Havarikommissionen
Accident Investigation Board Denmark

BULLETIN

Accident

18-08-2013

involving

D-FWME

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FOREWORD

This bulletin reflects the opinion of the Danish Accident Investigation Board regarding the circumstances of the occurrence and its causes and consequences.

In accordance with the provisions of the Danish Air Navigation Act and pursuant to Annex 13 of the International Civil Aviation Convention, the investigation is of an exclusively technical and operational nature, and its objective is not the assignment of blame or liability.

The investigation was carried out without having necessarily used legal evidence procedures and with no other basic aim than that of preventing future accidents and serious incidents.

Consequently, any use of this bulletin for purposes other than preventing future accidents and serious incidents may lead to erroneous or misleading interpretations.

BULLETIN

General

File number:	HCLJ510-2013-242
UTC date:	18-08-2013
UTC time:	13:16
Occurrence class:	Accident
Location:	0,5 NM east of Copenhagen, Roskilde Airport (EKRK)
Injury level:	None

Aircraft

Aircraft registration:	D-FWME
Aircraft make/model:	MESSERSCHMITT BF109
Current flight rules:	Visual Flight Rules (VFR)
Operation type:	General Aviation Other Airshow/race
Flight phase:	Approach
Aircraft category:	Fixed wing Airplane
Last departure point:	Denmark EKRK (RKE): Copenhagen/Roskilde
Planned destination:	Denmark EKRK (RKE): Copenhagen/Roskilde
Aircraft damage:	Substantial

Notification

All times in this report are UTC.

The Aviation Unit of the Accident Investigation Board Denmark (AIB DK) was notified of the accident by Area Control Centre at Copenhagen Airport, Kastrup on 18-08-2013 at 13:25 hrs.

The European Aviation Safety Agency (EASA), the European Commission (EC), the International Civil Aviation Organization (ICAO), Bundesstelle für Flugunfalluntersuchung (BFU) and the Danish Transport Authority (DTA) were notified on 20-08-2013.

FACTUAL INFORMATION

History of the flight

The accident flight was a display flight on an air show at Copenhagen, Airport Roskilde (EKRK).

During the display flight, the pilot performed different maneuvers including step turns, barrel rolls and inverted flight.

In the last part of the display flight and for a period of approximately 10 seconds, the pilot demonstrated inverted flight.

Thereafter, the aircraft made a right turn (180°) in normal flight position and followed a traffic pattern with a second right turn to the cross wind leg to runway 21.

While flying the cross wind leg approximately 24 seconds after the inverted flight was performed, the engine started to misfire and afterwards lost all engine power.

Without success, the pilot attempted to restart the engine by using the engine wobble pump (primer).

Due to the low altitude (500 feet Above Ground Level), the pilot decided to gain altitude at the expense of airspeed realizing that any of the four runways or the grass area at the airport could not be reached.

The pilot moved the engine power lever to idle and selected the ignition off.

The pilot prepared an off field landing with the landing gear in the up position to avoid a nose flick over at touch down.

The pilot called Roskilde tower and reported: “Red 7 in trouble”.

The pilot selected a touchdown area in a cornfield 0.5 NM northeast of the airport. Approximately 12 seconds after the loss of engine power, the aircraft belly landed.

After the belly landing, there was no fire.

The pilot was uninjured and left the aircraft by himself.

Seven minutes after the activation of the emergency alarm by Roskilde tower, the airport fire & rescue service arrived at the accident site.

The accident occurred in daylight and in visual meteorological condition (VMC).

Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal			
Serious			
None	1		

Damage to aircraft

The aircraft was substantially damaged (See appendix 1)

Personnel information

The pilot held a valid German Airline Transport Pilot Licence ATPL (A) issued first time on 10-01-1999 and valid until 02-06-2015. The medical certificate was valid with no limitations.

Flying hours:	Last 24 hours	Last 90 days	Total
All types	-		15 000
Accident type	-	3:15	100
Landings accident type	-	7 ldg	-

Aircraft information

General

In 1950 in Spain, the aircraft was built as a Hispano (CASA) BF-109 as s/n 139.

In 2008, the aircraft was restored and rebuild to a Me 109-G6 version with the original 1475 HP 12 cylinder Daimler-Benz DB605 engine installed.

The propeller was a three bladed (wood) constant speed propeller.

The maximum take-off mass was 2850 kg and the empty mass was 2398 kg.

The latest mass check was performed on 13-12-2012.

Fuel system

The fuel capacity was 396 liters and recommended fuel type was AVGAS 100LL.

Before the display flight the aircraft was uplifted with 100 liter of AVGAS 100LL.

Total fuel on board was approximately 210 liters.

The engine fuel consumption at 2300 engine rpm and at supercharged pressure of 1.3 bar was approximately 2.9 liter/min.

The fuel tank was situated behind and below the pilot seat in the cockpit.
The two fuel supply lines in the fuel tank were one in the front and one in the rear of the fuel tank, respectively

The suction point in the front was five mm above the bottom of the fuel tank and seven mm above the bottom of the fuel tank in the rear, where the electrical fuel pump was placed. (See appendix 1).

The total amount of fuel that could be contained in the fuel lines between the fuel tank and the engine was 1.9 liter.

Airworthiness and flying time

The aircraft airworthiness certificate was issued on 17-06-2013 and was valid until June 2014.

The last 25 hour inspection was performed on 12-07-2013.

The flight time since the last overhaul was 122:50 hours.

At the time of the accident and after the restoration in 2008, the aircraft had accumulated 122:50 flight hours and 195 landings after the restoration in 2008.

The aircraft total flight hours were unknown.

Aircraft Flight Manual

The fuel tank internal component description in the Flughandbuch (Aircraft Flight Manual) was not in agreement with the actual aircraft fuel tank configuration.

According to the Aircraft Flight Manual the engine was not suitable for inverted flight. (See appendix 2)

Meteorological information

EKRK Automatic Terminal Information Service (ATIS)

This is Roskilde Airport information Z 1252
IFR flights expect ILS approach

Runway in use 21
Transition level 55
RK is out of service
Wind 219 13 knots
Visibility 20 km
Scattered 1200
Broken 2000
Temperature 18 dew point 16
QNH 1008
This was Roskilde information Z

Flight recorders

Flight recorders were neither installed nor required.

Video recording

The flight time flying inverted until the engine misfire was approximately. The engine sound was taken from a video recording and the sound from the engine was disturbed by general noise from the airshow.

Wreckage and impact information

Impact information

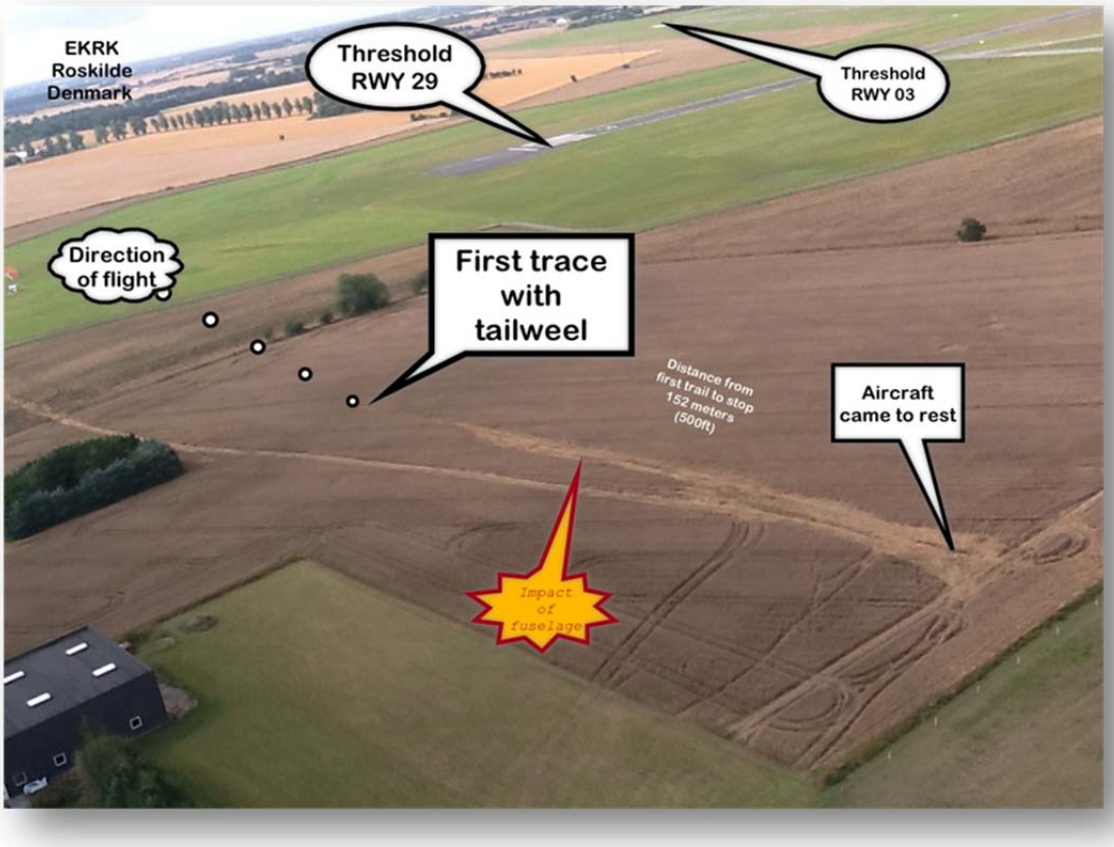
The aircraft first contact with the cornfield was with the tail wheel.

The total distance from the first wheel contact to the aircraft came to a full stop was 179 meters.

The distance from the first fuselage marks in the cornfield to a full stop was 152 meters.

Propellers slash mark and propeller blade debris was displaced 27 meters after the tail wheel impact and approximately 17 meters along the cornfield.

Accident site



Fuel system investigation

At the crash site immediately after the accident, the technical investigation was initiated by the AIB DK with support by the maintenance staff from the operator.

At that point of the investigation, a cause to the engine failure indicated some kind of fuel starvation.

The fuel amount was checked by dipstick and the fuel amount of the fuel tank indicated approximately 100 liters.

Later on during the investigation, when the main landing gear was in extended position (normal aircraft position on ground) the fuel amount was verified to be 180 liters.

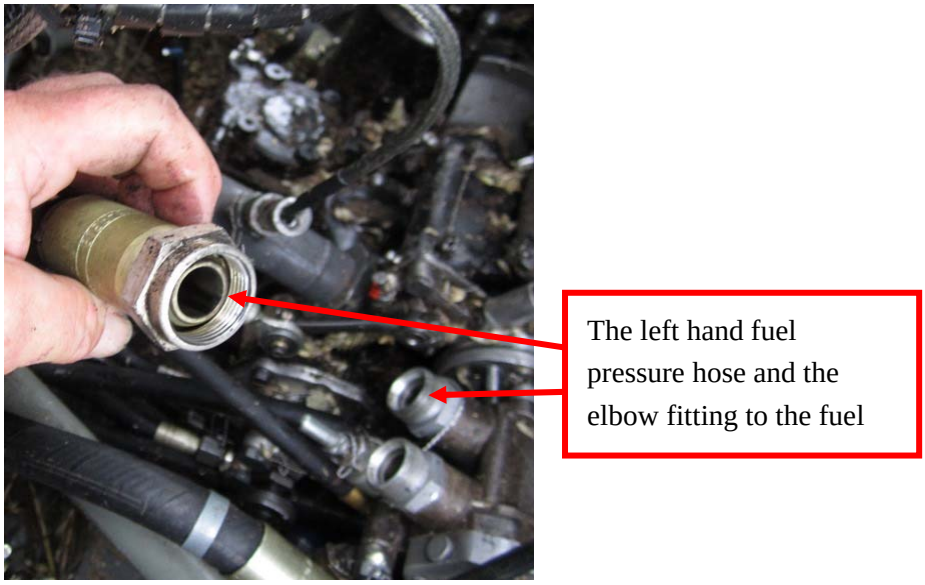
After removal of the engine cowlings, two fuel hoses between the firewall and the engine driven fuel injection pump were disconnected one by one, to verify fuel in the hoses.

The left hand fuel hose was a fuel hose that supplied fuel from the bottom of the fuel tank via an electrical fuel pump by pressure.

Normally the electrical fuel pump was only “ON” during take-off and landing.

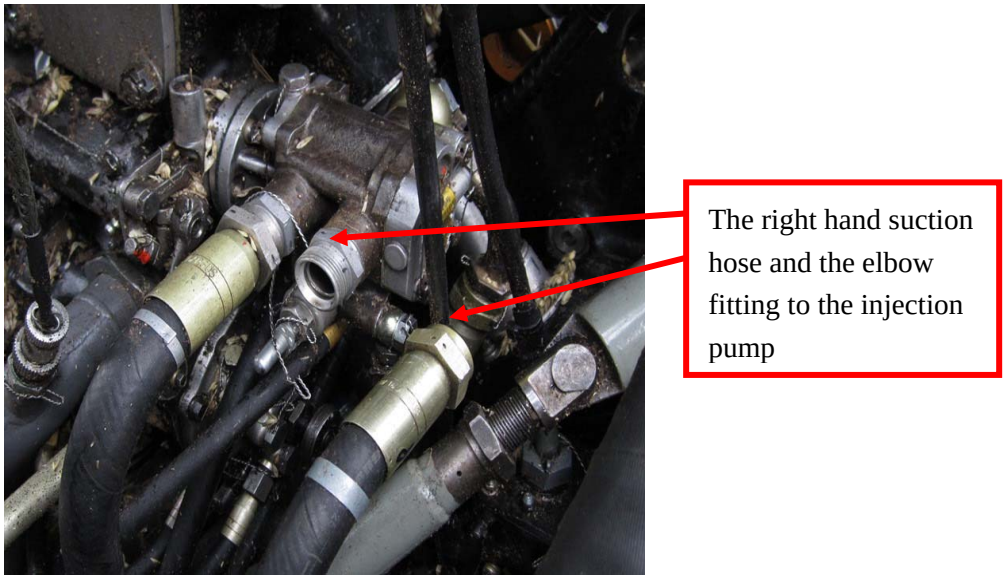
With the electrical fuel pump “OF” the engine driven fuel injection pump supplied fuel to the engine by motive flow.

The hose (pictured below) did only contain a few drops of fuel.



The right hand fuel hose sucked fuel from the bottom of the fuel tank by the engine driven fuel injection pump as motive flow.

The hose (pictured below) did only contain a few drops of fuel.



After the preliminary investigation at the accident site, the aircraft was transported to hangar facilities at EKRK for further investigation.

The main landing gear was manually extended, which made access to the aircraft fuel system.

Both fuel filters of the two supply lines were disassembled and neither contamination nor water was discovered.

Both fuel filters were almost full of fuel.

A fuel sample was taken and analyzed. The fuel analysis did not reveal any contamination.

Fuel tank investigation

The fuel tank was removed from the aircraft and a boroscope inspection was performed without remarks.

The fuel tank was turned upside down and situated in the same position as when the aircraft was flying inverted in level flight.
With respectively 320 liter, 250 liter and 180 liter fuel in the tank, a fuel supply test to the engine was performed.

The fuel supply test revealed that no fuel entered the engine injection fuel pump.

Engine investigation

The engine investigation was performed at an approved maintenance facility.

The investigation of the engine and the associated engine components did not reveal abnormalities or discrepancies which could lead to an engine misfire and engine stop.

ANALYSIS

During the display flight for a time period of approximately 10 seconds, the aircraft flew inverted.

For that period of time, the fuel stand pipes in the fuel tank were not emerged in fuel and air was sucked into the fuel supply system.

The engine fuel consumption at that time with 2300 rpm was approximately 2.9 liters/min.

After approximately 10 seconds of inverted flight the fuel amount in the fuel supply system was decreased by approximately 0.5 liters and the remaining fuel amount in the fuel supply system was approximately 1.4 liter.

Approximately 24 seconds after the inverted flight was completed, the engine started to misfire.
In this period of time, the engine consumed approximately 1.2 liter of the above mentioned 1.4 liter of fuel.

The test of the fuel tank in inverted position and with various amount of fuel verified that the fuel tank and the fuel supply system were not able to deliver fuel to the engine during inverted flight.

CONCLUSIONS

The accident was caused by fuel starvation as a consequence of inverted flight. The on board fuel system was not designed for inverted flight.

SAFETY RECOMMENDATION

Based on this investigation, the AIB DK did not issued recommendations.

However, as a consequence of the accident the operator revised the Flight Manual chapter 2.5 item 2.4:

1. Rückenflug ist verboten (Inverted flight is prohibited).

2. A detailed description of the aircraft fuel system will be incorporated in the Flight Manual Chapter 7. Flugzeug – und Systembeschreibung (Aircraft and system description.)

APPENDICES

Appendix 1: Aircraft damage
Appendix 2: Fuel system schematic
Appendix 3: Aircraft limitation

Appendix 1 – Aircraft damage
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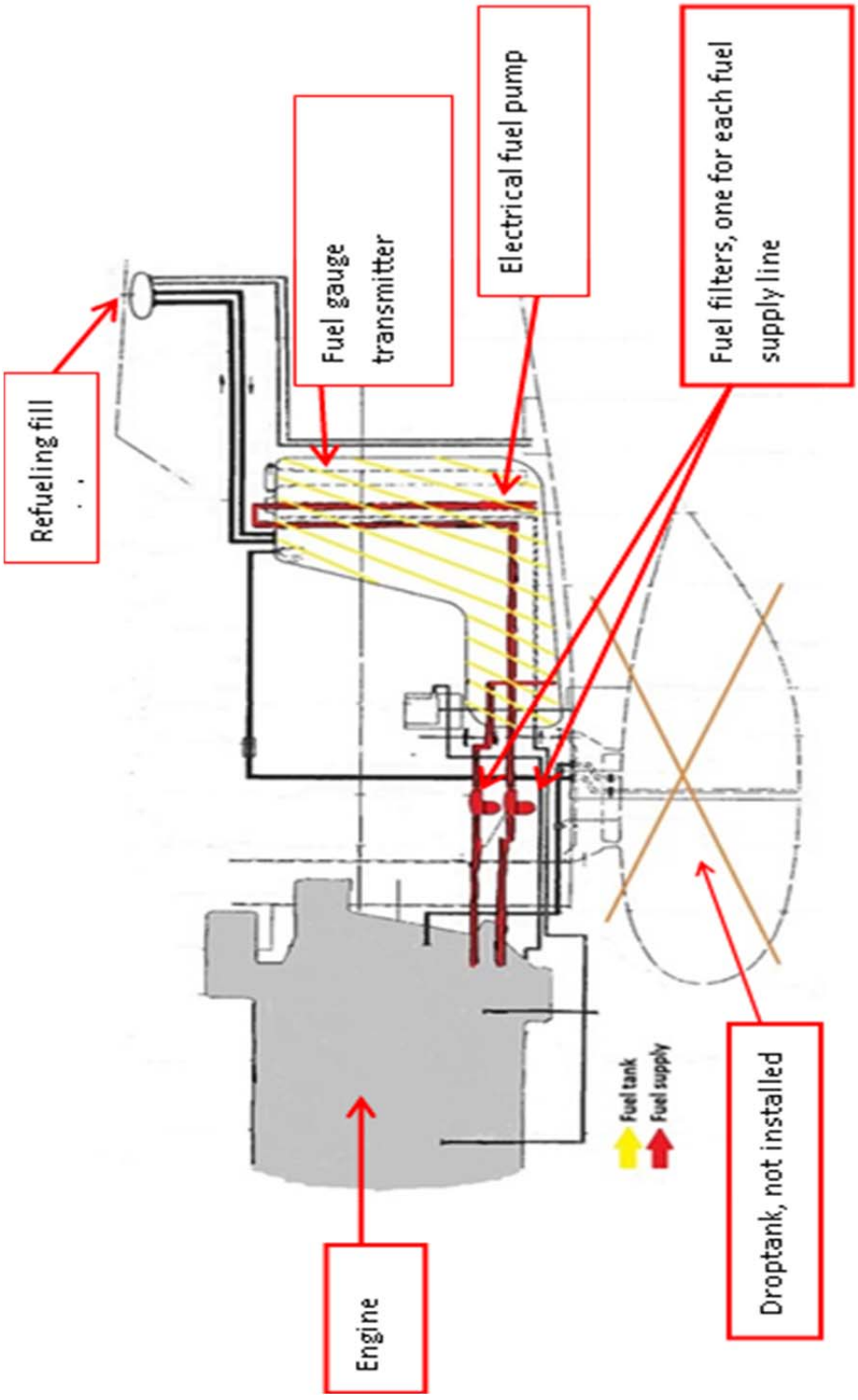
Ölpeilstab
Zu
Zu
Zu
18/08/2013 16:18

Appendix 2 - Fuel system schematic



Appendix 3 – Aircraft limitation

Bedienungsvorschrift

Me109 G-6

2.3.1	Zulässige Geschwindigkeit (IAS):			km/h IAS
	V_{ne} =	Höchstzulässige Geschwindigkeit		556
	V_{no} =	max. Reisegeschwindigkeit Normale Reisegeschwindigkeit	1.15/2300 1.05/1950	400 360
	V_a =	Manövergeschwindigkeit (Höchst-Geschwindigkeit für Flugmanöver bei vollem Ruderausschlag)		450
	V_f =	Höchstzulässigkeit Geschwindigkeit mit ausgefahrenen Landeklappen		250
	V_{lo} =	Höchstgeschwindigkeit zur Fahrwerkbetätigung		250
	V_{le} =	Höchstgeschwindigkeit mit ausgefahrenem Fahrwerk		350
2.4.	Lastvielfaches			+7g
	Motor ist für Rückenflug nicht geeignet			
2.5	Flugfiguren:	Rolle Looping, Auf-u.Abschwung	V_K IAS V_K IAS	≥ 300 ≥450
2.5.1	Beanspruchungsgruppe gemäß BVF 1933			H5K
2.6	Höchstzulässiges Fluggewicht			2850 kg
2.7	Besatzung/Zuladung			462 kg
2.8	Schwerpunktsbereich			
	Vorderste S-Lage: 278 cm		Hinterste S-Lage:	302 cm
2.8.1	Bezugsebene vertikal (BE)		2500 mm vor BP	
2.8.2	Bezugslinie horizontal (BL)		Meßpunkte links am Rumpf	
2.8.3	Leergewichtsschwerpunkt		273,4 cm von BE	

Engine is not suitable for inverted flight

2-5

ABSCHNITT 2
BETRIEBSGRENZEN