limits were amongst others that the aeroplane (PA-25-235/PH-BAT) had to be operated in the restricted category, with a maximum take-off weight of 912 kilograms, a minimum speed of 67 mph for banner towing, and a maximum banner tow size of 135 m^2.

Noted is that the banner towing flight tests were performed with a PA-25-235C which had a different aeroplane configuration than SE-KHF (PA-25-235D). The test aeroplane had only a fuselage fuel tank, whereas SE-KHF, next to its standard wing fuel tanks, also had a fuselage fuel tank. Nevertheless, these flight test results are the best available data and considered useful for the performance assessment in Chapter 3. The engine and standard propeller were of the same type for both aeroplanes.

Next to the mentioned flight tests, the HO 4/27 HM-185 propellers with different pitches were utilized for glider and banner towing on PA-25-235 aeroplanes in the Netherlands and Belgium in the period 2012-2014. The operational experience was that the performance of the 4-blade propeller was limited during towing operations. A significant reduction in climb performance was noted and flying with the propeller was felt to be unsafe.

18 Dutch Safety Board, *Noodlanding na motorstoring, Piper PA-25-235*, 31 March 2014.

2.9.2 SE-KHF Previous flights

Normally, the SE-KHF was equipped with a standard 2-blade propeller, as mentioned in Paragraph 2.4.7. Before the day of the accident, the aeroplane was operated five times for banner or glider towing flights, while being equipped with the Hoffmann HO 4/27 HM-185 125 propeller. The pilot of the accident flight flew with SE-KHF and the Hoffmann 4-blade propeller ten days prior the accident flight. Three other pilots also flew with SE-KHF and the 4-blade propeller in this period.

One of the pilots recalled that on a banner towing mission, the aircraft's climb performance was noticeably reduced: 'presumably because of the propeller'. He had no experience flying with a 4-blade propeller and he stated that he did not feel uncomfortable during the flight. Two pilots stated that the engine rpm was about 100-200 rpm lower than with the 2-blade propeller.

2.9.3 PA-25 Fuselage fuel tank

SE-KHF was originally equipped only with metal fuel tanks in the wings. In the year 2016 an additional fiberglass fuel tank was installed in the fuselage to increase the endurance/ range of the aeroplane. The fuel tank was of a type in accordance with Piper Service Bulletin No. 878, issued 18 January 1988.

In the past, the PA-25 fuselage fuel tank was cause for concern in relation to the crashworthiness and pilot's survivability in case of a crash and post-crash fire. The aeroplane was originally designed and used for low level crop spraying operations. Low level flying generates a high risk of collision with obstacles. Therefore, the US National Transportation Safety Board (NTSB) investigated accidents with the PA-25 (from 1983 till 1987) to determine the relationship between differences in types of fuel tanks, post-crash fires and fatalities. The NTSB report is included in Appendix E. In the year 1974, the manufacturer of the aeroplane changed the design of the aeroplane and situated the fuel tanks in the wing tips instead of the fuselage. According to the NTSB report, this new model with type identification "PA-25-235/260 Pawnee D", had a lower susceptibility for post-crash fires and related fatalities.

2.9.4 Procedures for banner pick-up

During the normal procedure for banner pick-up, the banner is laid down on the ground and attached to a rope which is looped between two posts, about three metres high. The aircraft approaches the two poles with the loop in between, at a height that allows the hook, hanging at a rope behind aircraft, to catch the loop. Just before picking up the banner, the pilot selects full power and pulls up firmly (maximum climb angle approximately 40 degrees). Just before the banner is lifted up from the ground, the nose of the aircraft must be lowered, allowing the aeroplane to accelerate. Thereafter, a climb at a safe and constant airspeed according the aeroplane's flight manual should be performed. The banner pick-up manoeuvre should be performed with the flaps in the up position.[19]

19 According similar type aeroplane PH-BAT Flight Manual, Special Purpose Operations Appendix.

2.9.5 Carburettor icing

The phenomenon of carburettor icing is known as a hazard for reducing engine power and even engine shutdown in flight. The forming of ice in the carburettor causes a restricted airflow to the engine and reduces the performance. It occurs nearly with all outside temperatures and a high relative humidity. Figure 7 shows the risk of carburettor icing in relation to outside air temperature and dew point. Carburettor icing can be prevented by heating the intake air; this results in a small loss of engine performance.

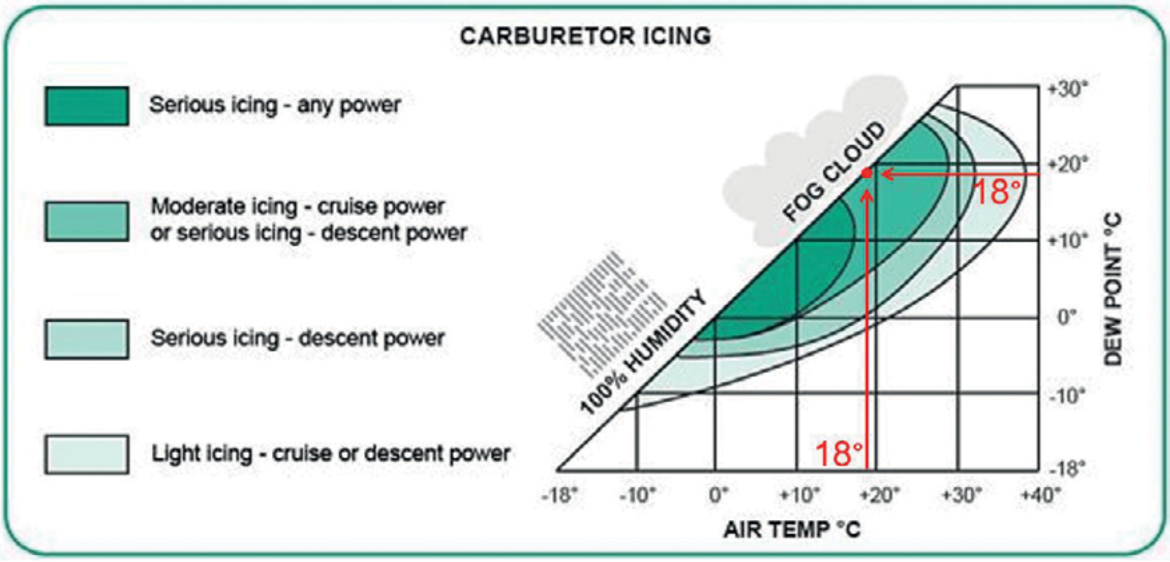


Figure 7: Carburettor icing prediction chart. (Source: Canadian Transportation Safety Board)

The actual carburettor icing conditions at the moment of take-off are notable and should be considered. The outside air temperature at the time of take-off was 18 °C and the dew point temperature was also 18 °C. With these temperatures the red dot in Figure 7 shows that the conditions were favourable for moderate to serious icing during cruise and descent with a low power setting. SE-KHF flew one circuit in the pattern of Breda Airport, before the pick-up of the banner. This is considered similar to a cruise/descent phase of flight. The carburettor heating controls in the cockpit were found in the 'Cold' position; which was the correct position during the pick-up and climb out with a high power setting. From downwind to just before the pick-up, the correct position is "hot", to prevent carburettor icing and guarantee maximum available engine power during the pick-up. It is unknown what the position was during the circuit.

3 INVESTIGATION AND ANALYSIS

The analysis during the investigation concerned the technical state and performance of the aeroplane, the operational factors, and the influence of the weather. Furthermore, the analysis focussed on the operator safety management and the competent authority's performance of oversight.

3.1 The accident

The flight path reconstruction in Figure 8 shows that after the pick-up of the banner, the aeroplane quickly developed a nose high attitude and a descending flight path. These indications are characteristic for a low airspeed situation. Therefore, an estimation of the aeroplane's hypothesized low airspeed was made by using the video images.

Figure 8: Video compilation showing the moment of the banner pick-up and the descending flight path. (Source: Breda International Airport, modified by the Dutch Safety Board)

The aeroplane flew 620 metres from the position where it picked up the banner until the position where it fell over its right wing in 30 seconds. From this distance and time, a ground speed of 47 mph IAS (41 KIAS) (21 m/sec) was calculated. Taking into account that a head wind component of approximately 6 mph (5 knots) was present (the windsock is hanging almost vertically down), the aeroplane flew with an estimated average airspeed of 53 mph IAS (46 KIAS).

The recommended minimum airspeed from the aircraft flight manual for normal operations is 61 mph IAS (53 KIAS). For banner towing operations, the recommended minimum indicated airspeed for the similar type aeroplane is 67 mph[20] IAS (58 KIAS). By comparing these airspeeds with the above calculated average airspeed, it is inferred that the airspeed had decreased to below the minimum recommended flying airspeed for normal and for banner towing operations, and that as a result the aeroplane had stalled.

At the calculated average airspeed, the aeroplane was flying in the 'region of reversed command'. Figure 9 illustrates a typical region of reversed command, indicating that when flying at airspeeds below the best rate of climb airspeed, more engine power (thrust) is required to maintain a lower airspeed. This is indicated by the power required curve (blue line) going left and upwards. It also shows that the power required curve on the left side of the graph has a steep rise, indicating that when the thrust deficient situation is not corrected promptly, the decrease in airspeed worsens at an increased rate.

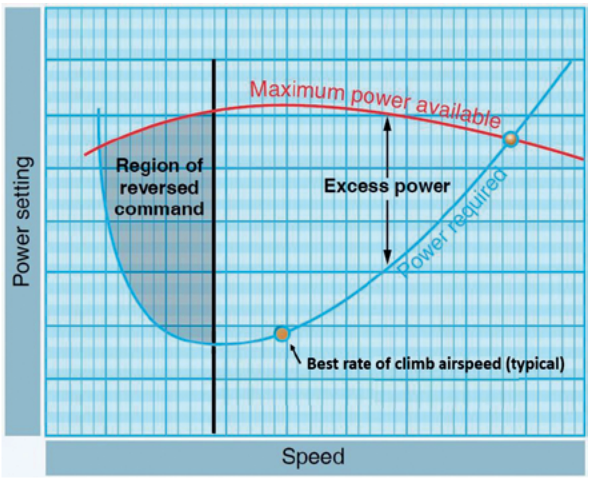


Figure 9: Typical region of reversed command. (Source: FAA, modified by the Dutch Safety Board)

It was further examined whether the low airspeed situation and stall were due to insufficient thrust produced by the recently installed 4-blade propeller. As indicated earlier, this propeller was not certified for SE-KHF and flight tests (see par. 2.9.1) showed that these 4-blade propellers performed marginal in combination with the PA-25-235. Next to the produced thrust, also the low airspeed, aeroplane's take-off weight, flying technique and banner size were analysed.

A propeller with a coarse pitch (125) produces more thrust and drag than a propeller with a finer pitch (115) at the same rpm in lower airspeeds situations.[21] Thus, a propeller with a coarse pitch requires more engine power (torque) to produce equal thrust compared to a fine pitch propeller at low airspeeds.[22] During the previous take-offs of SE-KHF with the

20 Minimum airspeed for banner towing derived from PH-BAT Flight Manual, Special Purpose Operations Appendix.
21 Derived from the Hoffmann HO 4/27 HM-185 115/120/125 propeller power required diagram and McCauly 1A200/FA8452 propeller thrust estimation charts.
22 More sophisticated aeroplanes do not have this thrust characteristic, they are normally fitted with a constant speed/variable pitch (= constant rpm) propeller. With such a propeller, the engine can run on high rpm (= high power) all the time delivering optimum power to provide maximum thrust.

Hoffmann 125 pitch propeller, the engine produced 100 to 200 lower rpm than with the standard McCauley 2-blade propeller.

Banner towing operations and especially the pick-up of the banner are normally conducted at low airspeeds. At these low airspeeds, the higher drag of the 125 pitch 4-blade propeller resulted in a lower engine rpm. Pilots who flew with SE-KHF and the 4-blade before the accident also noticed that there was a lower rpm (power). Thus, SE-KHF's engine could not produce the necessary rpm and therefore the propeller could not produce the required thrust.

Unrecoverable flight regime

At a certain point after the pick-up, the airspeed had decreased to where the aeroplane was flying in the region of reversed command. This means that flying a lower airspeed required more thrust to maintain that lower airspeed or to accelerate. Hence, the situation worsened as the speed of SE-KHF was decreasing gradually after picking up the banner. This situation could only be resolved by applying sufficient engine power (thrust) and/or by exchanging altitude (nose down) to increase the airspeed. The pilot could do neither of these, having an improper propeller fitted and being too low to the ground.

Exceeding maximum take-off weight

SE-KHF did not have authorized take-off weight limitations for banner towing operations. Therefore the maximum take-off weight of a similar type aeroplane is used to determine its effect on the performance of the aeroplane. Compared with the take-off weight limitation of similar type aeroplane, SE-KHF exceeded the maximum allowable take-off weight. The estimated exceedance of the maximum allowable take-off weight in the restricted category was 331 pounds (16 %).[23] A higher aeroplane's weight requires more thrust to fly. Therefore, the exceedance of SE-KHF's maximum take-off weight had an adverse effect on the performance of the aeroplane.

Notwithstanding the significance of the weight exceedance and the adverse effect on SE-KHF's performance, it is noted that the aeroplane had flown five times prior to the accident flight. A weight exceedance on these flights seems to be likely; however, this could not be confirmed for these flights. Nevertheless, for the accident flight, the weight exceedance can be considered a contributing factor.

Influence of the banner

The drag of the banner had an effect on the performance of the aeroplane. The operational limits from a similar aeroplane were used as a reference, to determine the influence of the banner. A comparison between the maximum allowable banner size of 135 m^2 from the similar aeroplane and the actual banner size of 53 m^2 showed that the latter falls well within the capabilities of a SE-KHF type of aeroplane, assuming that the aeroplane was equipped with either the standard 2-blade McCauley propeller or a Hoffmann 4-blade propeller with maximum 115 pitch. Although within operational limits,

23 The weight exceedance in the restricted category was significant. To illustrate: for the aeroplane weight to be at or below the maximum allowable take-off weight, the fuselage tank had to be empty and the wing tanks had to be approximately less than half full.

the banner, nevertheless, had an increasing effect on the aeroplane's total drag, which further decreased the difference between the available and the required thrust (power).

Furthermore, it was determined by experimentation that the weight increase of the banner due to the recent rain, was approximately 5.5 kilograms. The weight increased from approximately 34.5 kilograms to 40 kilograms. A comparison between the increase in weight due to rain and an increase in weight due to a larger banner size, shows that a 135 m² banner would at least have doubled the weight of the 53 m² banner of the accident flight. Therefore, it is concluded that the small weight increase of the wet banner had a negligible effect on the performance of the aeroplane.

Altogether, the size of the banner was well within the performance capabilities of this type of aeroplane. And, the increased weight of the banner due to the rain had a negligible effect on the performance of the aeroplane.

Variations in banner pick-up technique

Deviations in the approach airspeeds for banner pick-up will have an influence on the aeroplane's performance after the pick-up. A lower than recommended approach airspeed will result in an even lower airspeed after the aeroplane pulls up and reaches the highest point.

A lower than recommended airspeed will have reduced SE-KHF's performance because of the 125 pitch propeller and weight exceedance. An attempt to correct for a lower airspeed shortly before the pickup by adding more power, will not result in instant acceleration. It was not possible to determine the aeroplane's airspeed before the pick-up, because the airspeed measurement from the video was not sufficiently accurate for the moments before the pick-up.

Furthermore, a pilot's flying technique for picking up a banner will have an effect on the aeroplane's performance after the pick-up of the banner. The video images show that the pilot made a so-called assertive pitch-up manoeuvre to pick up the banner. This technique has the advantage that the banner is picked up from the grass quickly, thereby preventing damage to the banner and towlines. A disadvantage of this technique is that more airspeed is lost during the pitch-up, hence lowering the airspeed at the beginning of the climb out. The assertive pick-up technique the pilot used, thus required more thrust to accelerate, while the aeroplane's performance was already reduced as a result of the improper propeller and the exceedance of the maximum take-off weight.

A combination of a lower than recommended pick-up airspeed and an assertive banner pick-up manoeuvre will have resulted in a lower than normal airspeed after the pick-up of the banner. It was not possible to quantitatively determine the consequences of these two factors.

Technique for banner tow release
Shortly after the pilot released the banner, the aeroplane fell over its right wing. According to best practices[24] for banner towing operations, the banner should not be released at airspeeds near the stall speed. According to principles of aerodynamic stability, keeping the banner attached to the aeroplane increases the yaw (directional) stability. Considering this general aerodynamic principle, it can be inferred that releasing the banner had aggravated the yaw instability which caused the right wing drop. It should be noted that if the pilot had not released the banner, it would have released by itself because of a safety mechanism. This release mechanism releases the banner when it senses an abrupt increase in drag. Such a drag increase is caused for example by the banner touching the ground. The same destabilizing effect and wing drop will occur when the safety mechanism releases the banner.

Weather
Thunderstorms and rain showers had just passed the airport before the aeroplane took off. A relationship between the weather and the accident could be thought of as likely, however, the investigation has shown that this is not the case. From the analysis of the weather radar, weather satellite, and images from the surveillance cameras the following is determined.

The KNMI weather radar images show that the line with thunderstorms had moved past the airport from south-east to north-west. The airport being at the backside of the line of thunderstorm makes it unlikely for downdrafts and/or windshear to have occurred. The KNMI weather radar is capable of accurately detecting downdrafts. The images show no signs of a downdrafts or other strong vertical air current at the backside of the line of thunderstorms.

Furthermore, satellite images showed a sharp clearing of the air after the line of thunderstorms had passed. And the images from the surveillance cameras show that no extreme or significant weather could be identified just prior and during the flight of SE-KHF. The movement of the flags and trees appear stable, indicating a light wind condition. Besides that, the ceiling appears to be uniform and moving relatively slowly, which make a downdraft and windshear also unlikely.

Althogether, the weather conditions -backside of a line of thunderstorm and rain showers- did not contribute to the cause of the accident. There are no indications that a windshear and/or a downdraft had taken place at the airport at the time of the pick-up of the banner.

24 Vereniging Nederlandse Luchtvaart Ondernemingen (VNLO), *Manual for banner towing operations: Handboek voor de Nederlandse Reklamesleper.*

The aeroplane lost airspeed and stalled after it had picked up the banner because it was equipped with an improper propeller. The propeller had a pitch that was too coarse for the banner pick-up manoeuvre. In this low airspeed and high drag situation, the propeller could not produce the required thrust to accelerate. After the aeroplane had picked-up the banner and reached its highest point, it came into an unsafe flight regime from which it was impossible to recover.

The aeroplane was flown above the maximum take-off weight limit for banner towing operations. As the aeroplane did not have a supplemental type cerificate for banner towing and authorized take-off weight limits for banner towing, take-off weight limits from a similar type aeroplane were used as a reference. The exceedance of the maximum take-off weight had a worsening effect on the performance of the aeroplane during the pick-up of the banner.

3.2 Safety management factors

3.2.1 Choice for the 4-blade propeller

The 2-blade McCauley propeller was due for maintenance, and therefore, was temporarily replaced with a Hoffmann HO 4/27 HM-185 (125) 4-blade propeller to continue banner towing operations. This 4-blade propeller was stored at the operator's hangar and readily available. The choice for the Hoffmann 4-blade propeller as a replacement was made during a telephone conversation between the operator and the maintenance organization. According to the statements made by the operator and the maintenance organization, the choice and decision to install the propeller was based on the following three arguments. Firstly, the hand written annotation on page 1 of SE-KHF's airplane flight manual that allowed for the use of a Hoffmann HO 4/27 propeller was referenced. This annotation did not limit the use of the propeller to a specific pitch range, based on which basis it was assumed that all pitches were allowed. Furthermore, page 1 stated that these limitations were applicable only if the aeroplane was used in the normal category. As the aircraft was used for banner towing, propeller limitations for the restricted category had to be referenced. However, these limitations were not available because the aeroplane did not have a supplemental type certificate for banner towing. Noteworthy is that when the similar type aeroplane's supplemental type certificate for banner towing is referenced, only a pitch of 115 is allowed; contrary to the Hoffmann propeller installed on SE-KHF which had a pitch of 125.

Secondly, the advice was given by the maintenance organization to install a propeller for which an EASA form-1 was available. The 4-blade propeller with 125 pitch was the only propeller at the operator's hangar that had a form-1. The EASA form-1 stated that the propeller was allowed to be used on various aircraft. As this propeller was readily available, it was chosen to be installed on SE-KHF. An EASA form-1 document, however, only authorizes release of a component after fabrication or repair for use on aeroplanes in general. An EASA form-1 cannot not be used as a certification document.

Thirdly, the operator and the maintenance organization assumed that pilot experience with the 125 pitch propeller was positive and that this propeller performed better on the Piper Pawnee than the propellers with a finer pitch. This idea was in contrast to pilot experiences in the period 2012-2014, which indicated a poor climb performance and that is was, in general unsafe to operate with the 4-blade propeller. Based on these experiences, it was determined that flying with the 4-blade propeller on this type of aeroplane was unsafe. This negative experience led the operator to change the 4-blade propeller to the standard 2-blade propeller, with which SE-KHF flew ever since. Pilots with experience flying the Hoffmann 125 pitch propeller were not consulted before it was decided to order the technician to install the propeller on the aeroplane.

The HO 4/27 HM-185 (125) propeller was installed notwithstanding the guidance in the aeroplane flight manual, certification documents, maintenance documents, and the experience of unsafe performance with the combination of the Hoffmann HO 4/27 HM-185 propeller and the PA-25-235 during glider and banner towing operations.

3.2.2 Banner towing operations while not certified

As of 2012, the SE-KHF flew six years in the Netherlands without being officially certified and without authorized operational limits for banner towing. In this period, the aeroplane operated frequently as a banner tow. Not having appropriate certification and authorized operational limits had an adverse effect on the safe operation of the aeroplane. This enduring situation raised concerns about the operator's overall management of safety, and the oversight performed by ILT as will be discussed in Paragraph 3.2.5 and 3.3.2 respectively.

SE-KHF's documentation contained a copy of a supplemental type certificate for banner towing from a Dutch registered PA-25-260 aeroplane. This document was used as a substitute for the absence of authorised operational limitations. An aeroplane is required to have its own documentation. Apart from this legal requirement, the documentation used was inadequate for safe decision making due to the substantial differences in performance between the PA-25-235 and the PA-25-260. A PA-25-235 model, like the SE-KHF, has approximately 10 % less maximum power compared to the 260 model.

The operator performed banner towing operations with the aeroplane without a banner towing certification in the Netherlands since the year 2012. As a consequence, there were no authorized operating limitations to ensure safe banner towing operations.

3.2.3 Need for operational assessments after configuration changes

Changes to the configuration of an aeroplane may have an effect on the operational performance. The installation of the fuselage fuel tank in the year 2016 and the installation of the Hoffmann 4-blade propeller in 2018, are configuration changes that had an effect on the performance of SE-KHF. The EASA minor change approval for installation of the fuselage tank and the M 4/79 Rev 2 supplemental type certificate of the Hoffmann propeller, both contain a remark which requires to verify the effect on airworthiness due to interrelation between the different modifications. Both statements warrent the initiative from the operator to assess the operational effects of the modifications to determine the safe performance of the aeroplane. The necessity for such an assessment is also derived from the various regulatory obligations for the operator and the pilot in command[25]; however, such an assessment was not performed.

There are two operational performance concerns with these modifications. First, the installation of the fuselage fuel tank increased the weight and changed the centre of gravity (for weight and balance see Paragraph 3.1 and Appendix A). Second, after installation of the 4-blade propeller, it was unknown if the aeroplane could perform safely with the addition of the fuselage fuel tank and a maximum fuel load. The configuration of three fuel tanks, i.e., one fuselage and two wing fuel tanks, and a 4-blade propeller was not operationally assessed.

At the time of the installation of the fuselage fuel tank in 2016, SE-KHF was already modified with a tow cable retractor winch and cable cutting system. An operational assessment of the effects of these two modifications was not performed either.

There was no assessment of the operational performance of the aeroplane after the installation of the fuselage fuel tank and the installation of the 4-blade propeller. The necessity for operational assessments is to be deduced from the evaluation requirements in the various supplemental certificates and regulations. Such an assessment is a vital instrument to evaluate the performance and to identify the safety risks caused by the configuration changes and thus ensuring safe operations.

3.2.4 Pilot survivability and installation of fuselage fuel tank

The pilot's survivability in case of a crash and post-crash fire was affected by the installation of the fuselage fuel tank. The open source available NTSB report A-87-100[26] points out that specifically the PA-25s equipped with a fuselage fuel tank have a reduced pilots survivability in case of a crash and post-crash fire compared to PA-25s with wing tanks. Moreover, it is common knowledge amongst operators in general aviation that fuselage fuel tanks in case of a crash and post-crash fire have a lower pilot's survivability rate than when fuel is stored in the wings. Despite this generally known and available safety information, the fuselage fuel tank was installed.

The reason to install an additional fuel tank in fuselage was to expand the range and endurance of SE-KHF. However, this configuration change was not followed up by an operational risk assessment or a pilot's survivability assessment in case of a crash and post-crash fire. Despite the fact that the additional fuselage fuel tank was of the latest version with the rubber inner liner, it did not prevent a rapid spread of the fire after the crash.

25 EASA, *(EC) 216/2008, Basic Regulation, Annex IV*, 2008.
26 NTSB, *Safety Recommendation: A-87-100*, 1987.

The pilot's survivability in case of a crash and post-crash fire was reduced by the installation of an additional fuselage fuel tank by the operator.

3.2.5 Maintenance and operations safety

The investigation showed the following shortcomings with the operator related to maintenance and operational safety. First, the operator did not have a mandatory written contract with a CAMO. Even though, the Operations Manual[27] stated that a CAMO contract was in place for all aeroplanes, the investigation showed that this was not the case. The absence of a CAMO contract meant that responsibilities for the continuous airworthiness and maintenance were not appointed to an approved maintenance organisation, which implies that these responsibilities remained with the operator.

Second, the accomplishment of maintenance had changed from the Part 145 maintenance organization to the on-demand certified technician as of early 2018. This technician was experienced, though at the time of the accident not fully familiarized with the maintenance procedures and the airworthiness state of the operator's aeroplanes. The technician's initial assessment of the operator's fleet was that it was in a minimum, and sometimes below minimum, airworthy state and that the aeroplanes' documentation needed to be updated. The change from a Part 145 maintenance organization to an on-demand hired technician was an effort to reduce maintenance cost. However, according to EU regulation[28] the on-demand technician was not allowed to perform maintenance work, because commercial SPO operators[29] are required to have maintenance performed by a Part M (Subpart-F) organization or a Part 145 organization. The operator delegated the maintenance responsibilities to the on-demand hired technician, who was not adequately familiar with the fleet and who was, according EU regulations, not allowed to perform maintenance activities. In such a situation, it is expected that maintenance safety risks increase.

Third, it was found that the technical documentation of the aeroplane was disorderly and contained information that could not readily be interpreted. Concerning banner towing, the documentation contained a copy of another aeroplane's supplemental type certificate authorizing that aeroplane for banner towing operations. Furthermore, the supplemental type certificates authorizing glider towing, the certificates of the Hoffmann 4-blade propeller, and the weight and balance addendum were written in the Swedish language and therefore not useable for people involved in the operation and maintenance not familiar with Swedish. The investigation revealed that the documentation deficiency, applied to the documentation of all aeroplanes in general. The state of the documentation hampered safe maintenance and operation.

Fourth, there were no effective means to communicate maintenance and operational safety matters. Furthermore, there was no facility where pilots could discuss safety

27 The operations manual submitted by the operator to ILT on 21 July 2018.
28 EASA, *(EU) No 1321/2014, Annex 1 Part M, Subpart B Accountability, M.A.201(h) Responsibilities*, 2014.
29 The operator utilized other than complex motor-powered aircraft (CMPA).

matters. This prevented adequate learning from previous experiences. The operator had stated that he did not see a need to accommodate the pilots and that the responsibility for operations lay only with the pilots. This led to a situation where pilots could not be informed about changes and subsequent risks in operations. The change from the standard 2-blade propellers to the 4-blade propeller with 125 pitch and the effects this change had on the performance of the aeroplane were not communicated.

The operator's management of safety was characterized by a neglect of safety risks in maintenance and flying operations.

3.3 Systemic factors

3.3.1 Propeller flight tests for glider/banner towing

The PA-25-235 and the Hoffmann 4-blade propeller flight tests results need particular attention, in case the aeroplane and propeller are going to be used for banner or glider towing. The mentioned flight tests performed in the United Kingdom and Belgium concluded a marginal performance of the Hoffmann 4-blade propeller. In the UK it was concluded that with the use of the 115 pitch 4-blade propeller, the performance of PA-25-235 was significantly reduced. In Belgium it was concluded that the Hoffmann 4-blade propeller would be difficult to sell as a propeller for the PA-25-235, because of its marginal performance. Concerning the accident with SE-KHF, having a 4-blade propeller with 125 pitch fitted on the aeroplane reduced the performance of the aeroplane especially at low airspeeds.

The flight tests for banner towing with the PA-25-235 were, held to establish operational limitations. The flight tests with a similar type PA-25-235 established a maximum take-off weight of 2,010 pounds (912 kilograms). This maximum take-off weight of 2,010 pounds is lower than the maximum take-off weight of 2,205 pounds, as stated by the SE-SKF's Swedish type certificate for glider towing. This lower take-off weight is likely an indication of limited performance while performing banner towing operations.

The above determined marginal performance of the PA-25-235 and the Hoffmann 4-blade propeller is substantiated by the negative operational experiences gained in the Netherlands and Belgium in the period 2012-2014 during banner towing operations with the PA-25-235/260 and Hoffman 4-blade propeller. These experiences indicated a poor climb performance and that it was, in general, unsafe to operate with the Hoffmann 4-blade propeller.

Altogether, flight tests performed in Belgium and the United Kingdom and operational experiences in the Netherlands and Belgium pointed to reduced performance during glider and/or banner towing.

3.3.2 Oversight on the operator

The operator performed banner towing operations for nearly ten years at the time of the accident. In this period, ILT had never performed oversight in the form of desk, on-site audit or inspection on the operator. Prior to the effectuation date of EASA regulation (No 379/2014) in April 2017, there was no national requirement applicable to ILT to perform oversight inspections on SPO operators. As of April 2017, the mentioned EASA regulation required ILT to develop and implement a four year audit cycle on SPO operators. As of this date, ILT was in the process of developing and implementing an oversight program for commercial SPO operators.

The operator did not receive an on-site audit, although ILT had planned this audit on several occasions. In April 2017, ILT requested the operator a copy of the operator's Operating Manual to prepare for a desk audit. ILT's intention was, after the desk audit was held, to administer an on-site audit late 2019. However, ILT indicated that this audit was cancelled due to private circumstances of the operator during the aftermath of the accident with SE-KHF. The on-site audit was then rescheduled to early 2020. This audit was cancelled as well, because of private circumstances of the operator and Covid-19 restrictions. No further appointments were planned. In December 2020, ILT directed to terminate the operator's commercial specialized operations with the issuance of a level 1 warning letter.[30]

Until the day of the accident, the operator performed operations for more than ten years. In this period, the operator's aeroplanes were involved in two incidents and one accident. The implications of these incidents and the accident, the severity of the accident with SE-KHF with a clear risk for third parties, and poor results of the desk audit are signals of safety problems. In such a case, from a safety perspective, active oversight from ILT is warranted.

ILT did not perform active oversight on the operator from the operator's founding in 2008 until the day of the accident; the absence of oversight on the operator contributed to the persistence of safety deficiencies and safety risks. In case of such safety performance, revealed by incidents, an active role from the Inspectorate towards operators is warranted.

30 EASA, *(EU) 965/2012, Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Annex II, Authority Requirements for Air Operations [PART-ARO], ARO.GEN.360: Findings and enforcement measures — all operators*, March 2019.

The Dutch Safety Board has concluded in similar accident investigations[31] in the general aviation sector, that oversight performed by ILT was insufficient. These earlier finding and the findings of this accident are a cause for concern about the effectiveness off oversight to identify the safety risks concerning pilots and third parties in the general aviation sector.

3.3.3 Reporting of unsafe situations in general aviation

In the period the operator conducted operations, ILT did not receive formal safety occurrence reports on the operator. However, concerns about the operator existed for a long period of time. Although not formally informed, it is likely that ILT was informally aware of the safety concerns of the operator, as their statements alluded to. The Dutch Safety Board was informed about many of these safety concerns, during the investigation in interviews and in writing, by pilots and technicians who had worked with the operator, and other individuals. These concerns involve the way the operator handled the safety of maintenance and operations. Mentioned were the reduction of maintenance cost to a point where it affected airworthiness and flight safety, the performance of maintenance tasks by non-certified technicians, the use of unauthorized types of fuel for the aeroplanes, and that several pilots and technicians no longer wished to work for the operator anymore. It is recognized that these statements are subjective; however, a number of people have formally shared their concerns with the investigation team. These concerns are substantiated by the other findings of the investigation. For the reason that ensuring confidentiality of witness statements is essential as set forth by the Dutch Safety Board Act[32], the Board chose to share these concerns in this summarized manner.

Earlier, the Dutch Safety Board identified a reluctance to report safety occurrences in the investigation: "Fatal aircraft accident in low flying area Gouda, 22 May 2018".[33] In this investigation, it was found that when persons had experienced or witnessed unsafe situations, they did not report this to ILT. The inspectorate uses this occurrence reporting information to enhance the safety in the general aviation sector.

In a previous investigation and in the present investigation, the Dutch Safety Board noticed a reluctance to report unsafe situations in the general aviation sector. It is important for the overall safety in the general aviation sector that occurrences are reported within companies as part of their safety management system and providing mandatory and voluntary safety reports to ILT.

31 Dutch Safety Board, *Loss of Control Pipistrel Alpha Electro near Stadskanaal airfield*, 13 October 2018; *Inflight break up, Zenair Zodiac CH601 XL, Markermeer*, 14 September 2008; *Accidents with Russian registered aircraft, Yakovlev 52, near Heeten, Sukhoi 29, MVK De Kooy*, 1 December 2006; *Verlies van controle over besturing tijdens oppikken reclamesleep, Aviat A-1 Husky, Rotterdam Airport*, 18 August 2003.

32 Dutch Safety Board Act, 1 February 2005.

33 Dutch Safety Board, *Fatal aircraft accident in low flying area Gouda*, 22 May 2018.

4 CONCLUSIONS

4.1 Operational factors

The aeroplane lost airspeed and stalled after it had picked up the banner, because it was equipped with an improper propeller. The propeller had a pitch that was too coarse for the banner pick-up manoeuvre. In this low airspeed and high drag situation, the propeller could not produce the required thrust to accelerate. After the aeroplane had picked-up the banner and reached its highest point, it came into an unsafe flight regime from which it was impossible to recover.

The aeroplane was flown above the maximum take-off weight limit for banner towing operations. As the aeroplane did not have a supplemental type cerificate for banner towing and authorized take-off weight limits for banner towing, take-off weight limits from a similar type aeroplane were used as a reference. The exceedance of the maximum take-off weight had a worsening effect on the performance of the aeroplane during the pick-up of the banner.

4.2 Management of safety

The operator's management of safety was characterized by a neglect of safety risks in maintenance and flying operations.

The HO 4/27 HM-185 (125) propeller was installed notwithstanding the guidance in the aeroplane flight manual, certification documents, maintenance documents, and the experience of unsafe performance with the combination of the Hoffmann HO 4/27 HM-185 propeller and the PA-25-235 during glider and banner towing operations.

The operator performed banner towing operations with the aeroplane without a banner towing certification in the Netherlands since the year 2012. As a consequence, there were no authorized operating limitations to ensure safe banner towing operations.

The pilot's survivability in case of a crash and post-crash fire was reduced by the installation of an additional fuselage fuel tank by the operator.

There was no assessment of the operational performance of the aeroplane after the installation of the fuselage fuel tank and the installation of the 4-blade propeller. The necessity for operational assessments is to be deduced from the evaluation requirements in the various supplemental certificates and regulations. Such assessments are vital instrument to evaluate the performance and to identify the safety risks caused by the configuration changes and thus ensuring safe operations.

4.3 Oversight

ILT did not perform active oversight on the operator from the operator's founding in 2008 until the day of the accident ten years later; the absence of oversight on the operator contributed to the persistence of safety deficiencies and safety risks. In case such safety performance, revealed by incidents, an active role from the Inspectorate towards operators is warranted.

4.4 Reporting culture

In a previous investigation as well in the current investigation, the Dutch Safety Board noticed a reluctance to report unsafe situations in the general aviation sector. It is important for the overall safety in the general aviation sector that occurrences are reported within companies as part of their safety management system, as well as filling mandatory and voluntary safety reports to ILT.

5 RECOMMENDATIONS

Specialized operations (SPO) inherently have an increased level of risk for operators, pilots and third parties. SPO operations such as banner towing, are governed by Regulation (EU) No 965/2012 and (EU) No 379/2014. These SPO regulations aim to increase the operators' level of safety and provides the member states with guidelines for effective oversight. The regulation on SPO has been in place since 1 July 2014 and became effective on 21 April 2017.

The Dutch Safety Board noticed a reluctance to report unsafe situations in the general aviation sector in this investigation and in an earlier investigation. To improve the reporting of unsafe situations within aviation companies and to the Aviation Occurrence Analysis Agency (ABL) of the Human Environment and Transport Inspectorate (ILT), every person involved in the general aviation sector is called upon to report unsafe situations and so to contribute to aviation safety.

To promptly increase and ascertain the level of safety in the SPO sector, the Dutch Safety Board makes the following recommendations.

To CNE Air:

1. Implement a fit for purpose safety management system to ensure that maintenance and operational hazards are known and that risks are managed. Make sure that the responsibility for safety management is appropriately appointed within the company. Finally, foster communication within the company and with people who work with the company, such as hired pilots and technicians, about operational safety matters.

To the Minister of Infrastructure and Water Management:

1. Improve the level of safety in the sector of Specialised Operations (SPO) and the safety of third parties by setting up and implementing an effective oversight program. The oversight program should include flight, ground and ramp inspections.

2. Strengthen the current ILT oversight capacity on SPO operators to match the array of oversight activities as demanded by European regulation. At a minimum, the goal must be to have all SPO operators entered in the oversight program and adequately inspected before March 2022.

To Specialised Operations Operators:

1. Specialised Operations (SPO) operators are urged to apply pertinent lessons from this accident to improve the safety of their operations.

Weight and balance

The information below clarifies the small weight and balance margin of SE-KHF as referred to in the aeroplane's flight manual addendum when operating in the normal and restricted categories.

The graph in Figure 10 illustrates the aircraft flight manual weight and balance regions for the normal (blue) and restricted (red) categories.[34] The graph further shows the actual weight and balance region of SE-KHF (grey area). The line 'abc' within the grey area, shows the centre of gravity change as a result of decreasing weight due to fuel consumption.

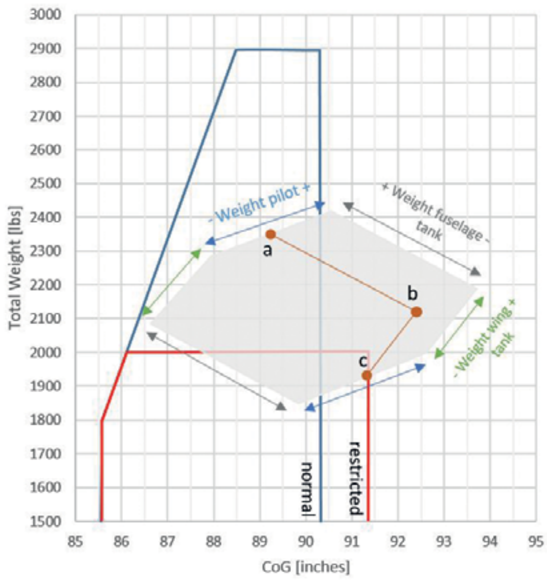


Figure 10: The centre of gravity limits for the normal and restricted categories (SE-KHF). (Source: Dutch Safety Board)

SE-KHF was fitted with an additional fuselage fuel tank which increased the aeroplane's weight with approximately 250 pounds.[35] This contributed to the exceedance of the maximum take-off weight. The aeroplane would not have been within the range for maximum weight for the restricted category, even if the fuselage fuel tank would have been empty (point 'b'). The aeroplane would only have been within weight range for the restricted category after fuel would have been used from the wing tanks (line 'bc').

34 The weight and centre of gravity limits for the normal category derived from SE-KHF aircraft flight manual and for the restricted category derived from the similar type aircraft flight manual (PH-BAT).
35 The estimated weight increase is based on the weight of fuselage fuel tank and weight of the fuel.

Furthermore the graph shows that SE-KHF's centre of gravity during operations in the normal category would have been too far aft, after the fuselage tank was less than halve full for the remainder of the flight.

Finally, the graph shows the effect on the centre of gravity when the pilots' weight is changed between 132 to 265 pounds (60 to 120 kilograms), proving the narrow for weight and balance margin. The aeroplane's flight manual weight and balance addendum cautioned that the centre of gravity limits change significantly only under influence of the pilots' weight.

APPENDIX B

Weather information

Additional weather information relevant to the time of the accident for area is provided below consisting of the Terminal Aerodrome Forecast (TAF) and the Meteorological Aerodrome Report (METAR) from Woensdrecht Air Base. Breda International Airport is located 11 NM north east of Woensdrecht Air Base.

TAF Woensdrecht Air Base

310500	TAF EHWO 3104448Z 3105/31/17 VRB08KT 0800 FG SCT001 BECMG 3105/3107 5000 SCT010 BKN 050 PROB40 TEMPO 3105/3110 4000 SHRA FEW010 SCT30CB BKN 050 TEMPO 3112/3117 3500 SHRA TSRA SCT050CB BKN060 PROB40 TEMPO 3112/3117 VRB15G25KT 2000 +TSRAGR FEW015 SCT040CB BKN050=

METAR Woensdrecht Air Base

METAR EHWO 310755Z AUTO 21007KT 180V260 4200 R25/1800D +SHRA FEW002 SCT006 BKN007 BKN015CB 18/18 Q1015 RETS YLO 24007KT 2500 +SHRA FEW007 SCT020CB BKN030 TEMPO 1000 +TSRA VRB6G16KT SCT007 SCT025CB BKN030=

METAR EHWO 310825Z AUTO 18003KT 100V260 6000 TSRA FEW005 SCT007 BKN015CB 18/18 Q1016 GRN 24007KT 5000 FEW015 BKN050 TEMPO VRB6G16KT 3000 +TSRA SCT010 SCT020CB BKN030=

METAR EHWO 310855Z AUTO 31004KT 290V010 4600 TSRA BKN015CB SCT085 OVC095 18/18 Q1015 GRN 24006KT 6000 FEW015 BKN050 TEMPO VRB05KT 3000 +TSRA SCT010 SCT020CB BKN030=

METAR EHWO 310925Z AUTO 34004KT 300V010 6000 SHRA BKN015CB BKN094 OVC099 18/18 Q1015 RETS WHT 24006KT 6000 FEW015 BKN050 TEMPO VRB05KT 3000 +TSRA SCT010 SCT020CB BKN030=

Propeller flight tests

The additional information about the flight test with the Hoffman HO 4/27 HM-185 propeller provide an indication of the fight test results for glider flying operations. These results are relevant for assessing the performance of the Hoffmann 4-blade propeller in general on the PA-25-235.

In 1984 the Federal Aviation Administration (FAA) approved the use of the Hoffmann 4-blade propeller with a pitch of 120 (HO 4/27 HM-185 (120)) for use with the PA-25-235 based on flight tests performed by Calistoga Soaring Centre. The approval states amongst others that it is only valid for PA-25 modified for the special purpose of glider towing and also it's applicability to PA-25 with type certificate 2A10.[36]

In Sweden flight tests have been performed in the period 1985-1986 to certify the HO 4/27 HM-185 (xxx) propeller for glider towing operations. The flight test report is not available anymore. The flight tests resulted amongst others in the certification of the 4-blade Hoffmann propeller with pitch ranches from 105 up to and including 120, as indicated in supplement S 3/79 to the SE-KHF aeroplane's flight manual.

In 1989 the United Kingdom Civil Aviation Authority (CAA UK) approved the use of the HO 4/27 HM-185 (115) propeller with the PA-25-235. This approval was based on the above mentioned FAA SA/2515NM approval and flight tests performed by the British Gliding Association. The CAA UK approval notes in the limitations section, Paragraph 6 that with the use of this Hoffmann propeller "the performance with this propeller will be significantly reduced".

Belgium flight tests were performed on 7 October 1993.[37] These flight tests entailed the towing of a glider aeroplane by the PA-25-235 using a standard McCauley 2-blade (1A200-FA8452) and the HO 4/27 HM-185 (115) propeller. The test results for the Hoffman propeller where amongst others that the achieved climb performance was 5,6° climb gradient; this is just above the minimum required climb gradient of 5.0° as stated in the report.

36 FAA, *Supplemental Type Certificate SA2515NM*.
37 Belgium Civil Aviation Authority, *Verslag proefvlucht slepen van een tweepersoonsvliegtuig met Piper Pawnee-235 kennletter OO-LVN*, 1993.

According to the test report, the Hoffmann 4-blade propeller had a considerable decreased towing performance in comparison to the original McCauley 2-blade propeller which had a 7,9° climb gradient. The report, which was directed at the Hoffmann Company, further states that the Hoffmann 4-blade propeller with 115 pitch would be difficult to sell as propeller for the PA-25-235 because of its “much lower climb” performance.

APPENDIX D

Fuselage fuel tank and pilots survivability

In 1987 concerns about the crashworthiness and pilot's survivability of the Piper PA-25 Pawnee where voiced by the PA-25 community as a result of the number of post-crash fires and fatalities. The US National Transport Safety Board (NTSB) investigated accidents with the PA-25 (from 1983 till 1987) to determine the relationship between differences in types of fuel tanks, post-crash fires and fatalities. The PA-25 was originally equipped with a fiberglass fuselage fuel tank. From 1967 the aeroplanes were equipped with a fiberglass fuselage fuel tank with a rubber inner liner. In 1974 the Piper PA-25 Pawnee D model was introduced. This model has a metal fuel tank in each wing, close to the wing tip.

According the NTSB investigation PA-25's with a fiberglass fuselage fuel tanks were found more susceptible to post-crash fires and fatalities than aeroplanes equipped with a rubber fuselage fuel tanks or metal wing fuel tanks. The reason for this is that the rigid fiberglass fuel tanks will distort and release a vast amount of fuel close to the hot engine parts as a result of catastrophic impact. In contrast to a flexible rubber inner liner fuel tanks which will rather puncture and release fuel in a smaller volume over time, causing a less intense fire and more time for the pilot to escape the aeroplane. Accidents with aeroplanes equipped with wing tanks showed a significant lesser susceptibility to post crash fires and fatalities. The Piper PA-25 Pawnee version 'D' (like SE-KHF) was originally equipped with metal wing tanks. The Pawnee D-version was produced starting 1974, no other versions were produced since.

To reduce the risk of these fatal injuries the NTSB issued a safety recommendation to the Piper Company and National Agricultural Aviation Association to propose the option to install a rubber fuselage fuel tank. (NTSB safety recommendation A-87-99, 22 July 1987). On 18 January 1988 Piper Aircraft issued Service Bulletin No. 878, to modify all Piper Pawnee aircraft to a rubber fuel cell liner in the fibreglass fuel tank

Other national civil aviation authorities adopted the recommendation from the NTSB and Piper Company. The CAA of Australia required the modification of all Piper Pawnee aircraft in accordance with Piper Service Bulletin No. 878, before 31 October 1988. Transport Canada responded by issuing a Service Difficulty Report AL-91-08, dated 16 December 1991, which "strongly recommended" that owners and operators of Piper PA-25 Pawnee aircraft replace original fuel tank assemblies with the ones specified in Piper Service Bulletin.

APPENDIX E

Responses to draft report

In accordance with the Dutch Safety Board Act, a draft version (without recommendations) of this report was submitted to the parties involved for review. The following parties have been requested to check the report for any factual inaccuracies and ambiguities:

- CNE air
- Vliegwerk Holland BV
- Volans Aviation Consultants
- European Union Aviation Safety Agency
- German Federal Bureau of Aircraft Accident Investigation
- Swedish Accident Investigation Authority
- National Transportation Safety Board
- Human Environment and Transport Inspectorate
- Ministry of Infrastructure and Water Management
- Relatives

The responses received, as well as the way in which they were processed, are set out in a table that can be found on the Dutch Safety Board's website (www.safetyboard.nl).

The responses received can be divided into the following categories:

- Corrections and factual inaccuracies, additional details and editorial comments that were taken over by the Dutch Safety Board (insofar as correct and relevant). The relevant passages were amended in the final report.
- Not adopted responses; the reason for this decision is explained in the table.
- Adopted responses; they are also listed in the table.

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