Havarikommissionen
Accident Investigation Board Denmark

Bulletin 2023-645

Serious incident to OY-JZN (Boeing 737-800) in Copenhagen, Kastrup (EKCH) on 21-12-2023

INTRODUCTION

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 EU Regulation 996/2010, the Danish Air Navigation Act and pursuant to Annex 13 of the International Civil Aviation Convention, the safety investigation is of an exclusively technical and operational nature, and its objective is not the assignment of blame or liability.

The safety investigation was carried out without having necessarily used legal evidence procedures and with no other basic aim than 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.

CONTENTS

GENERAL

State file number:	2023-645
UTC date:	21-12-2023
UTC time:	21:55
Occurrence class:	Serious incident
Location:	Copenhagen, Kastrup (EKCH)
Injury level:	None
Aircraft registration:	OY-JZN
Aircraft make/model:	Boeing 737-800
Current flight rules:	Instrument Flight Rules (IFR)
Operation type:	Charter
Flight phase:	En route
Aircraft category:	Fixed wing
Last departure point:	Hurghada (HEGN)
Planned destination:	Billund (EKBI)
Aircraft damage:	None
Engine make/model:	2 x CFM56-7B26

SYNOPSIS

Notification

All time references in this bulletin are Coordinated Universal Time (UTC).

The Aviation Unit of the Danish Accident Investigation Board (AIB) was notified of the serious incident by the Area Control Centre on 21-12-2023 at 22:40 hours (hrs).

The AIB notified the Danish Civil Aviation and Railway Authority (DCARA), the US National Transportation Safety Board (NTSB), the European Aviation Safety Agency (EASA), the Directorate-General for Mobility and Transport (DG MOVE) and the International Civil Aviation Organisation (ICAO) on 22-12-2023 at 13:51 hrs.

The NTSB accredited a non-travelling representative to the safety investigation.

Summary

Following a missed approach due to windshear at the destination aerodrome, a flap overspeed occurred during initial climb-out.

The Flap Slat Electronic Unit (FSEU) commanded an automatic flap retraction while the flight crew simultaneously moved the flap handle to position 15°. A flap solenoid valve failed to reset, and the FSEU removed power to the flap drive system when the flaps were retracting at position 13°.

Due to the weather conditions, the flight crew decided to divert to the destination alternate aerodrome.

The increased fuel consumption due to the flap 13° non-normal aircraft configuration reduced landing fuel to less than the required minimum final reserve.

The flight crew declared a fuel emergency leading to Air Traffic Control (ATC) priority and direct routing.

The aircraft landed with 119 kilos (kg)/(three minutes) less than the required minimum final reserve fuel of 1,118 kg/(30 minutes).

This serious incident occurred in darkness and under Visual Meteorological Conditions (VMC).

FACTUAL INFORMATION

History of flight

The serious incident occurred during a charter flight from Hurghada (HEGN) to Billund (EKBI) with Gothenburg (ESGG) as destination alternate.

A technical malfunction of a leading edge flap proximity sensor, occurring on the previous flight, delayed the serious incident flight for 28 hours.

At HEGN before departure, an operator aircraft technician corrected the malfunction.

Due to the delay, the flight crew updated the Operational Flight Plan (OFP) with assistance from the operator Operational Control Centre (OCC). The available OFP indicated a minimum required fuel of 16,814 kg. Based on the latest winds aloft forecast, OCC verbally communicated to the flight crew a revised minimum required fuel of 17,400 kg.

The flight crew did not succeed in updating the OFP with the latest winds aloft forecast on their Electronic Flight Bags (EFB) and based their flight planning on 16,814 kg of minimum required fuel.

Because of the outdated winds aloft forecast, a forecasted storm in Denmark, and the previous technical malfunction, the flight crew decided to add 1,186 kg of extra fuel. The aircraft departed HEGN at 15:45 hrs with 17,890 kg of take-off fuel.

At 18:20 hrs, approximately halfway between HEGN and EKBI, the flight crew noticed that the estimated landing fuel had decreased from 4,000 kg to 3,200 kg. The flight crew decided to change destination alternate from ESGG to Copenhagen, Kastrup (EKCH), as EKCH was located closer to EKBI than ESGG and had more favourable wind conditions.

At 21:09 hrs, the aircraft, with an onboard remaining fuel quantity of 3,278 kg, was established on the Instrument Landing System (ILS) for runway 27 in EKBI.

At 21:10:06 hrs, Billund Approach/Tower cleared the aircraft to land and instructed the flight crew that in case of a missed approach, they were cleared to climb to any altitude they desired. The wind conditions were 310°/36 knots (kt), gusting 50 kt minimum 17 kt.

During the approach, the flight crew experienced strong winds but the aircraft remained stabilised passing 1,000 feet (ft) and 500 ft above ground level (agl). At a radio altitude of 300 ft, the Enhanced Ground Proximity Warning System (EGPSW) presented an aural windshear warning, and the flight crew decided to go around and perform a missed approach.

The flight crew selected Take-Off and Go-Around (TOGA) thrust, selected the landing gear to up position, and moved the flap lever from 30° to 15°. At that point, the remaining fuel quantity was 3,090 kg.

Climbing through 725 ft radio altitude, the flight crew identified a trailing edge flap disagree condition. The flap lever position was at 15°, and the flap position indicator indicated 13°.

The flight crew levelled off at 4,000 ft, and Billund Approach radar vectored the aircraft north of EKBI and onto an easterly heading in preparation for a new approach. The flight crew initiated the “Trailing Edge Flap Disagree” Non-Normal Checklist procedure.

At 21:17:16 hrs, the flight crew informed Billund Approach that they diverted to EKCH, and that they had a stuck flap condition. The remaining fuel quantity was 2,837 kg.

Billund Approach cleared the aircraft to climb to Flight Level (FL) 120 and instructed the flight crew to contact Copenhagen Control.

At 21.22:32 hrs, the flight crew contacted Copenhagen Control and requested a climb to FL 180 and stated: “We have a stuck flap, and would like some kind of priority for runway 30”.

Copenhagen Control cleared the aircraft to climb to FL 180 inbound the waypoint COPHO for a short left hand approach to runway 30 in EKCH. The flight crew informed about souls onboard, expected fuel upon landing and a higher than normal approach and landing speed.

En route to EKCH, a revised fuel calculation based on the non-normal aircraft configuration indicated a remaining flight time to EKCH of 20 minutes and a remaining flight endurance of 38 min. The required minimum final reserve fuel was 30 minutes/1,118 kg.

At 21:33:49 hrs, the flight crew declared an emergency: “Mayday, Mayday, Mayday due to fuel”. Copenhagen Control acknowledged the distress call.

Copenhagen Control suggested Roskilde (EKRK) as an alternate diversion aerodrome. The aircraft was approximately over the town of Jyderup in level flight at FL 180.

The flight crew requested the latest weather conditions for EKCH, received the information, and decided to continue to EKCH.

Copenhagen Control transferred the flight crew to Copenhagen Approach.

Copenhagen Approach instructed the flight crew to descend to 4,000 ft and radar vectored the aircraft onto the ILS for runway 30 in EKCH.

At 21:47:14 hrs and in accordance with the Non-Normal Checklist, the flight crew extended the trailing edge flaps to 15°.

Established on final for runway 30, Copenhagen Approach transferred the flight crew to Kastrup Tower.

Kastrup Tower cleared the aircraft to land on runway 30 and reported the wind conditions to be 290°/26 kt, gusting 40 kt.

At 21:54:19 hrs, the aircraft landed on runway 30 with a remaining fuel quantity of 999 kg, and taxied to the assigned aircraft stand.

Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal			
Serious			
None	7	178	

Damage to aircraft

None.

Other damage

None.

Personnel information

License and medical certificate – the commander

The commander – male, 51 years – was the holder of a valid Airline Transport Pilot License (ATPL (A)) issued by the DCARA.

The rating B737 300-900/Instrument Rating (IR) was valid until 17-12-2024.

The medical certificate (class 1) was valid until 01-11-2024.

Flying experience – the commander

	Last 24 hours	Last 90 days	Total
All types	0	50	12,768
This type	0	50	3,789

License and medical certificate – the first officer

The first officer – female, 53 years – was the holder of a valid Commercial Pilot License (CPL (A)) issued by the DCARA.

The rating B737 300-900/IR Co-pilot only was valid until 30-11-2024.

The medical certificate (class 1) was valid until 27-03-2024.

Flying experience – the first officer

	Last 24 hours	Last 90 days	Total
All types	0	190	11,080
This type	0	190	5,100

Duty time and fatigue

On the day of the serious incident, the flight crew checked in at 10:30 hrs (after a rest period of 18 hrs) to support the aircraft technician rectifying the technical malfunction.

The operator maximum daily flight duty period for acclimatised crew with check-in time from 06:00 hrs until 13:29 hrs was 13 hrs.

During the serious incident flight, the flight crew did not experience fatigue.

Aircraft information

General information

Manufacturer:	Boeing Aircraft Corporation
Type:	737-8K5
Serial number:	34689
Airworthiness review certificate:	Valid until 8-11- 2024
Engine manufacturer:	CFM International
Engine type:	CFM56-7B26
Maximum take-off mass (MTOM):	78,999 kilogram (kg)
Maximum landing mass (MLM):	65,137 kg
Maximum fuel capacity:	20,896 kg
Fuel on board (TO/LA):	17,890 kg/999 kg
Aircraft total flight hours:	59,699
Latest maintenance:	Service check on 20-12-2023

Mass and balance

The operator loadsheet – see appendix 1.

Meteorological information

General overview

During the period between early morning on 21-12-2023 and until the afternoon on 22-12-2023, a deep low pressure passed north of Denmark, moving from west towards east.

According to the Danish Meteorological Institute (DMI) “Storms in Denmark since 1891”, and in extract below, the low pressure generated average wind speeds corresponding to a Class 2 storm:

Class 4		**Class 3**		**Class 2**		**Class 1**	
Strong storm to hurricane ≥ 28,5 m/s		Strong storm (hurricane-like) ≥ 26,5 m/s		Storm ≥ 24,5 m/s		Stormy weather ≥ 20,8 m/s	
National > 30%	Regional 10-30%	National > 30%	Regional 10-30%	National > 30%	Regional 10-30%	National > 30%	Regional 10-30%

Figure 1: DMI Storm classification scheme.

The storm was named Pia, and DMI published the below prognostic chart (in extract), valid on 21-12-2023 at 24:00 hrs:

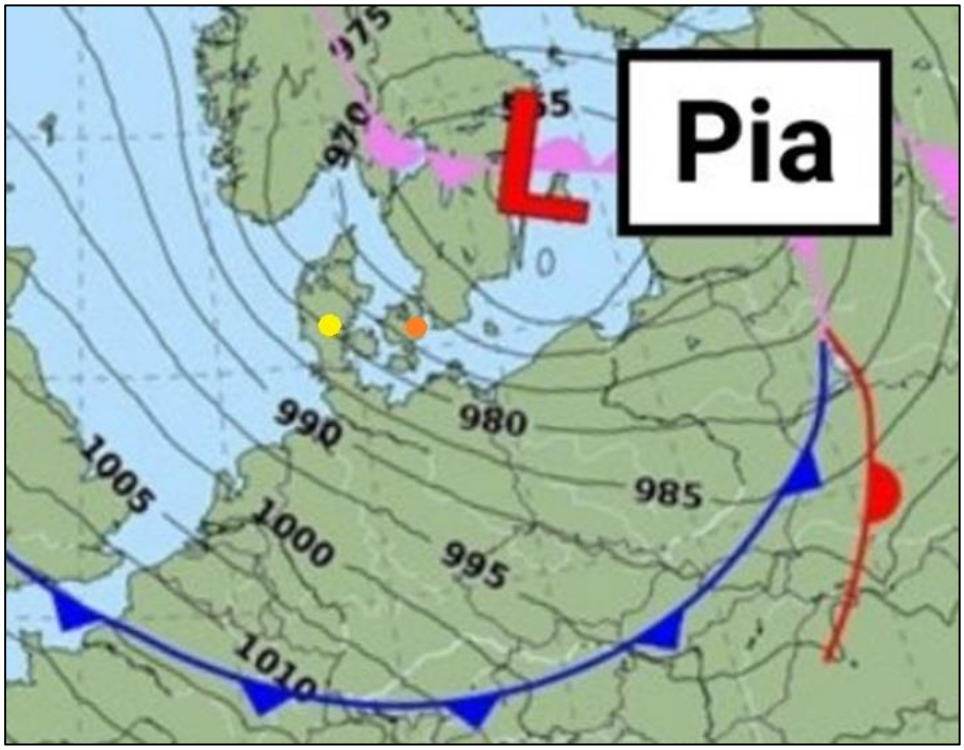

Figure 2. DMI prognostic chart.
The AIB marked EKBI with a yellow dot and EKCH with an orange dot.

Terminal Aerodrome Forecast (TAF)

EKBI 211102Z 2112/2212 29025G45KT 9999 SCT015 TEMPO 2112/2118 29030KT 4000 SHRA BKN012 BKN020CB TEMPO 2118/2206 31035G55KT 1500 SHRASN BKN008 SCT020CB TEMPO 2206/2212 BKN012 SCT020CB=

EKBI 211700Z 2118/2218 30035G55KT 9999 SCT015 TEMPO 2118/2204 30030KT 1500 SHRASNGS BKN008 BKN020CB BECMG 2204/2206 31030G40KT TEMPO 2204/2206 3000 -SHRASNGS BKN012 SCT020CB TEMPO 2206/2211 30025KT SCT020TCU BECMG 2211/2214 31020G30KT BECMG 2214/2217 29010KT=

EKCH 211105Z 2112/2212 22020KT 9999 BKN020 TEMPO 2112/2113 24020G30KT 4000 RA BKN008 BECMG 2113/2115 28028G42KT TEMPO 2113/2115 SHRA BKN012 SCT020CB TEMPO 2115/2119 SHRA SCT020CB TEMPO 2119/2202 29035G55KT 2500 SHRASN BKN012 SCT020CB TEMPO 2202/2212 30030G50KT -SHRASN SCT020CB=

EKCH 211700Z 2118/2218 29025G42KT 9999 BKN020 TEMPO 2118/2202 30035G52KT 2000 SHRASN BKN012 SCT020CB TEMPO 2202/2218 30025KT -SHRASN SCT020CB=

Aviation Routine Weather Report (METAR)

EKBI 212050Z AUTO 30029G46KT 9999 BKN028/// 04/M01 Q0977=

EKBI 212120Z AUTO 29035G50KT 270V330 9999 OVC036/// 04/M03 Q0978=

EKBI 212150Z AUTO 30027G44KT 270V330 9999 OVC037/// 04/M03 Q0979=

EKCH 212124Z 29024G36KT 4000 SHRA BKN015CB 04/02 Q0969 BECMG 9999 - SHRA SCT020CB=

EKCH 212150Z 29027G40KT 9999 BKN027CB 05/01 Q0969 NOSIG=

EKCH 212220Z 29029G50KT 5000 BKN018CB 04/01 Q0971 TEMPO 29030G45 3000 SHRASN BKN012 SCT020CB=

Communication

In Denmark the flight crew communicated with (in extract):

Billund Approach/Tower (same air traffic controller) (127.575 Megahertz (MHz))
Copenhagen Control (133.155 MHz)
Copenhagen Approach (119.805 MHz)
Kastrup Tower (118.105 MHz)

The AIB requested a copy of the radio communication from the Air Navigation Service Provider (ANSP). The audio recordings were of good quality and useful to the safety investigation.

Aerodrome information

General information

EKBI:

Aerodrome Reference Point:	55 44 25.16N 009 09 06.40E
Elevation:	247 ft
Runway directions:	09/27
Dimensions runway 27:	3,100 meter (m) x 45m
Surface runway 27:	Asphalt
Landing distance available runway 27:	2,951 m

EKCH:

Aerodrome Reference Point:	55 37 04.50N 012 39 21.50E
Elevation:	17 ft
Runway directions:	04L/22R, 04R/22L, 12/30
Dimensions runway 30:	2,365 m x 45m
Surface runway 30:	Asphalt
Landing distance available runway 30:	2,095 m (excluding 300 m stopway)

Flight recorders

The operator downloaded the aircraft Quick Access Recorder (QAR).

The downloaded data were of good quality and useful to the AIB safety investigation.

The AIB forwarded, via the NTSB, a copy of the QAR data to the aircraft manufacturer for further analysis.

Upon the serious incident, the Cockpit Voice Recorder (CVR) circuit breaker was not pulled. Relevant CVR data was overwritten and thus not available for the safety investigation.

Organization and management

Fuel planning requirements

The Commission Regulation (EU) 965/2012 (Part-OPS) section CAT.OP.MPA.150 Fuel Policy contained the legislation for the EASA fuel policy which included CAT.OP.MPA.180/181 Fuel/energy scheme – fuel/energy planning and in-flight re-planning policy – aeroplanes.

The operator implemented these criteria in the operator Operations Manual part A (OM-A) 8.1.7 Determination of the quantities of fuel and oil carried.

In brief, the operator should ensure that the pre-flight fuel calculation included:

- Taxi fuel (to taxi prior to departure).
- Trip fuel (for take-off and flight to the destination).
- Contingency fuel (3% of contingency fuel for unforeseen factors).
- Alternate fuel (for diversion to an alternate (if required)).
- Additional fuel (to cope with any additional known or expected delays).
- Final reserve fuel (fuel to fly for 30 minutes at holding speed at 1,500 ft above the destination alternate aerodrome).
- Extra fuel (if required by the commander).

OM-A 8.3.7.3.1 stipulated procedures regarding final reserve fuel:

> 8.3.7.3.1 Final reserve fuel protection
>
> The objective of the final reserve fuel protection is to ensure that a safe landing is made at any aerodrome when unforeseen circumstances may not allow to safely complete the flight, as originally planned.
>
> The commander should always consider first planning a safe-landing option and estimating whether this landing can be performed with more than the final reserve fuel. When this estimation indicates that the final reserve fuel can no longer be protected, then a fuel emergency should be declared and any landing option explored (e.g. aerodromes not assessed by operators, military aerodromes, closed runways), including deviating from rules, operational procedures, and methods in the interest of safety.

Operational flight plan

According to the operator OM-A, an OFP should be prepared and used for the flight.

The OM-A stipulated that the OFP should indicate sufficient take-off fuel quantity to safely perform the flight without infringing the provisions in the OM-A 8.1.7.

The winds aloft forecast was included as a parameter when calculating the required amount of fuel.

The operator electronic systems did not automatically send an updated OFP to the flight crew EFB when a flight was postponed/delayed past midnight. This caused the EFB to present the original OFP based on the original data including outdated winds aloft forecast.

Flight crew could manually update the OFP in the EFB, but the OM-A and/or OM-B did not describe this procedure.

Fuel planning and consumption

Before departure, the flight crew revised the original fuel calculation performed on 20-12-2023.

A change of the destination alternate aerodrome from Aarhus (EKAH) to ESGG increased the amount of alternate fuel by 842 kg.

Because of the outdated winds aloft forecast, the technical issue occurring on the previous flight, and the prevailing weather conditions in Denmark at the expected time of arrival, the commander decided to add 1,186 kg of extra fuel (28 minutes extra flight time).

The revised fuel planning added a total of 2,028 kg, increasing the Block-off fuel to 18,000 kg as presented below:

Fuel planning	Planned on 20-12-2023	Revised on 21-12-2023
Taxi	200 kg	200 kg
Trip	13,445 kg	13,445 kg
Contingency	403 kg	403 kg
Alternate	(EKAH) 806 kg	(ESGG) 1,648 kg
Additional	0 kg	0 kg
Final reserve	1,118 kg	1,118 kg
Minimum required	15,972 kg	16,814 kg
Extra	0 kg	1,186 kg
Block-off	15,972 kg	18,000 kg

Upon the serious incident flight, the operator calculated diversion fuel from EKBI to EKCH to be 1,478 kg, giving a minimum required fuel at the time of go-around in EKBI of 2,596 kg.

The actual fuel burn from the time of go-around in EKBI until landing in EKCH was 2,091 kg due to the aircraft non-normal configuration with flaps extended to 13°.

Trailing Edge Flap Disagree

Flap drive system

In order to prevent flap structural damage in the event of a flap overspeed condition, the aircraft manufacturer designed the aircraft with a flap load relief system. If the FSEU sensed a flap overspeed condition, the FSEU commanded the flap load relief solenoid to retract the flaps by one detent.

A FSEU built-in protection (Uncommanded Motion) would shut down the flap drive system if movement of the flaps disagreed with the selected flap handle position. During a FSEU flap auto-retract command, the Uncommanded Motion protection was disabled.

In October 2013, the aircraft manufacturer published a Fleet Team Digest (FTD) document notifying operators that the trailing edge control valve installed on the aircraft at the time (type 1 valve) had been superseded by an updated version of the part (type 2 valve). The new part incorporated new seals that reduced friction on the flap load relief valve sleeve.

The aircraft manufacturer noted that during some pre-delivery test flights, the flap load relief solenoid failed to reset after the FSEU began a flap load relief retraction if the flight crew commanded a similar retraction at about the same time using the flap handle.

One additional received in-service report described similar behaviour, so updated valves (type 2 valves) were developed and installed on new production aircraft and offered to operators of existing aircraft. In the FTD, the aircraft manufacturer noted that the older control valves (type 1 valves) could be replaced by attrition, meaning that type 1 valves that operated normally did not need to be replaced.

Flap drive system shutdown

During flap retraction following the go-around in EKBI, the flap drive shutdown occurred.

During the missed approach procedure, QAR data presented four flap overspeed events, one coinciding with a flight crew flap handle movement.

The flight crew performed the “Trailing Edge Flap Disagree” Non-Normal Checklist procedure resulting in the non-normal flap configuration for the remaining part of the flight.

Post flight inspection

The operator maintenance department performed an aircraft post flight inspection and troubleshooting, including a FSEU Built-in Test Equipment (BITE) and fault code read-out. The read-out did not disclose any exiting fault code, only a historic fault code related to the previous leading edge flap sensor issue. Furthermore, the operator maintenance department performed a visual inspection and an operational test of the trailing edge flap system without any findings.

Because the aircraft had the type 1 valve installed, and because of QAR data analysis, the operator maintenance department concluded that the trailing edge flap drive system shutdown was due to the high friction issue described in the aircraft manufacturer FTD.

The operator maintenance department replaced the valve and released the aircraft back to service.

The aircraft manufacturer agreed that the above scenario was the most likely explanation for the flap drive system shutdown.

Additional information

On 21-12-2023 from 12:00 hrs until 24:00 hrs, 14 out of 39 approaches in EKBI were unsuccessful and resulted in a go around, all due to strong winds and windshear.

ANALYSIS

General

To the AIB, the following had no negative influence on the sequence of events:

- Flight crew licenses, qualifications and aircraft type flying experience.
- Flight crew flight and duty time (with no indications of fatigue).
- Aircraft mass and balance.

The pre-flight planning

The flight crew performed pre-flight planning with assistance from the operator OCC, based on the requirements in the OM-A 8.1.7 which were in line with the EASA fuel policy CAT.OP.MPA.180/181.

The commander decided to upload 1,186 kg of extra fuel taking into account the following factors:

- The flight crew did not succeed in updating their OFP and receiving the latest winds aloft forecast on their EFB.
- The forecasted weather conditions (storm) in Denmark at the time of arrival.
- A perceived risk of the previous leading edge flap proximity sensor malfunction reappearing during flight.

The 1,186 kg extra fuel provided 28 minutes of extra flight time allowing a reasonable operational margin. However, it was based on the original winds aloft information and not on the updated information.

For comparison, and based on the updated winds aloft forecast, the operator OCC calculated the minimum required fuel to be 17,400 kg. The operator OCC calculation reduced the operational margin (extra fuel) to 582 kg or approximately 50 % but still exceeded the operator OM-A 8.1.7 requirements.

The reason to add extra fuel because of the previous leading edge flap proximity sensor malfunction seemed unsubstantiated.

The change of the destination alternate aerodrome from EKAH to ESGG improved the possibilities for inflight re-planning, because a number of useable destination alternate aerodromes were located farther away from EKBI than EKAH but closer than ESGG.

The AIB considers the upload of extra fuel to be rational. However, it is worth noting that the aircraft fuel capacity and maximum take-off and landing masses allowed an extra fuel quantity of up to 4,082 kg, or 2896 kg more than the uplifted 1,186 kg. Considering the relatively long flight in “unknown” wind conditions, and the rather extreme weather conditions in Denmark, it might have been suitable to uplift more extra fuel than the uplifted 1,186 kg.

The flight to EKBI

After departure from HEGN, the flight proceeded as planned until the flight crew noticed stronger headwinds than anticipated resulting in an increased fuel consumption.

The flight crew checked the latest weather conditions for the area and changed the destination alternate aerodrome to EKCH. The flight crew decision reduced the required destination alternate fuel with 170 kg, indirectly increasing the amount of extra fuel available at the time.

The missed approach

The flight crew configured the aircraft for the ILS approach to runway 27 in EKBI. The flight crew was aware of the weather conditions and got an ATC clearance to climb to any altitude in case of a missed approach.

Due to the unusual high rate of missed approaches in EKBI during the day, ATC likely anticipated a higher than normal possibility of a missed approach.

Until shortly before the go-around, the approach was stabilised. However, and due to wind shear, the approach ended in a missed approach.

When the flight crew initiated the missed approach, the remaining fuel quantity was 3,090 kg that was 494 kg higher than the required fuel quantity of 2,596 kg with EKCH as the destination alternate aerodrome (in normal configuration with retracted flaps).

The flap drive system shutdown

QAR data presented four flap overspeed events during the missed approach, most likely due to windshear.

One flap overspeed event resulted in a FSEU flap load relief automatic flap retraction when the flight crew coincidently selected a flap setting of 15° during the go-around. The flap load relief solenoid likely failed to reset after the FSEU load relief was removed, causing the flaps to retract beyond the selected 15°, i.e. to 13°. The FSEU registered this as an Uncommanded Motion, and as per design and as a cautionary action, removed power to the flap drive system.

The aircraft manufacturer addressed this issue in the FTD and informed the aircraft operators of a mitigating action (non-mandatory) by replacement of the solenoid valve. At the time of the serious incident, the operator had not experienced this issue, and refrained from changing functional type 1 valves.

For the remaining part of the flight and until on short final to runway 30 in EKCH, the flaps remained at a flap position of 13°.

The diversion to EKCH

Following the missed approach and due to the weather conditions in EKBI and the stuck flap condition, the flight crew decided to divert to EKCH.

The flight crew assessed the consequences of the stuck flaps, i.e. increased drag causing an increased fuel consumption and a reduced control of the aircraft flaps/slats configuration. The flight crew informed ATC of their situation and requested a short routing to EKCH that ATC provided. Thus and from this point, the flight crew included ATC as a mitigating resource.

A recalculation of the expected fuel burn for the diversion to EKCH indicated that the aircraft would land with less than the required minimum final reserve fuel.
The recalculation prompted the flight crew to declare a fuel emergency, formally ensuring ATC priority and was in line with the operator OM-A.

ATC provided assistance and priority to the aircraft for the remaining part of the flight and in addition suggested an alternate course of action to the flight crew, i.e. offering EKRK as a destination alternate aerodrome.

This could potentially have shortened the flight distance from overhead the town of Jyderup with approximately 15-17 nm or four minutes of flight time. However, the aircraft flight altitude seemed to be high for an optimum descent and landing in EKRK, and the runway length (available landing distance) in EKRK was shorter than in EKCH. Additionally, it would increase the flight crew workload at a critical time, because a landing in EKRK would require a new approach planning and likely extra communication with the operator OCC for post landing logistic purposes.

The AIB considers the flight crew decision to continue to EKCH as the safest course of action at that time. ATC provided the shortest possible routing, and EKCH had larger ground support and emergency services of available alternate aerodromes.

Fuel management

The aircraft landed in EKCH with 999 kg/27 minutes of remaining fuel. The remaining fuel was 119 kg/three minutes less than the required minimum final reserve fuel according to the operator OM-A and EASA regulations.

Throughout the flight, the flight crew focused on the fuel consumption and the weather conditions and acted proactively when the circumstances changed.

After the missed approach in EKBI, and had it not been for the unexpected stuck flap situation, the aircraft would have landed in EKCH with more than the required minimum final reserve fuel.

As the situation evolved, suitable alternate aerodromes and remaining fuel were limited, leaving the flight crew with few options other than divert to EKCH and declare a fuel emergency.

ATC priority mitigated the consequences but could not prevent a landing with less than the required minimum final reserve fuel.

The flight crew opted not to go beyond the non-normal checklist and attempt to retract the flaps in order to reduce the unexpectedly increased fuel consumption. This is an option available to any commander if deemed necessary for flight safety reasons. Considering the quantity of the fuel shortage versus any possible unexpected consequences of going beyond the checklist, the AIB considers the decision to be rational.

CONCLUSION

Summary

Following a missed approach due to windshear at the destination aerodrome, a flap overspeed occurred during initial climb-out.

The FSEU commanded an automatic flap retraction while the flight crew simultaneously moved the flap handle to position 15°. A flap solenoid valve failed to reset, and the FSEU removed power to the flap drive system, when the flaps were retracting at position 13°.

Due to the weather conditions, the flight crew decided to divert to the destination alternate aerodrome.

The increased fuel consumption due to the flap 13° non-normal aircraft configuration reduced landing fuel to less than the required minimum final reserve.

The flight crew declared a fuel emergency leading to ATC priority and direct routing.

The aircraft landed with 119 kg)/(three minutes) less than the required minimum final reserve fuel of 1,118 kg/(30 minutes).

PREVENTIVE ACTIONS

Following the serious incident, the operator implemented a number of preventive safety measures:

1) The operator issued an OM-A/-B Bulletin – Flight Preparations Instructions, which incorporated a procedure on when and how to update the OFP in the EFB, to ensure operation with current OFP data (short-term solution).
2) To ensure development of EFB software to exclude the possibility of the valid OFP being hidden from the flight crew (long-term solution).
3) The replacement of all Trailing Edge Control type 1 valves with type 2 valves on the operator aircraft.
4) To include the serious incident in both internal promotion and in training for flight crews, with focus on application of non-normal checklist procedures and troubleshooting beyond the scope of the non-normal checklist.

APPENDIX 1

Return to mass and balance

```
L O A D S H E E T            CHECKED                    APPROVED
ALL WEIGHTS IN KILOGRAMS      (COMM)    ON 21 DEC       (COMM) ON 21 DEC 2023
                              2023 1441Z                1441Z
FROM/TO FLIGHT          A/C REG  VARIATION        CONFIG     DATE        TIME
HRG BLL                 OYJZN    OYJZN - 737-800SSW 2/4        20 DEC 2023 1330Z
HEGN EKBI
                        WEIGHT           DISTRIBUTION
LOAD IN COMPARTMENTS    1730   0 0 480 0 1250 0 0
PASSENGER / CABIN BAG   12709  076/084/017/001 TTL 177
TOTAL TRAFFIC LOAD      14439                  SOC
DRY OPERATING WEIGHT    42719
ZERO FUEL WEIGHT ACTUAL 57158  MAX 61688
TAKE OFF FUEL           17800
TAKE OFF WEIGHT  ACTUAL 74958  MAX 78999
TRIP FUEL               13445
LANDING WEIGHT   ACTUAL 61513  MAX 65317
*******************************************************************************
BALANCE AND SEATING CONDITIONS
DOI                     46.80
LIZFW                   43.30 MACZFW                  18.15
LITOW                   35.26 MACTOW                  16.87
LILW                    45.73 MACLW                   18.91
FWD AND AFT INDEX LIMITS
TO: 17.5 I--*--------I 99.4
LD:  8.6 I----*------I 99.3
ZF: 12.3 I----*------I 95.2
THS
PAX DISTRIBUTION        56 74 47
UNDERLOAD BEFORE LMC    3804
*******************************************************************************
NOTOC                   NO
```

Note. The AIB removed the operator name, flight number, and flight crew data.