Havarikommissionen
Accident Investigation Board Denmark

Report 2019-327

Report on accident to D-CAWM (Cessna 560 XLS+) at Aarhus (EKAH) on 5-8-2019.

ISSUED JUNE 2020

INTRODUCTION

This report 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 report for purposes other than preventing future accidents and serious incidents may lead to erroneous or misleading interpretations.

CONTENTS

GENERAL

State file number:	2019-327
UTC date:	5-8-2019
UTC time:	22:36
Occurrence class:	Accident
Location:	Aarhus (EKAH)
Injury level:	None
Aircraft registration:	D-CAWM
Aircraft make/model:	Cessna 560 XLS+
Current flight rules:	Instrument Flight Rules (IFR)
Operation type:	Taxi
Flight phase:	Landing
Aircraft category:	Fixed wing
Last departure point:	Oslo (ENGM)
Planned destination:	Aarhus (EKAH)
Aircraft damage:	Destroyed
Engine make/model:	2 x Pratt & Whitney Canada, PW545C

SYNOPSIS

Notification

All date and time references in this report are Coordinated Universal Time (UTC).

The Area Control Center at Copenhagen Airport, Kastrup (EKCH), notified the Aviation Unit of the Danish Accident Investigation Board (AIB) of the accident on 5-8-2019 at 23:02 hours (hrs).

The Danish AIB notified the Danish Transport, Construction and Housing Authority (DTCHA), the German Federal Bureau of Aircraft Accident Investigation (BFU), 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 Organization (ICAO) on 7-8-2019 at 21:32 hrs.

The BFU accredited travelling representatives to the AIB safety investigation.

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

Summary

On short final for runway 10R, the aircraft collided with the antenna mast system of the localizer (LLZ) of runway 28L resulting in a left wing fuel tank rupture and a fuel leakage.

The aircraft touched down in the Runway End Safety Area (RESA) for runway 28L.

While rolling on the main wheels and skidding on the nose section, the aircraft entered the stopway for runway 28L and came to a full stop on runway 10R.

Leaking fuel from the left wing fuel tank caught fire, and the fire eventually engulfed the left side of the aircraft fuselage.

The following causal factors led to a Controlled Flight Into Terrain (CFIT) accident:

- An action plan on flying below the Glide Slope (GS), performing a *towed approach,* and touching down on the threshold in dark night and low visibility.
- A deactivation of a hardware safety barrier.
- Deviations from Standard Operating Procedures (SOP).
- Less than optimum Crew Resource Management (CRM).
- A confusion over and a misinterpretation of the Category (CAT) 1 approach and runway lighting system of runway 10R.

The accident occurred in dark night under Instrument Meteorological Conditions (IMC).

1 FACTUAL INFORMATION

1.1 History of flight

The accident occurred during an IFR air taxi flight from Oslo (ENGM) to Aarhus (EKAH).

The flight was uneventful until the landing phase.

The commander was the pilot flying, and the first officer was the pilot monitoring.

En route, the flight crew set the V_{app} 15° to 123 knots (kt) and the V_{ref} 35° to 116 kt and agreed upon, if foggy at EKAH, to pull the curtains between the cockpit and the passenger cabin in order to avoid blinding from lights in the passenger cabin.

During the descent, the flight crew decided not to descend below Flight Level (FL) 170, if the weather did not allow an approach and landing in EKAH. Instead they would continue to a pre-planned destination alternate. The pre-planned and nearest useable destination alternate was Billund (EKBI) at a great circle distance of 60 nautical miles southwest of EKAH.

At 22:09 hrs, the first officer established preliminary radio contact with Aarhus Tower (118.525 MegaHertz (MHz)) in order to obtain the latest weather report for EKAH.

The air traffic controller at Aarhus Tower communicated the following landing details:

- Expected landing on runway 10R.
- Wind conditions to be 140° 2 kt.
- Meteorological visibility to be 250 meters (m).
- Runway Visual Range (RVR) at landing to be 900 m, 750 m, and 400 m in fog patches.
- Few clouds at 200 feet (ft), few clouds at 6500 ft.
- Temperature 16° Celcius (C) and Dewpoint 15° C.
- QNH 1008 Hectopascal (hPa).

The first officer read back a meteorological visibility of 2500 m to the commander. The flight crew discussed the reported RVR values and agreed that runway 10R would be the preferable landing runway.

The commander made an approach briefing for the Instrument Landing System (ILS) for runway 10R including a summary of SOP in case of a missed approach.

The first officer pulled the curtain between the cockpit and the passenger cabin.

At established radio contact with Aarhus Approach (119.275 MHz) at 22:20 hrs, the air traffic controller instructed the flight crew to descend to altitude 3000 feet on QNH 1008 hPa and to expect radar vectors for an ILS approach to runway 10R.

The flight crew performed the approach checklist.

The flight crew discussed the weather situation at EKAH with expected shallow fog and fog patches at landing.

At 22:28 hrs, the air traffic controller instructed the flight crew to turn right by 10°, descend to 2000 ft on QNH 1008 hPa, and informed that Low Visibility Procedures (LVP)[1] were in operation at EKAH.

[1] An extract of LVP for Aarhus Tower and Approach - see chapter 1.18.2

Due the weather conditions, the air traffic controller radar vectored the aircraft for a long final allowing the flight crew to be properly established before the final approach.

The commander called out the instrument presentation of an operative radio altimeter.

At 22:31 hrs, the air traffic controller instructed the flight crew to turn left on heading 130° and cleared the flight crew to perform an ILS approach to runway 10R.

The commander armed the approach mode of the aircraft Automatic Flight Control System and ordered a flap setting of 15°.

When established on the LLZ for runway 10R and shortly before leaving 2000 ft on the GS, the commander through shallow fog obtained and called visual contact with the approach and runway lighting system.

At that point, the first officer as well noted the approach and runway lighting system including the position of the green threshold identification lights.

The commander ordered a landing gear down selection.

The flight crew observed that a fog layer was situated above the middle of the runway.

Though visual contact with the approach and runway lighting system, the commander requested altitude call-outs on approach.

The commander ordered a flap setting of 35°.

The aircraft was established on the ILS (LLZ and GS) for runway 10R in landing configuration.

At 22:32 hrs, the first officer reported to Aarhus Approach that the aircraft was established on the ILS for runway 10R.

The air traffic controller reported the wind conditions to be 150° 2 kt and cleared the aircraft to land on runway 10R.

The flight crew initiated the final checklist. The landing lights were on.

The first officer noted two white and two red lights of the Precision Approach Path Indicator (PAPI)[2] to the left of runway 10R.

Passing approximately 1500 ft Radio Height (RH), the first officer reported to the commander visual contact with the approach and runway lighting system, fog above the middle of the runway, and that the touchdown zone and the runway end were both visible. The commander confirmed.

At approximately 900 ft RH, the commander disengaged the autopilot, and the flight crew completed the final checklist.

The aircraft was established on the ILS (LLZ and GS) for runway 10R in landing configuration at a recorded computed airspeed of approximately 128 kt.

The first officer called: *500 to minimum* (passing approximately 800 ft RH), and the commander called: *Runway in sight.*

The commander confirmed that the intensity of the approach and runway lighting system was okay.

[2] A generic illustration of PAPI indications - see chapter 1.8.4.

The commander informed the first officer that the intention was to touch down at the beginning of the runway. In order to avoid entering fog patches during the landing roll, the commander planned flying one dot below the GS, performing a *towed approach*, and touching down on the threshold. However, the commander did not communicate this plan of action to the first officer.

The aircraft started descending below the GS for runway 10R.

The first officer asked the commander whether to cancel potential Enhanced Ground Proximity Warning System (EGPWS) GS warnings. The commander confirmed.

At approximately 500 ft RH, the Solid State Flight Data Recorder (SSFDR) recorded cancellation of potential EGPWS GS warnings.

The aircraft aural alert warning system announced passing 500 feet RH. The recorded computed airspeed was 125 kt, the recorded vertical speed was approximately 700 ft/minute, and the GS deviation approached one dot below the GS.

The commander noted the PAPI indicating the aircraft flying below the GS (one white and three red lights).

The first officer called: *Approaching minimum.* Shortly after, the aircraft aural alert warning system announced: *Minimums Minimums.* The SSFDR recorded a beginning thrust reduction towards flight idle and a full scale GS deviation (flying below).

The commander called: *Continue.* The commander had visual contact with the approach and runway lighting system.

It was the perception of the first officer that the commander had sufficient visual cues to continue the approach and landing. The first officer as pilot monitoring neither made call-outs on altitude nor deviation from GS.

The commander noticed passing a white crossbar, a second white crossbar and then red lights. To the commander, the red lights indicated the beginning of runway 10R, and the commander initiated the flare.

The aircraft collided with the antenna mast system of the LLZ for runway 28L, touched down in the grass RESA for runway 28L, and the nose landing gear collided with a near field antenna (LLZ for runway 28L) and collapsed.

The aircraft ended up on runway 10R.

Throughout the sequence of events and due to fog, the air traffic controller in the control tower (Aarhus Approach) had neither visual contact with the approach sector, the threshold for runway 10R nor the aircraft on ground, when it came to a full stop.

Upon full stop on runway 10R, the first officer with a calm voice reported to Aarhus Approach: *Aarhus Tower, Delta Whiskey Mike, we had a crash landing.*

The air traffic controller did not quite perceive the reporting and was uncertain on the content of the reporting and replied: *Say again.*

The cabin crewmember without instructions from the flight crew initiated the evacuation of the passengers via the cabin entry door.

The aircraft caught fire.

Aarhus Approach and the Aerodrome Office in cooperation activated the aerodrome firefighting services and the area emergency dispatch centre.

Upon completion of the on ground emergency procedure and the evacuation of the aircraft, the flight crew met the cabin crewmember and the passengers at a safe distance in front of the aircraft.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal			
Serious			
None	3	7	

1.3 Damage to aircraft

The aircraft was destroyed.

Photo no. 1. The wreckage at night.

Photo no. 2. The wreckage in daytime.

1.4 Other damage

There were damages to:

- the antenna mast system of the LLZ for runway 28L located in front of runway 10R
- a near field antenna (LLZ for runway 28L) located on the extended centreline between the localizer antenna mast system and runway 10R
- the runway surface on runway 10R.

Photo no. 3. Damages to the antenna mast system of the LLZ for runway 28L.

Photo no. 4. Damages to the nearfield antenna.

1.5 Personal information

1.5.1 The commander

1.5.1.1 License and medical certificate

The commander - male, 53 years - was the holder of a valid Air Traffic Pilot License (ATPL (A)) initially issued by Austro Control GmbH on 15-3-2016.

The rating C560 XL/XLS was valid until 31-3-2020.

The commander's examiner authorization document contained the following privileges:

- *CRE SEP (land) valid until 30 April 2020.*
- *CRE MEP (land) valid until 30 April 2020.*
- *CRE TMG valid until 30 April 2020.*
- *FE(A) valid until 30 April 2020.*
- *IRE(A) valid until 30 April 2020.*
- *TRE PA31T/42 valid until 30 April 2020.*
- *TRE C406/425 valid until 30 April 2020.*

The medical certificate (class 1) was valid until 27-1-2020. The medical certificate held the limitation: *Valid only with correction for defective distant vision.*

1.5.1.2 Other duties at the operator

At the operator, the commander acted as Flight Instructor, Line Check Commander and Head of the Approved Training Organization.

1.5.1.3 Operator flying experience

Below data are extracts from the operator crewmember activity summary (until 5-8-2019).

	Last 24 hours	Last 90 days	Total
All types	-	167:53	2757:21
This type	-	152:15	1311:37
Landings this type	-	-	-

1.5.1.4 Flying experience

The commander informed the AIB of the below approximately total flying experience.

	Last 24 hours	Last 90 days	Total
All types	-	-	9800:00
This type	-	-	1400:00
Landings in total	-	-	10500

1.5.1.5 Operator training

- On 7-1-2019, the commander performed his latest CRM training.
- On 12-2-2019, the commander performed his latest C560 XL/XLS Operator Proficiency Check (OPC). The overall OPC grading was 5 (equal to very good).
- On 12-2-2019, the commander performed his latest emergency and safety equipment training.
- On 23-2-2019, the commander performed his latest line check.

1.5.1.6 Flight and duty time

The commander's duty time summary - see appendix 5.1.

The AIB removed the name of the commander and the operator.

1.5.2 The first officer

1.5.2.1 License and medical certificate

The first officer - male, 36 years - was the holder of a valid Commercial Pilot License (CPL (A)) issued by the German Luftfart-Bundesamt (LBA) on 18-8-2016.

The rating C560 XL/XLS COP IR was valid until 31-12-2019.

The medical certificate (class 1) was valid until 22-12-2019. The medical certificate held no limitations.

1.5.2.2 Operator flying experience

Below data are extracts from the operator crewmember activity summary (until 5-8-2019).

	Last 24 hours	Last 90 days	Total
All types	-	151:53	654:51
This type	-	151:53	654:51
Landings this type	-	-	-

1.5.2.3 Experience as a commercial pilot

The job as first officer at this operator was the first officer's first job as a commercial pilot.

1.5.2.4 Operator training (extracts)

- On 30-11-2018, the first officer performed his latest emergency and safety equipment training.
- On 7-1-2019, the first officer performed his latest CRM training.
- On 30-5-2019, the first officer performed his latest C560 XL/XLS OPC. The overall OPC grading was 2 (equal to poor) or 3 (equal to acceptable).
- On 14-7-2019, the first officer performed his latest line check.

OPC elements graded 2 were:

- *considering others*
- *supporting others*
- *conflict solving*
- *use of authority and assertiveness*
- *workload management*
- *option generation*
- *risk assessment*
- *outcome review*
- *appropriate level.*

OPC elements graded 3 were:

- *team building*
- *maintaining standards*
- *planning and coordination*
- *aircraft system awareness*
- *environmental awareness*
- *awareness of time*
- *problem definition/diagnosis*

- *accuracy*
- *smoothness*
- *appropriate flight plan*
- *monitoring*
- *programming*
- *understand and correct use of aircraft systems, controls and instruments*
- *knowledge of Ops Manual and Company docs*
- *performance, mass and balance*
- *adherence to SOP*
- *use of checklist*
- *R/T discipline*
- *Flight discipline*
- *Cabin crew/pax interaction.*

1.5.2.5 Operator grading system

1. Fail	*2. Poor*	*3. Acceptable*	*4. Good*	*5. Very good*
Behavior directly endangers flights safety	*Observed performance was below standard and could affect safety*	*Observed performance was satisfactory but need improvement*	*Observed performance was good and conducted with safety in mind*	*Observed performance was outstanding in all areas*

Important note.

Any NOTECH of 2 or below must immediately be reported to the Head of Training & Standards.

1.5.2.6 Operator restriction

As a consequence of the latest OPC grading, the Head of Training & Standards restricted the first officer to fly only with supervision commanders.

1.5.2.7 Flight and duty time

The first officer's duty time summary - see appendix 5.2.

The AIB removed the name of the first officer and the operator.

1.5.3 Cabin crewmember

The duty of the on-board cabin crewmember was to serve and entertain the passengers during the flight. An on-board cabin crewmember was not a formal requirement for this aircraft type.

The cabin crewmember had not received specific aircraft type training (not required) and was not formally responsible for on-board cabin flight safety.

1.6 Aircraft information

1.6.1 General information

Manufacturer:	Textron Aviation Inc
Type:	Cessna 560 XLS+.
Serial number:	560-6002
Airworthiness review certificate:	Valid until 13-5-2020
Engine manufacturer:	Pratt & Whitney Canada
Engine type:	PW545C
Maximum take-off mass (MTOM):	20200 pounds (lbs)
Maximum landing mass (MLM):	18700 lbs
Fuel on board at take-off:	4300 lbs
Aircraft total flight hours:	7214:15 hrs (on 4-8-2019).
Next maintenance due:	7259:00 hrs
Technical log remarks:	Before the flight, there were no technical log remarks
Technical status of the aircraft:	Except aural alerts for windshield heating during the initial and the intermediate approach to EKAH, the flight crew experienced no technical deficiencies. There were no aural alerts for windshield heating during the final approach.

1.6.2 Operational flight plan and mass and balance

Before the flight from ENGM, the flight crew prepared an operational flight plan and a mass and balance calculation.

The AIB removed the names of the flight crew and the operator, and inserted a red marking of the noted reported meteorological visibility - see appendix 5.3.

1.6.3 Airplane Flight Manual (AFM) (extracts)

Date of approval:	30-5-2008
Reissue revision 2:	8-1-2014

Emergency procedures

Emergency evacuation

1.	*Parking Brake*	*Set*
2.	*Throttles (both)*	*CUT OFF*
3.	*NORM/EMER Button*	*NORM*
4.	*LEFT/RIGHT ENGINE FIRE Buttons (Both)*	*Push*
5.	*BOTTLE 1 AND BOTTLE 2 ARMED Buttons (if fire suspected)*	*Push*
6.	*APU MASTER Button*	*OFF*

7.	*BATT Button*	*BATT OFF*
8.	*Emergency Locator Transmitter (ELT)*	*Activate as required*
9.	*Airplane and Immediate Area*	*Determine Escape Route and Direct*
10.	*Move away from airplane*	

Supplements

Abnormal procedures

Basic Ground Proximity alerts

MODE	*AURAL CAUTION MESSAGE*	*VISUAL CAUTION MESSAGE (Color/Display)*	*ACTION*
5.	*"GLIDESLOPE"*	*GND PROX (Amber/PFD/ADIs ILS selected)*	*Maneuver the airplane to recapture the glideslope, go-around, or continue the approach (if visual), as required. (This message indicates the airplane has descended more than approximately 1.3 dots below the glideslope on an ILS, is below 1000 feet AGL, and is descending greater than 500 feet per minute.)*

Performance - landing distance - flaps 35° - sea level

Conditions:

- *Runway gradient - zero*
- *Landing gear dowm*
- *Airspeed - Vref at 50 feet*
- *Anti-ice - on or off*
- *Speed brakes - extend after touchdown*
- *Thrust - idle*
- *Weight 18000 lbs*
- *Temperature 15°C*
- *Zero wind*

The landing distance was 3100 ft (945 m).

1.6.4 Operating Manual (extracts)

Revision status: November 2008.

Terrain Awareness and Warning System (TAWS)

TAWS G/S (CANCELLED) – Activate to cancel alerts if knowingly going more than 1.3 dots below an ILS glideslope.

Approaches and landing procedures

ILS Approach – Normal/Single Engine - see appendix 5.4.

1.6.5 Information from the aircraft manufacturer

1.6.5.1 Instrument presentation of GS on the Primary Flight Display (PFD)

GS presentation is a 2-dot presentation meaning a full-scale deflection of +/- 2.125 dots. Deviation is +/- 0.0875 Difference in Depth of Modulation (DDM)/dot. Therefore, full-scale deflection should be +/- 0.186 DDM.

1.6.5.2 Flight crew angle of visibility over aircraft nose

The drawing shows the designed eye reference point and the angle of visibility over the nose from that point, which is 14.5 degrees.

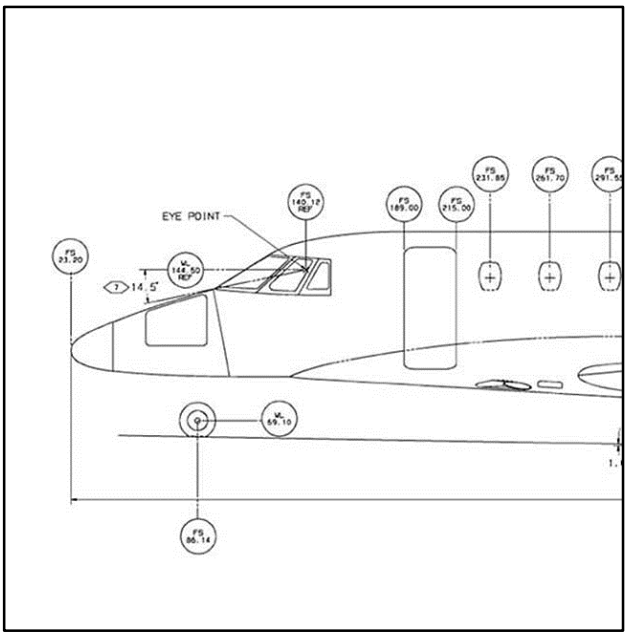


Photo no. 5. Angle of visibility over aircraft nose.

1.7 Meteorological information

1.7.1 Terminal Aerodrome Forecast (TAF) - EKAH

taf amd ekah 052100z 0521/0618 18007kt 9999 bkn025 tempo 0521/0524 0800 bcfg shra bkn012 sct020cb tempo 0600/0608 4000 shra br bkn010 sct020cb becmg 0606/0609 26010kt tempo 0608/0613 -shra few020cb=

taf amd ekah 052222z 0522/0618 18007kt 0200 fg sct002 becmg 0522/0524 8000 nsw tempo 0600/0608 4000 shra br bkn008 sct020cb becmg 0606/0609 26010kt tempo 0608/0613 -shra few020cb=

1.7.2 Aviation Routine Weather Report (METAR) - EKAH

metar ekah 052150z auto 11002kt 0200ndv r10r/0500n r28l/0450d fg few002/// bkn067/// 16/16 q1008=

metar ekah 052220z auto 11001kt 0200ndv r10r/0650n r28l/0900n bcfg bkn064/// 16/16 q1008=

metar ekah 052250z auto 17002kt 0350ndv r10r/p1500u r28l/p1500n fg few001/// sct064/// bkn099/// 16/16 q1008=

1.7.3 Significant weather charts (SIGWX)

SIGWX valid on 5-8-2019 at 18.00 hrs - see appendix 5.5.

SIGWX valid on 6-8-2019 at 00:00 hrs - see appendix 5.6.

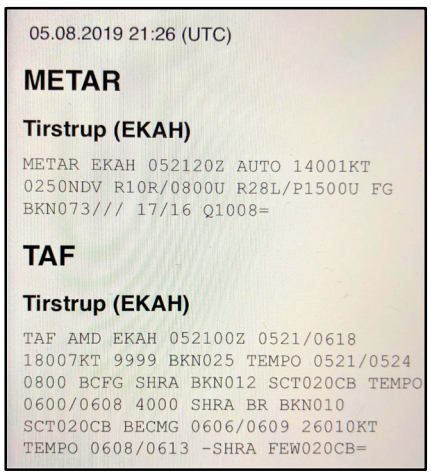
1.7.4 Aftercast valid for EKAH

General:	An occlusion passed Djursland/EKAH from the southwest. At approximately 20:00 hrs, the rain from the occlusion ceased at EKAH. Behind the occlusion, the air was humid, and winds were weak, with fog/fog patches forming. Between 22:00 hrs and 22:40 hrs, a cluster of thunderstorms/CB near EKBI slowly moved towards EKAH, but at 22:37 hrs they were too far away from EKAH to have any influence at EKAH. Between 22:00 hrs and 22:40 hrs, other less intense rain showers/CB (without thunder) were located in the area between Viborg and Randers - also moving slowly towards the northeast. These too had no influence at EKAH.
Visibilty:	Meteorological visibility reported by auto METAR at EKAH was at 22:20 hrs 200 m, and at 22:50 hrs 350 m in fog or fog patches. Values for Runway Visual Range (RVR) for runway 10R were at 22:20 hrs 650 m, and at 22:50 hrs >1500 m. Comparing these reports to nearby automated observation stations “Aarhus Syd” and “Hald Vest” (near Randers), the reported visibilities at EKAH seemed plausible. At least, it seemed very likely that fog patches or fog (visibility <1000 m) indeed was present at or near EKAH.

	However, one should bear in mind that visibility/RVR reported by auto METARs and automated observation stations were based on measurements by transmissometers or scatterometers of - loosely speaking - how transparent the air was at one or more discrete points. The reported values were not necessarily a reliable guide to how far a human observer on the ground would actually be able to see, let alone a pilot in a cockpit on final approach.
Clouds and icing:	Broken, maybe scattered, altocumulus/altostratus base 6000-10000 ft. The cloud layer was rather thin. The thinning-out and perhaps temporary breaking-up of this cloud layer during the evening caused fog or patches of fog to form in the Djursland area, i.e. there might also be locally few/broken stratus with base 0-200 ft, top 50-500 ft. Freezing level at FL 090 - FL 100.
Surface wind:	Wind at 10 meters above ground: 110-170°/01-04 kt. Wind at FL 050: 240°/15 kt.
Other information:	Sunset at 19:21 hrs. Nautical twilight ended at 21:06 hrs Moonset at 21:24 hrs. There was no moonlight at 22:36 hrs, meaning dark night conditions.

1.7.5 Latest weather for EKAH before departure

Before departure from ENGM, the commander obtained the latest TAF and METAR valid for EKAH.



05.08.2019 21:26 (UTC)

METAR

Tirstrup (EKAH)

METAR EKAH 052120Z AUTO 14001KT
0250NDV R10R/0800U R28L/P1500U FG
BKN073/// 17/16 Q1008=

TAF

Tirstrup (EKAH)

TAF AMD EKAH 052100Z 0521/0618
18007KT 9999 BKN025 TEMPO 0521/0524
0800 BCFG SHRA BKN012 SCT020CB TEMPO
0600/0608 4000 SHRA BR BKN010
SCT020CB BECMG 0606/0609 26010KT
TEMPO 0608/0613 -SHRA FEW020CB=

Photo no. 6. Latest TAF and METAR obtained by the commander before departure from ENGM.

1.8 Aids to navigation

1.8.1 Notice to Airmen (NOTAM)

At 14:43 hrs, the flight crew performed the latest documented search for Notice to Airmen (NOTAM).

The result of the search for EKAH was:

EKAH-AAR-AARHUS RWY 10L 10R 28L 28R

No relevant NOTAMs found.

1.8.2 Operational status of aids to navigation

The ILS, the Distance Measuring Equipment (DME), the PAPI, and the approach and runway lighting system for runway 10R were operative.

There were no reports of deficiencies.

The conclusion of the latest flight inspection (ILS CAT 1/DME and PAPI at EKAH runway 10R) was:

Flight inspection of the above ILS CAT 1/DME was performed 2019-03-04. The equipment complies with all the requirements of ICAO ANNEX 10 concerning ILS CAT 1/DME. The LOC fulfils the requirements for class D. Flight inspection of the above PAPI was performed 2019-03-04. The equipment complies with all the requirements of ICAO ANNEX 14 concerning PAPI.

On 29-7-2019 at 08:21 hrs, the latest aerodrome functional test of the LLZ for runway 10R was performed without remarks.

On 29-7-2019 at 08:31 hrs, the latest aerodrome functional test of the GS for runway 10R was performed without remarks.

1.8.3 Activation of approach and runway lighting system

In order to mitigate high humidity condensation on PAPI lenses and thereby avoiding false slope indications, the procedures for Aarhus Tower and Approach stipulated that an air traffic controller should turn on the PAPI lights at least 10 minutes before the arrival of an aircraft.

On the night of the accident, the PAPI lights had been turned on since the previous aircraft arrival at 20:32 hrs.

The air traffic controller (Aarhus Approach) turned on the approach and runway lighting system at first radio contact with D-CAWM at 22:09 hrs.

The air traffic controller set the intensity of the approach and runway lighting system to 30%.

1.8.4 A generic illustration of PAPI indications

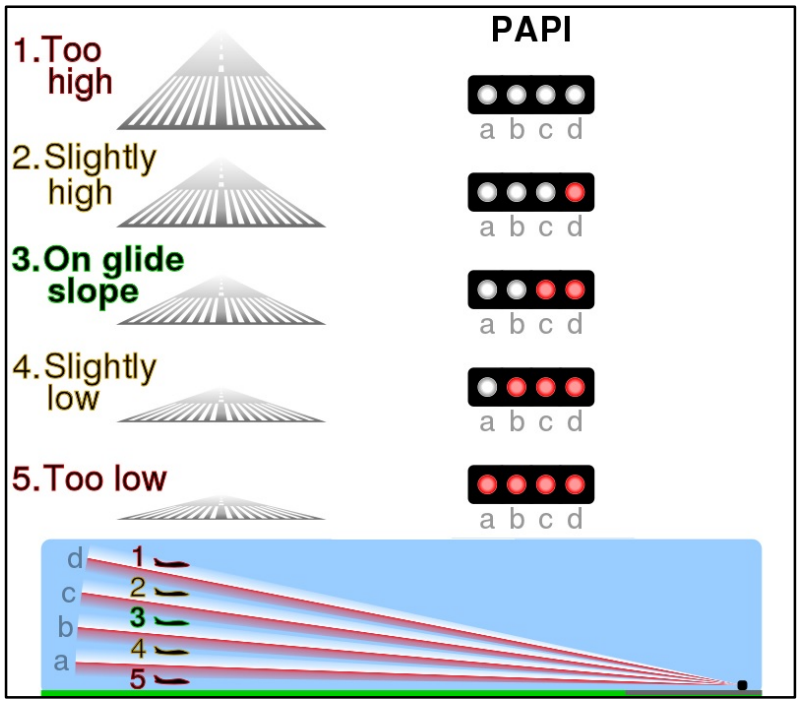


Photo no. 7. A generic illustration of PAPI indications. The source is Wikipedia.

1.9 Communication

The flight crew were in radio contact with Aarhus Tower (118.525 MHz) and Aarhus Approach (119.275 MHz). At the time of the accident, the Air Traffic Control (ATC) frequencies were combined.

The AIB obtained the involved ATC voice recordings. The recordings were of good quality and useful to the AIB safety investigation.

1.10 Aerodrome information

1.10.1 General information

Aerodrome Reference Point:	56 18 00.06N 010 37 08.43E
Elevation:	82 ft
Runway directions:	10R (098.5° MAG), 28L (278.5° MAG)
Runway dimensions	2702 m x 45 m
Runway surface:	Asphalt
Landing Distance Available (10R):	2702 m
RVR equipment runway 10R:	RVR measuring equipment at touchdown, midfield, and runway end was operative. There were no reports of deficiencies. EKAH had procedures for recording and storing RVR values. However, these procedures failed.
Height of LLZ antenna mast system (runway 28L):	2.89 m (the localizer antenna mast system did not penetrate the ILS Obstacle Assessment Surface (OAS))

Rescue and firefighting service:	Outside AD hours, category provided to commercial flights with passengers according to aircraft category

1.10.2 Aerodrome chart for EKAH

An extract of the Aeronautical Information Publication (AIP) Denmark.

See appendix 5.7.

1.10.3 Operator's aerodrome chart for EKAH

For route documentation, the flight crew used Electronic Flight Bags (EFB).

Subsequently, the flight crew informed the AIB of the route documentation provider.

The AIB extracted the aerodrome chart for EKAH from the provided route documentation.

From the route documentation provider, the AIB unsuccessfully tried to obtain the valid aerodrome chart at the time of the accident.

However, the presented aerodrome chart stated that the changes from the previously valid aerodrome chart were: *Note added. Apron.*

See appendix 5.8.

The AIB removed the name of the route documentation provider.

1.10.4 Operator's Instrument Approach Chart (IAC) for EKAH

The AIB extracted the valid IAC (ILS DME 10R) from the provided route documentation.

See appendix 5.9.

1.10.5 Aerodrome fence obstacle lights

The surrounding aerodrome fence crossed the area, perpendicularly to the runway direction, between the first and second white crossbar of the approach lighting system for runway 10R.

EKAH installed red omnidirectional aerodrome fence obstacle lights in November 2010, and its presence complied with DTCHA requirements. The red omnidirectional aerodrome fence obstacle lights did not penetrate the ILS OAS.

Black arrows and yellow circles mark the position of the red omnidirectional aerodrome fence obstacle lights.

See appendix 5.10.

1.11 Flight recorders

The BFU downloaded data from the SSFDR (serial number 0005585588 / part number FA2100-2043-00) and the Solid State Cockpit Voice Recorder (SSCVR) (serial number 000568679 / part number FA2100-1020-02).

Both the SSFDR and the SSCVR showed traces of fire or soot to the external housing.

Nevertheless, following a careful inspection of the printed circuit boards of the interior, both recorders had been successfully downloaded via the original interfaces.

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

The Very High Frequency (VHF) keying parameter was used to synchronize the SSFDR with the identical radio transmission recorded on the SSCVR and ATC voice recordings.

SSFDR plots:

- Final approach from 2000 ft - see appendix 5.11.
- Final approach from 1000 ft - see appendix 5.12.
- AIB selected parameters from 1000 ft - see appendix 5.13.

Reconstructions based on SSFDR data:

- SSFDR reconstruction no. 1 (from 2000 ft) - see appendix 5.14.
- SSFDR reconstruction no. 2 (short final) - see appendix 5.15.

1.12 Wreckage and impact information

At collision with the antenna mast system located 450 meters before the beginning of runway 10R (measured from the green threshold identification lights), the left wing fuel tank ruptured resulting in a fuel leakage.

Approximately 390 m before the beginning of runway 10R (measured from the green threshold identification lights), the aircraft touched down in the RESA for runway 28L (grass area).

After a landing roll of approximately 60 meters, the nose landing gear collided with the near field antenna of the LLZ for runway 28L and collapsed.

While rolling on the main wheels and skidding on the nose section, the aircraft entered the stopway for runway 28L.

Approximately 230 m after the beginning of runway 10R (measured from the green threshold identification lights), the aircraft came to a full stop on runway 10R.

Photo no. 8. Impact area in front of runway 10R.

Wreckage trail - see appendix 5.16.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

Upon full stop on runway 10R, leaking fuel from the left wing fuel tank caught fire, and the fire eventually engulfed the left side of the aircraft fuselage.

1.15 Survival aspects

1.15.1 General

The flight crew, the cabin crewmember, and the passengers were using seatbelts.

Neither seats nor seatbelts were overstressed or suffered from malfunctioning.

There were no hindrances to free movement in the passenger cabin.

The impact G-forces were below the criteria for an automatic activation of the on-board Emergency Locator Transmitter (ELT), and the ELT did not activate the International Satellite System for Search and Rescue Services (COSPAS-SARSAT).

1.15.2 Exposure

At the time of the accident and confer the operational flight plan, the remaining fuel on-board was approximately 3190 lbs (take-off fuel of 4300 lbs ÷ calculated trip fuel of 1110 lbs).

Collision with the antenna mast system resulted in damage to the left wing fuel tank causing leakage of fuel and fire.

Neither passengers nor crew were exposed to fuel, fumes or any other substance.

1.15.3 Emergency exits

The aircraft had a seating capacity of nine passengers.

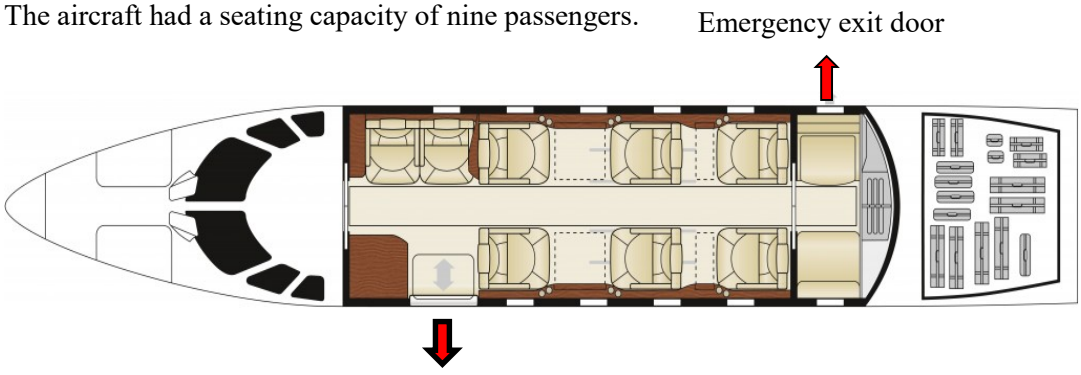


Photo no. 9. Emergency exits.

1.15.4 Emergency actions

1.15.4.1 In the aircraft

The cabin crewmember sat on the passenger seat next to the cockpit.

Immediately upon full stop on the runway, the cabin crewmember without instructions from the flight crew initiated the evacuation of the passengers via the cabin entry door.

In the cockpit, the commander ordered an evacuation and started working on the on ground emergency procedure.

The first officer entered the passenger cabin and observed that everyone had left the passenger cabin.

Through the cabin entry door, the first officer observed fuel leaking from beneath the left wing and fuel on the runway. The fuel was on fire, and the first officer felt the heat from the burning fuel.

The first officer alerted the commander about the fire, evacuated the aircraft, and ran towards the cabin crewmember and the passengers.

After having completed the on ground emergency procedure and a check of the passenger cabin, the commander evacuated the aircraft.

1.15.4.2 At the aerodrome

At 22:36:15 hrs (recorded ATC time), the first officer with a calm voice called Aarhus Approach:

Aarhus Tower, Delta Whiskey Mike, we had a crash landing.

At 22:36:22 hrs (recorded ATC time), Aarhus Approach replied: *Say again.*

At 22:36:58 hrs (recorded ATC time), Aarhus Approach and the Aerodrome Office in cooperation activated the aerodrome firefighting services and the area emergency dispatch centre.

Neither the air traffic controller in Aarhus Approach nor personnel in the Aerodrome Office had, due to fog, visual contact with the aircraft.

At 22:37:22 hrs and 22:38:23 hrs (recorded ATC time), Aarhus Approach in vain tried to re-establish radio contact with the aircraft.

At 22:37:42 hrs (recorded ATC time), the fire chief received ATC clearance to enter the runway system with one first responding vehicle and two fire engines.

At 22:38:45 hrs (recorded ATC time), the fire chief reported entering the runway system.

At 22:39:21 hrs (recorded ATC time), the fire chief reported visual contact (approximately 350 meters in front of the aircraft) and subsequently arrived at the aircraft. Furthermore, the fire chief warned the drivers of the fire engines of people on the runway.

At 22:41:10 hrs (recorded ATC time), one of the drivers of the fire engines reported visual contact with the aircraft.

At 22:41:55 hrs (recorded ATC time), the fire chief reported that all persons on-board had evacuated the aircraft, and that there were no injuries to persons.

1.16 Tests and research

Not applicable.

1.17 Organization and management

1.17.1 Air Operator Certificate (AOC)

On 15-10-2014, the German LBA issued an AOC to the German operator.

1.17.2 Operations Specifications (OS)

The operator OS contained 5 aircraft models:

- *Cessna 680A.*
- *Cessna 425.*
- *Cessna 560.*
- *Cessna 560 XL.*
- *Cessna Citation 680 Sovereign.*

On 28-3-2019, the LBA issued an OS for D-CAWM.

The below text are extracts of the issued OS:

Commercial air transportation:	*Passengers and cargo*
Area(s) of operation:	*EUR, AFI, NAT, NAM, CAR, SAM MID/ASIA*
Instrument flight rules IFR:	*CAT I RVR 550 m DH 200 ft*
Low visibility operations:	*No*
Navigations specifications for PBN operations:	*RNP AR APCH*

1.17.3 Operations Manual Part A (extract)

The AIB replaced the name of the operator with *xxxxxx.*

7.4 Maximum daily flight duty time for operation with two pilots

7.4.1 Maximum flight duty time

a) xxxxxx ensures that the maximum daily flight duty is basically 13 hours.

- *If the maximum permitted daily flight duty is interrupted by a break of at least 2 hours and the crew member has a quiet room with sleeping accommodation during this time, the maximum daily service is 14 hours.*
- *If the maximum permitted daily flight duty is interrupted by a break of at least 3 hours and the crew member has a quiet room with sleeping facilities in the immediate vicinity of the airfield during the break, the maximum daily service is 18 hours.*

The following stipulations must be observed:

Each crew member may not operate and operate an aircraft for more than 10 hours.

- *Within the service, no more than 2 landings may be scheduled after the break*
- *Within each 7 consecutive days not more than 2 air services acc. 7.4.1 (Maximum flight duty) a) Point 2.*
- *Aircraft services under 7.4.1 (maximum flight duty period) a) Points 2 and 7.6 (extension of flight duty period due to a rest period during the flight) shall not be provided within seven consecutive days.*

b) From the maximum daily allowable service time specified in 7.4.1 (a), 30 minutes shall be deducted for each leg from the third leg of the flight, with a maximum of 2 hours in total.

Note:

Already for the third section 30 minutes have to be deducted.

c) *If the flight duty time starts at the daily rhythm low (between 0200 and 0559), 100% of the overlap, but no more than two hours, shall be deducted from the maximum value specified in paragraph 7.4.1 (a) and (b).*

1.17.4 Operations Manual Part B (extracts)

2.4 Call-out procedures

Abandoned Approach

When within 500 ft AGL, the aircraft must be within the „approach window".

- *within one dot deflection, both LOC and GS.*
- *IVSI less than 1.000 ft/min.*
- *IAS with VAP ± 10 kt - no less than VREF.*
- *no flight instrument flags with the landing runway or visual references not in sight.*
- *landing configuration, except for full flaps (non-precision or single engine approaches).*
- *If the aircraft is not within this „Window ", a go-around must be executed.*

Approach (continue)	
PF	***PNF***
• *Approach Deviation ± One Dot-Glide slope* *Call: „Correcting"* • *Approach Deviation ± One Dot-Localizer/VOR* *Call: „Correcting"*	*Call: „One dot high/low"* *Call: „One dot left/right"*

1.18 Additional information

1.18.1 EU Regulation No 139/2014 (Rules for Aerodromes) (extract)

EASA AMC5 ADR.OPS.B.010(a)(2) Rescue and firefighting services RESPONSE TIME

The aerodrome operator should ensure that:

(a) *rescue and firefighting service achieves a response time not exceeding three minutes with an operational objective of not exceeding two minutes from the time of the initial call to the rescue and firefighting services, to any point of each operational runway, in*

optimum visibility and surface conditions, and be in a position to apply foam at a rate of, at least, 50 % of the discharge rate specified in AMC4 ADR.OPS.B.010 Table 1;

(b) response times to any other part of the movement area, in optimum visibility and surface conditions, are calculated and included in the Aerodrome Emergency Plan;

(c) any vehicle, other than the first responding vehicle(s), required to achieve continuous agent application of the amount of extinguishing agents specified in Table 1 of AMC4 ADR.OPS.B.010 arrives no more than one minute after the first responding vehicle(s); and

(d) suitable guidance, equipment and/or procedures for rescue and firefighting services are provided, to meet the operational objective, as nearly as possible, in less than optimum conditions of visibility, especially during low visibility operations.

1.18.2 Local LVP instruction valid for Aarhus Tower and Approach (extract)

The AIB has translated the extract from Danish into English.

1.1 Low Visibility Procedures (LVP)

1.1.1 If MET visibility or RVR is 800 meters or less, involved aircraft are to be informed of "Low visibility procedures in operation".

1.1.2 Low visibility procedures at EKAH means:

If MET visibility or RVR is 800 meters or less or CAT II approaches are in operation:

- *All stop bar lighting are to be turned on.*
- *Road Holding Position lighting is to be turned on.*
- *AUTO PING on channel 6 is active.*
- *Tower control uses specific ATC progress strips for individual registration of vehicles and persons on the maneuvering area.*

1.19 Useful or effective investigation techniques

1.19.1 Flight crew field of vision over aircraft nose

Taking into consideration aircraft geometry and in order to determine whether or not the flight crew were capable of establishing visual contact with the approach and runway lighting system, the AIB set up two scenarios.

The premises for the AIB theoretically calculated scenarios were:

- The aircraft was on short final for runway 10R.
- The aircraft flew at a low altitude below the GS for runway 10R.
- The terrain on final for runway 10R was throughout flat.
- The eye point position, with reference to chapter 1.6.5.2, was 6 meters in front of the position of the radio altimeter.
- The nose of the aircraft was 2.7 meters in front of and 0.7 meter below the eye point position.

- The center of the flight crew field of vision over the aircraft nose was equal to the eye point position.

Scenario 1:

For the calculations, the AIB extracted the following data from the SSFDR:

- RH of 134 feet (41 m).
- Pitch angle 0.84°.
- Aircraft position at a distance of 1113 m in front of the threshold for runway 10R (measured from the green threshold identification lights).

Within flight crew field of vision Outside flight crew field of vision

Scenario 2:

For the calculations, the AIB extracted the following data from the SSFDR:

- RH of 58 feet (18 m) (beginning of the aircraft flare).
- Pitch angle 2.68°.
- Aircraft position at a distance of 863 m in front of the threshold for runway 10R (measured from the green threshold identification lights).

Within flight crew field of vision Outside flight crew field of vision

See appendix 5.17.

1.19.2 AIB drone photos

1.19.2.1 On short final and established on the ILS for runway 10R

By use of a drone, the AIB took the picture in appendix 5.18 in dark night under Visual Meteorological Conditions (VMC).

The position of the AIB drone simulated establishment on the ILS (LLZ and GS) for runway 10R at a distance of 1113 m in front of the threshold to runway 10R (measured from the green threshold identification lights).

The intensity of the approach and runway lighting system was set to 30%.

The AIB drone photo is not to scale and only represents a photographic illustration of the approach and runway lighting system for runway 10R.

1.19.2.2 On short final at a height above ground of 134 ft

By use of a drone, the AIB took the picture in appendix 5.19 in dark night under VMC.

The position of the AIB drone simulated establishment on the LLZ for runway 10R at a height above ground of 134 ft at a distance of 1113 m in front of the threshold to runway 10R (measured from the green threshold identification lights).

The intensity of the approach and runway lighting system was set to 30%.

The height above ground of the AIB drone simulated the SSFDR recorded RH of the aircraft at the same position.

The AIB drone photo is not to scale and only represents a photographic illustration of the approach and runway lighting system for runway 10R.

1.19.2.3 A zoom in of appendix 5.19

The AIB drone photo in appendix 5.20 presents the positions of the red illuminated omnidirectional aerodrome fence obstacle lights (marked in yellow cicles) and the red illuminated omnidirectional obstacle lights (marked in red cicles) of the antenna mast system of the LLZ for runway 28L

1.19.3 Flight crew sleep pattern and fatigue

The AIB received no consistent information on sleep pattern and sleep quality the previous 7 days from the flight crew.

For that reason and in cooperation with the Danish Air Force, the AIB set up two scenarios based on premises determined by the AIB.

1.19.3.1 Optimum sleep in Oslo

- Wake up call at 06:00 hrs Local Time (LT).
- Check-in for flight duty at 08:15 hrs LT.
- Three flights on the day of the accident ending up in Oslo (ENGM) at 16:31 hrs LT.
- The flight crew awaited aircraft refueling until 18:13 hrs LT.
- Check-in at hotel at 18:30 hrs LT.
- Sleep (good quality) from 18:45 hrs LT until 22:00 hrs LT.
- Check-out at hotel at 22:15 hrs LT.
- Departure from ENGM at 23:42 hrs LT.

See appendix 5.21.

1.19.3.2 No sleep in Oslo

- Wake up call at 06:00 hrs local time (LT).
- Check-in for flight duty at 08:15 hrs LT.
- Three flights on the day of the accident ending up in Oslo (ENGM) at 16:31 hrs LT.
- The flight crew awaited aircraft refueling until 18:13 hrs LT.
- Check-in at hotel at 18:30 hrs LT.
- No sleep.
- Check-out at hotel at 22:15 hrs LT.
- Departure from ENGM at 23:42 hrs LT.

See appendix 5.22.

1.19.4 Planned flight crew rest in Aarhus

Due to expected late arrival in EKAH, the operator planned and arranged an overnight stay in Aarhus.

Taking into account the overnight stay in Aarhus, the number of total legs on the day of the accident ended up with four.

2 ANALYSIS

2.1 General

The following revealed findings had, in the AIB's opinion, no influence on the sequence of events:

- The operational approval of the operator (aircraft approved for CAT 1 operations).
- The technical status of the aircraft (the aural alerts for windshield heating during the initial and the intermediate approach seemed to be nuisance alerts. There were no aural alerts for windshield heating during the final approach).
- The aircraft mass and balance.
- The pre-flight operational flight planning.
- NOTAM for EKAH.
- The technical status of the aids to navigation with no recorded or reported deficiencies. Aids to navigation complied with ICAO Annex 10.
- The technical status of the CAT 1 approach and runway lighting system for runway 10R with no recorded or reported deficiencies.
- The indication of the PAPI (no expected high humidity condensation on lenses, and the first officer noted two white and two red lights when established on the GS). The PAPI for runway 10R complied with ICAO Annex 14.
- The AIP chart presentation versus the operator chart non-presentation of the position of the localizer antenna mast system (runway 28L). The localizer antenna mast system did not penetrate the ILS OAS.

The forecasted weather conditions at EKAH were generally consistent with the actual weather reports (latest obtained by the flight crew shortly before departure from ENGM). Fog could be expected and was present at EKAH.

However, on initial radio contact with Aarhus Tower, the first officer perceived, noted, and read back to the commander the meteorological visibility to be 2500 m instead of the reported 250 m.

Despite of reported RVR values significantly below the perceived reported meteorological visibility, this common perception of meteorological visibility might have provoked a common false persuasion of the general visibility being better than the actual visibility.

Furthermore, this common perception of meteorological visibility might have provoked changes to the flight crew decision-making processes and actions on final approach.

The reported controlling RVR values (touchdown 900 m and midfield 750 m) were above the applicable CAT 1 approach minima and did not formally prevent the flight crew from performing the ILS approach for runway 10R.

The operational flight plan prepared by the flight crew indicated the pre-planned landing distance[3] at EKAH to be 2803 ft (854 m). The conditional AFM presentation (see chapter 1.6.3) of landing distance was 3100 ft (945 m).

[3] ICAO defines the term 'Landing Distance' as "the horizontal distance traversed by the aeroplane from a point on the approach path at a selected height above the landing surface to the point on the landing surface at which the aeroplane comes to a complete stop".

Taking into consideration the pre-planned landing distance of 854 m and/or the conditional AFM presentation of landing distance of 945 m, the landing distance available[4] of 2702 m, the availability of runway centreline lighting (15 m spacing), and the reported RVR values (900 m, 750 m, and 400 m), the AIB from an operational point of view finds the concern about entering fog patches during the landing roll to be unjustified.

Upon a stabilized approach for and landing on runway 10R, and if not coming to a full stop in the first sector (touchdown zone with a reported RVR value of 900 m), the aircraft would have entered the second sector (midfield zone with a reported RVR of 750 m) at low speed with the availability of directional guidance (runway centreline lighting).

EKAH had procedures for recording and storing RVR values. However, these procedures failed.

The AIB has not been able to restore recorded RVR values, but finds it likely that the area of fog patches above runway 10R with time might have been moving, but these potential movements did not provoke changes to the reported RVR values by ATC.

Appropriate risk controls like the EGPWS (with alerts for excessive GS deviations) and SOP on call-outs and stabilized approach were in place.

2.2 Final approach for runway 10R

Before leaving 2000 ft on the GS, the flight crew obtained visual contact with the approach and runway lighting system for runway 10R, and the first officer identified the position of the green threshold identification lights.

The first officer identified the indication of the PAPI (established on the GS).

Furthermore, passing approximately 1500 feet RH, the flight crew agreed on visual contact with the approach and runway lighting system, fog above the middle of the runway, and that the touchdown zone and the runway end were both visible.

To the AIB, the flight crew intercommunication justified the premise that reliable external visual cues of the approach runway and runway lighting system were available to the flight crew on final approach for runway 10R.

With the autopilot engaged during the final approach, the aircraft was established on the ILS (LLZ and GS) for runway 10R in landing configuration. At approximately 900 ft RH, the commander disengaged the autopilot.

The commander communicated his intention of landing in the beginning of the runway but not his action plan of flying one dot below the GS, performing a *towed approach*, and touching down on the threshold. The first officer did not challenge the intention of the commander.

However, the first officer encouraged the commander to a cancellation of potential EGPWS GS alerts for excessive GS deviations (more than one dot) indicating that the first officer was familiar with the non-standard procedure on flying below the GS. The commander started flying below the GS.

[4] ICAO defines the term 'Landing Distance Available' as "the length of the runway which is declared available by the appropriate Authority and is suitable for the ground run of an aeroplane landing".

Though, the plan of action might have been unclear, the flight crew accepted and instituted a deactivation of a safety barrier by cancelling potential EGPWS GS alerts and a deviation from SOP by not maintaining the GS upon runway visual references in sight.

To the AIB, deviations from SOP in dark night and low visibility combined with the cancellation of a hardware safety barrier compromised flight safety.

Passing 500 ft RH, the aircraft was still within the operator criteria (*approach window)* for a stabilized approach.

Passing the set ILS approach minima, the aircraft was flying more than 2 dot below the GS and was no longer within the operator criteria (*approach window*) for a stabilized approach.

The first officer as pilot monitoring believed that the commander by calling *Continue* had appropriate visual cues to complete the approach and landing and made no corrective call-outs on altitude, GS deviation or unstabilized approach.

To the AIB, at least one of the following visual cues or maybe all, when passing the set ILS approach minima, was/were distinctly visible and identifiable to the flight crew:

- The elements of the approach lighting system.
- The green threshold identification lights.
- The PAPI.
- The runway edge lights.

At some point on short final for runway 10R, the commander noted the availability of the PAPI as a visual cue (one white and three red lights).

The AIB believes that the commander, from passing the set ILS approach minima until touchdown, mostly relied on external visual cues and potential corrective call-outs from the first officer. The first officer mentally seemed to rely on the commander's perception of external visual cues and did not challenge, though expected to partly monitor the flights instruments, a full scale GS deviation (more than two dots below the GS).

In the opinion of the AIB, the first officer, in a critical stage of the flight, did not provide effective monitoring and operational support to the commander and did not recognize the unstable approach.

The flight crew seemed to be unaware of the developing unsafe condition and probably was, due to lack of situational awareness and vigilance, unable to recognize the need for corrections.

Even though flying at a full scale GS deviation at a low altitude, the aircraft geometry neither at 134 ft RH nor at 58 ft RH (beginning of the flare) prevented flight crew field of vision over the aircraft nose.

To the commander, target fixation on touching down on the threshold might have provoked a steeper than intended short final approach leaving out alternate options like aborting the approach.

To the AIB, a combination of events contributed to the sequence of events:

- The commander intended to fly one dot below the GS, performing a *towed approach*, and touching down on the threshold, which required initiation of the flare when passing above the stopway for runway 28L (stopway marked with red edge lights).
- During the final approach, the flight crew did not clarify the commander's plan of action.

- The flight crew deviated from SOP and cancelled a hardware safety barrier (potential EGPWS GS warnings).
- Flying the visual segment with reference to mainly external visual cues combined with target fixation on touching down on the threshold might have provoked a steeper than intended short final approach.
- On short final, the first officer as pilot monitoring made no corrective and crucial call-outs on altitude, GS deviation or unstabilized approach.
- The commander most likely mixed up the two red omnidirectional aerodrome fence obstacle lights with the stopway red edge lights and also misinterpreted the CAT 1 approach and runway lighting system.
- The confusion over and the misinterpretation of the approach and runway lighting system resulted in a too early flare and consequently a CFIT.

2.3 Human performance

2.3.1 Flight crew authority gradient

Both flight crewmembers were properly licensed.

The commander was an experienced pilot and highly ranked at the operator.

The first officer held his first job as a commercial pilot and had limited flying experience.

At the latest OPC, the flight examiner on critical CRM subjects graded the first officer to be below standard, which according to the operator's grading system might affect flight safety. Critical CRM subjects were:

- use of authority and assertiveness
- workload management
- option generation
- risk assessment
- outcome review.

The AIB did not reveal whether the first officer's OPC challenges was due to, for instance, lack of training or lack of pilot experience, but the AIB questions the effect of an imposed restriction rather than additional pilot training.

When comparing sequential elements of this accident, proactive determination by the first officer would, in the opinion of the AIB, have mitigated the risk of the accident.

In general, an authority gradient refers to the established, and/or perceived, command and decision-making power hierarchy in a crew, and also how balanced the distribution of this power is experienced within the crew.

The AIB finds it possible that the commander's rank and experience at the operator biased the first officer on final approach to allow concentration of authority/power in one person steepening the flight crew gradient.

The bias might have excluded conditions like:

- expression of concerns
- questions to decisions
- clarification of instructions/intentions
- determination
- accountability for overall flight safety.

2.3.2 Flight and duty time

The operator calculated the flight and duty time on the day of the accident to be 16:24 hrs.

The approved Operations Manual Part A allowed a daily flight and duty time of 18:00 hrs, if the flight crew had access to a rest period of least 3 hrs.

Even though, the refueling at ENGM lasted longer than expected, the flight crew did have access to at least 3 hrs of rest.

Due the number of total legs (four) on the day of the accident, the deduction of flight and duty time was 1:00 hr.

The AIB finds that the actual flight and duty time on the day of the accident was within approved limitations.

2.3.3 Flight crew fatigue

Due to inconsistent flight crew information, the AIB has not been able to objectively reveal whether or not flight crew fatigue was contributing to the sequence of events.

However, on the other hand the AIB cannot exclude that recent sleep, hours awake, and time of the day (acute fatigue) might have impacted the decision-making processes of the flight crew.

2.3.4 Threat and error management

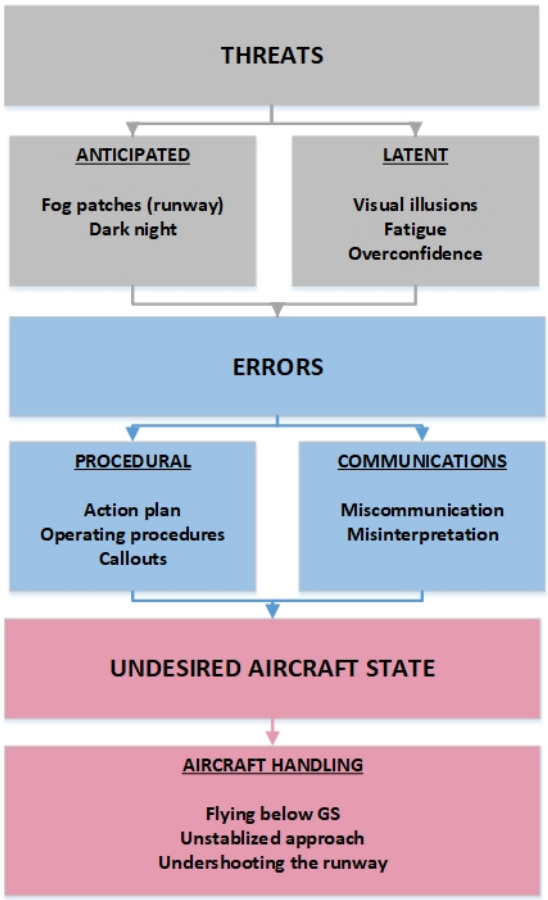


Photo no. 10. Threat and error management.

The commander mitigated a perceived threat (concern about entering fog patches during the landing roll) by an action plan on going one dot below the GS, performing a *towed approach*, and touching down on the threshold and thereby introducing and facing other operational threats. It seems unlikely that the flight crew was aware of the potential consequences of these introduced threats.

Following elements on final might have provoked changes to the flight crew's depth perception leading to a visual illusion of the aircraft being high and the runway being too close:

- Dark night.
- Bright approach and runway lighting.
- Limited runway visibility.
- Fog patches above the middle of the runway.
- Concern about entering fog patches during the landing roll.

The visual illusion might have provoked a steeper than intended short final approach and target fixation on touching down on the threshold leaving out alternate options like aborting the approach.

Furthermore, a visual illusion of being overhead the stopway for runway 28L at passage of the two red omnidirectional aerodrome fence obstacle lights most likely changed the commander's perception of flight progress from initiating a *towed approach* to a flare resulting in the collision with the antenna mast system of the LLZ of runway 28L.

Generally seen, the flight crew did not employ appropriate execution countermeasures to keep threats, errors, and an undesired aircraft state from reducing margins of flight safety.

2.4 Survival aspects

2.4.1 General

The accident was survivable.

A touchdown on soft but solid ground in a landing attitude at a low airspeed absorbed most of the impact forces and reduced the risk of serious injuries to passengers and crew.

Though the flight crew and the cabin crewmember did not coordinate the aircraft evacuation process, the following interdependent conditions in this specific accident sequence made the aircraft evacuation effective:

- A decisive initiation of the aircraft evacuation by the cabin crewmember. The AIB considers that the advantages or disadvantages of using either the cabin entry door or the emergency exit door in this specific accident sequence counterbalanced each other and did not impact the aircraft evacuation process.
- Neither seats nor seatbelts were overstressed or suffered from malfunctioning.
- No hindrances to free movement in the passenger cabin.

2.4.2 Firefighting services

A combination of lack of visual contact with the aircraft on the runway (Aarhus Approach and the Aerodrome Office) and no distinct distress call (MAYDAY) from the flight crew prolonged the initial aerodrome emergency response time (36 seconds).

The fire chief reported visual contact with the aircraft (approximately 350 meters in front of the aircraft) 2:23 minutes after the activation of the aerodrome firefighting and rescue services.

One of the drivers of the two fire engines reported visual contact with the aircraft 4:12 minutes after the activation of the aerodrome firefighting and rescue services.

Less than optimum conditions of visibility (fog) in combination with the uncertainty about the total number of persons on the runway system most likely caused a necessary slowdown of speed of involved firefighting vehicles.

For that reason, the AIB finds the aerodrome emergency response time to be adequate.

3 CONCLUSIONS

3.1 Findings

1. The licenses and qualifications held by the flight crew, flight and duty times, the pre-flight planning phase, the documented technical status of the aircraft, the aircraft mass and balance, issued NOTAMs, chart presentations, the status of aids to navigation, and the status of the CAT 1 approach and runway lighting system had no influence on the sequence of events.
2. The forecasted weather conditions at EKAH were generally consistent with the actual weather reports.
3. The first officer perceived, noted, and read back to the commander the meteorological visibility to be 2500 m instead of the reported 250 m.
4. Flight crew common perception of reported meteorological visibility might have provoked a common false persuasion of the general visibility being better than the actual visibility.
5. The reported controlling RVR values were above the applicable CAT 1 approach minima and did not prevent the flight crew from performing the ILS approach for runway 10R.
6. From an operational point of view, the commander's concern about entering fog patches during the landing roll was unjustified.
7. EKAH procedures for recording and storing RVR values failed.
8. Appropriate risk controls like the EGPWS (with alerts for excessive GS deviations) and SOP on call-outs and stabilized approach were in place.
9. Before leaving 2000 ft on the GS, the flight crew obtained visual contact with the approach and runway lighting system for runway 10R.
10. Passing approximately 1500 feet RH, the flight crew agreed on visual contact with the approach and runway lighting system, fog above the middle of the runway, and that the touchdown zone and the runway end were both visible.
11. The first officer identified the indication of the PAPI (established on the GS).
12. With the autopilot engaged during the final appaorach, the aircraft was established on the ILS (LLZ and GS) for runway 10R in landing configuration.
13. At approximately 900 ft RH, the commander disengaged the autopilot.
14. The commander communicated his intention of landing in the beginning of the runway but not his action plan.
15. The first officer did not challenge the intention of the commander.
16. The action plan of the commander was to fly one dot below the GS, performing a *towed approach*, and touching down on the threshold, which required initiation of the flare when passing above the stopway for runway 28L.
17. The commander started flying below the GS.
18. Both pilots accepted and instituted a deactivation of a hardware safety barrier by cancelling potential EGPWS GS alerts for excessive GS deviations.
19. The first officer seemed to be familiar with the non-standard procedure on flying below the GS.
20. Both pilots accepted and instituted a deviation from SOP by not maintaining the GS upon runway visual references in sight.
21. Deviations from SOP in dark night and low visibility combined with the cancellation of a hardware safety barrier compromised flight safety.

22. Passing 500 ft RH, the aircraft was still within the operator criteria for a stabilized approach (*approach window*).
23. Passing the set ILS approach minima, the aircraft was flying more than 2 dot below the GS and was no longer within the operator criteria for a stabilized approach (*approach window*).
24. The first officer as pilot monitoring believed that the commander by calling *Continue* had appropriate visual cues to complete the approach and landing.
25. At low altitude, the first officer made no corrective call-outs on altitude, GS deviation or unstabilized approach.
26. The commander noted the availability of the PAPI as a visual cue (one white and three red lights).
27. The commander, from passing the set ILS approach minima until touchdown, most likely relied on external visual cues and potential corrective call-outs from the first officer.
28. The first officer mentally seemed to rely on the commander's perception of external visual cues and did not challenge, though expected to partly monitor the flights instruments, a full scale GS deviation.
29. The first officer, in a critical stage of the flight, did not provide effective monitoring and operational support to the commander and did not recognize the unstable approach.
30. The flight crew seemed to be unaware of the developing unsafe condition and probably was, due to lack of situational awareness and vigilance, unable to recognize the need for corrections.
31. The aircraft geometry neither at 134 ft RH nor at 58 ft RH (beginning of the flare) prevented flight crew field of vision over the aircraft nose.
32. The commander most likely mixed up (visual illusion) the two red omnidirectional aerodrome fence obstacle lights with the stopway red edge lights to runway 28L and also misinterpreted the CAT 1 approach and runway lighting system for runway 10R.
33. The confusion over and misinterpretation of the CAT 1 approach and runway lighting system resulted in a too early flare and consequently a CFIT.
34. The aircraft collided with the antenna mast system of the LLZ to runway 28L.
35. The left wing fuel tank ruptured resulting in a fuel leakage.
36. The aircraft touched down in the RESA for runway 28L.
37. After a landing roll of approximately 60 meters, the nose landing gear collided with the near field antenna of the LLZ for runway 28L and collapsed.
38. While rolling on the main wheels and skidding on the nose section, the aircraft entered the stopway for runway 28L.
39. Approximately 230 m after the beginning of runway 10R, the aircraft came to a full stop on runway 10R.
40. Leaking fuel from the left wing fuel tank caught fire, and the fire eventually engulfed the left side of the aircraft fuselage.
41. A touchdown on soft but solid ground in a landing attitude at low airspeed absorbed most of the impact forces and reduced the risk of serious injuries to passengers and crew.
42. The flight crew and the cabin crewmember did not coordinate the aircraft evacuation process.
43. In this specific accident sequence, the aircraft evacuation was effective.

44. The accident was survivable.
45. The commander was an experienced pilot and highly ranked at the operator.
46. The first officer held his first job as a commercial pilot and had limited flying experience.
47. At his latest OPC, the first officer was below standard on critical CRM subjects.
48. The commander's rank and experience at the operator might have biased the first officer on final approach to allow concentration of authority/power in one person steepening the flight crew gradient.
49. The actual flight and duty time on the day of the accident was within approved limitations.
50. Recent sleep, hours awake, and time of the day (acute fatigue) might have impacted the decision-making processes of the flight crew.
51. A visual illusion might have provoked a steeper than intended short final approach and target fixation on touching down on the threshold leaving out alternate options like aborting the approach.
52. The flight crew did not employ appropriate execution countermeasures to keep threats, errors, and an undesired aircraft state from reducing margins of flight safety.
53. A combination of lack of visual contact with the aircraft on the runway (Aarhus Approach and the Aerodrome Office) and no distinct distress call (MAYDAY) from the flight crew prolonged the initial aerodrome emergency response time.
54. Local conditions like fog and people on the runway system prolonged the aerodrome emergency response time.
55. The aerodrome emergency response time was adequate.

3.2 Factors

1. Deviations from SOP in dark night and low visibility combined with the cancellation of a hardware safety barrier compromised flight safety.
2. The commander started flying below the GS.
3. Both pilots accepted and instituted a deactivation of a hardware safety barrier by cancelling potential EGPWS GS alerts for excessive GS deviations.
4. Both pilots accepted and instituted a deviation from SOP by not maintaining the GS upon runway visual references in sight.
5. At low altitude, the first officer made no corrective call-outs on altitude, GS deviation or unstabilized approach.
6. The confusion over and misinterpretation of the CAT 1 approach and runway lighting system resulted in a too early flare and consequently a CFIT.

3.3 Summary

On short final for runway 10R, the aircraft collided with the antenna mast system of the LLZ of runway 28L resulting in a left wing fuel tank rupture and a fuel leakage.

The aircraft touched down in the RESA for runway 28L.

While rolling on the main wheels and skidding on the nose section, the aircraft entered the stopway for runway 28L and came to a full stop on runway 10R.

Leaking fuel from the left wing fuel tank caught fire, and the fire eventually engulfed the left side of the aircraft fuselage.

The following causal factors led to a CFIT accident:

- An action plan on flying below the GS, performing a *towed approach,* and touching down on the threshold in dark night and low visibility.
- A deactivation of a hardware safety barrier.
- Deviations from SOP.
- Less than optimum CRM.
- A confusion over and a misinterpretation of the CAT 1 approach and runway lighting system of runway 10R.

4 SAFETY RECOMMENDATIONS

This safety investigation did not result in the issue of safety recommendations.

Appendices

5 APPENDICES

5.1 Commander's duty time summary.

5.2 First officer's duty time summary.

5.3 Operational flight and mass and balance.

5.4 ILS approach – Normal/Single Engine.

5.5 SIGWX valid on 5-8-2019 at 18:00 hrs.

5.6 SIGWX valid on 6-8-2019 at 00:00 hrs.

5.7 Aerodrome chart for EKAH.

5.8 Operator's aerodrome chart.

5.9 Operator's IAC.

5.10 Aerodrome fence obstacle lights.

5.11 Final approach from 2000 ft.

5.12 Final approach from 1000 ft.

5.13 AIB selected parameters from 1000 ft.

5.14 SSFDR reconstruction no. 1.

5.15 SSFDR reconstruction no. 2.

5.16 Wreckage trail.

5.17 Flight crew field of vision over aircraft nose.

5.18 AIB drone photo no. 1.

5.19 AIB drone photo no. 2.

5.20 AIB drone photo no. 3.

5.21 Optimum sleep in Oslo.

5.22 No sleep in Oslo.

5.1 Commander's duty time summary

Return to the commander's flight and duty time

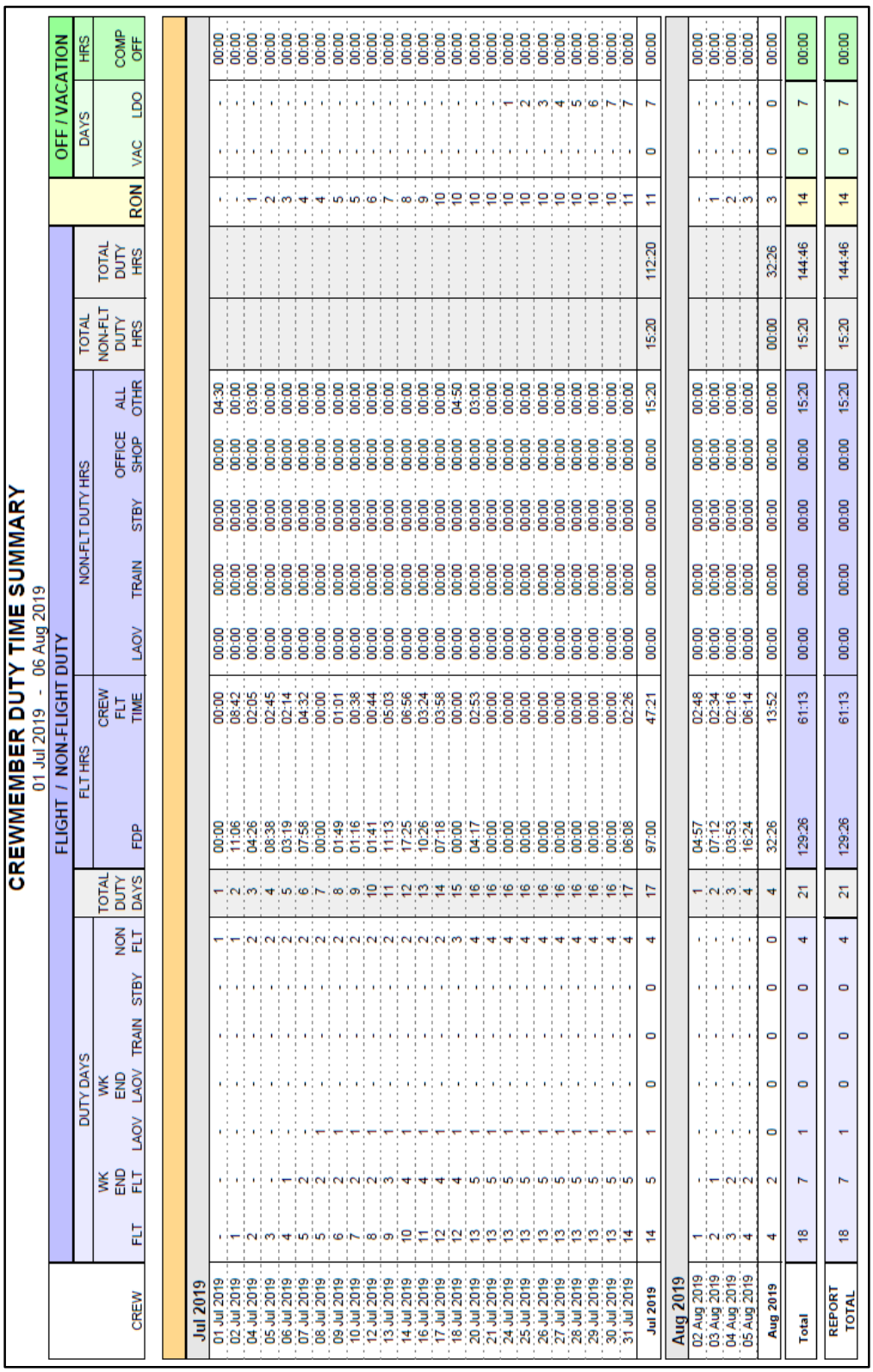
CREWMEMBER DUTY TIME SUMMARY

01 Jul 2019 - 06 Aug 2019

CREW	FLIGHT / NON-FLIGHT DUTY																					OFF / VACATION		
	DUTY DAYS								FLT HRS			NON-FLT DUTY HRS										DAYS		
	FLT	WK END FLT	WK END LAOV	WK END TRAIN	STBY	NON FLT	TOTAL DUTY DAYS	FDP	CREW FLT TIME	LAOV	TRAIN	STBY	OFFICE SHOP	ALL OTHR	TOTAL NON-FLT DUTY HRS	TOTAL DUTY HRS	RON	VAC	LDO	HRS COMP OFF
Jul 2019																								
01 Jul 2019	1	-	-	-	-	-	1	12:07	05:29	00:00	00:00	00:00	00:00	00:00			1	-	-	00:00
02 Jul 2019	2	-	-	-	-	-	2	02:55	02:05	00:00	00:00	00:00	00:00	00:00			1	-	-	00:00
03 Jul 2019	2	-	-	-	-	-	2	00:00	00:00	00:00	00:00	00:00	00:00	00:00			1	-	1	00:00
04 Jul 2019	2	-	-	-	-	-	2	00:00	00:00	00:00	00:00	00:00	00:00	00:00			1	-	2	00:00
05 Jul 2019	2	-	-	-	-	-	2	00:00	00:00	00:00	00:00	00:00	00:00	00:00			1	-	3	00:00
06 Jul 2019	2	-	-	-	-	-	2	00:00	00:00	00:00	00:00	00:00	00:00	00:00			1	-	4	00:00
07 Jul 2019	2	-	-	-	-	-	2	00:00	00:00	00:00	00:00	00:00	00:00	00:00			1	-	5	00:00
08 Jul 2019	2	-	-	-	-	-	2	00:00	00:00	00:00	00:00	00:00	00:00	00:00			1	-	6	00:00
09 Jul 2019	2	-	-	-	-	-	2	00:00	00:00	00:00	00:00	00:00	00:00	00:00			1	-	7	00:00
10 Jul 2019	2	-	-	-	-	-	2	00:00	00:00	00:00	00:00	00:00	00:00	00:00			1	-	8	00:00
11 Jul 2019	2	-	-	-	-	-	2	00:00	00:00	00:00	00:00	00:00	00:00	00:00			1	-	9	00:00
12 Jul 2019	3	-	-	-	-	-	3	01:41	00:44	00:00	00:00	00:00	00:00	00:00			2	-	9	00:00
13 Jul 2019	4	1	-	-	-	-	4	11:13	05:03	00:00	00:00	00:00	00:00	00:00			3	-	9	00:00
14 Jul 2019	5	2	-	-	-	-	5	17:25	06:56	00:00	00:00	00:00	00:00	00:00			4	-	9	00:00
16 Jul 2019	6	2	-	-	-	-	6	10:26	03:24	00:00	00:00	00:00	00:00	00:00			5	-	9	00:00
17 Jul 2019	6	2	1	-	-	-	7	00:00	00:00	00:00	00:00	00:00	00:00	00:00			5	-	9	00:00
18 Jul 2019	7	2	1	-	-	-	8	02:03	00:57	00:00	00:00	00:00	00:00	00:00			6	-	9	00:00
19 Jul 2019	8	2	1	-	-	-	9	03:19	01:36	00:00	00:00	00:00	00:00	00:00			7	-	9	00:00
20 Jul 2019	9	3	1	-	-	1	10	05:04	03:06	00:00	00:00	00:00	00:00	02:00			8	-	9	00:00
21 Jul 2019	10	4	1	-	-	1	11	03:44	02:17	00:00	00:00	00:00	00:00	00:00			9	-	9	00:00
22 Jul 2019	11	4	1	-	-	1	12	06:12	04:05	00:00	00:00	00:00	00:00	00:00			10	-	9	00:00
23 Jul 2019	12	4	1	-	-	1	13	12:43	04:13	00:00	00:00	00:00	00:00	00:00			10	-	9	00:00
25 Jul 2019	13	4	1	-	-	1	14	04:05	02:03	00:00	00:00	00:00	00:00	00:00			10	-	9	00:00
26 Jul 2019	13	4	1	-	-	2	15	00:00	00:00	00:00	00:00	00:00	00:00	05:00			11	-	9	00:00
27 Jul 2019	14	5	1	-	-	2	16	02:21	01:18	00:00	00:00	00:00	00:00	00:00			12	-	9	00:00
28 Jul 2019	15	6	1	-	-	2	17	07:59	03:46	00:00	00:00	00:00	00:00	00:00			13	-	9	00:00
29 Jul 2019	16	6	1	-	-	2	18	15:13	06:34	00:00	00:00	00:00	00:00	00:00			13	-	9	00:00
30 Jul 2019	17	6	1	0	0	2	19	11:40	04:20	00:00	00:00	00:00	00:00	00:00			13	-	9	00:00
Jul 2019	17	6	1	0	0	2	19	130:10	57:56	00:00	00:00	00:00	00:00	07:00	07:00	137:10	13	0	9	00:00
Aug 2019																				
01 Aug 2019	-	-	-	-	-	-	0	00:00	00:00	00:00	00:00	00:00	00:00	00:00			-	-	1	00:00
02 Aug 2019	-	-	-	-	-	-	0	00:00	00:00	00:00	00:00	00:00	00:00	00:00			-	-	2	00:00
03 Aug 2019	1	-	-	-	-	-	1	07:12	02:34	00:00	00:00	00:00	00:00	00:00			1	-	2	00:00
04 Aug 2019	2	-	-	-	-	-	2	03:53	02:16	00:00	00:00	00:00	00:00	00:00			2	-	2	00:00
05 Aug 2019	3	2	-	-	-	-	3	16:24	06:14	00:00	00:00	00:00	00:00	00:00			3	-	2	00:00
Aug 2019	3	2	0	0	0	0	3	27:29	11:04	00:00	00:00	00:00	00:00	00:00	00:00	27:29	3	0	2	00:00
Total	20	8	1	0	0	2	22	157:39	69:00	00:00	00:00	00:00	00:00	07:00	07:00	164:39	16	0	11	00:00
REPORT TOTAL	20	8	1	0	0	2	22	157:39	69:00	00:00	00:00	00:00	00:00	07:00	07:00	164:39	16	0	11	00:00

5.2 First officer's duty time summary

Return to the first officer's flight and duty time



CREWMEMBER DUTY TIME SUMMARY

01 Jul 2019 - 06 Aug 2019

CREW	FLIGHT / NON-FLIGHT DUTY																										OFF / VACATION			
	DUTY DAYS								FLT HRS			NON-FLT DUTY HRS							TOTAL NON-FLT DUTY HRS	TOTAL DUTY HRS	RON	DAYS		HRS	
	FLT	WK END FLT	LAOV	WK END LAOV	TRAIN	STBY	NON FLT	TOTAL DUTY DAYS	FDP	CREW FLT TIME	LAOV	TRAIN	STBY	OFFICE SHOP	ALL OTHR				VAC	LDO	COMP OFF
Jul 2019																														
01 Jul 2019	-	-	-	-	-	-	1	1	00:00	00:00	00:00	00:00	00:00	00:00	04:30				-	-	-	-	-	-	-	-	-	-	-	00:00
02 Jul 2019	1	-	-	-	-	-	1	2	11:06	08:42	00:00	00:00	00:00	00:00	00:00				-	-	-	-	-	-	-	-	-	-	-	00:00
04 Jul 2019	2	-	-	-	-	-	2	3	04:26	02:05	00:00	00:00	00:00	00:00	03:00				1	-	-	-	-	-	-	-	-	-	-	00:00
05 Jul 2019	3	-	-	-	-	-	2	4	08:38	02:45	00:00	00:00	00:00	00:00	00:00				2	-	-	-	-	-	-	-	-	-	-	00:00
06 Jul 2019	4	1	-	-	-	-	2	5	03:19	02:14	00:00	00:00	00:00	00:00	00:00				3	-	-	-	-	-	-	-	-	-	-	00:00
07 Jul 2019	5	2	-	-	-	-	2	6	07:58	04:32	00:00	00:00	00:00	00:00	00:00				4	-	-	-	-	-	-	-	-	-	-	00:00
08 Jul 2019	5	2	1	-	-	-	2	7	00:00	00:00	00:00	00:00	00:00	00:00	00:00				4	-	-	-	-	-	-	-	-	-	-	00:00
09 Jul 2019	6	2	1	-	-	-	2	8	01:49	01:01	00:00	00:00	00:00	00:00	00:00				5	-	-	-	-	-	-	-	-	-	-	00:00
10 Jul 2019	7	2	1	-	-	-	2	9	01:16	00:38	00:00	00:00	00:00	00:00	00:00				5	-	-	-	-	-	-	-	-	-	-	00:00
12 Jul 2019	8	2	1	-	-	-	2	10	01:41	00:44	00:00	00:00	00:00	00:00	00:00				6	-	-	-	-	-	-	-	-	-	-	00:00
13 Jul 2019	9	3	1	-	-	-	2	11	11:13	05:03	00:00	00:00	00:00	00:00	00:00				7	-	-	-	-	-	-	-	-	-	-	00:00
14 Jul 2019	10	4	1	-	-	-	2	12	17:25	06:56	00:00	00:00	00:00	00:00	00:00				8	-	-	-	-	-	-	-	-	-	-	00:00
16 Jul 2019	11	4	1	-	-	-	2	13	10:26	03:24	00:00	00:00	00:00	00:00	00:00				9	-	-	-	-	-	-	-	-	-	-	00:00
17 Jul 2019	12	4	1	-	-	-	2	14	07:18	03:58	00:00	00:00	00:00	00:00	04:50				10	-	-	-	-	-	-	-	-	-	-	00:00
18 Jul 2019	12	4	1	-	-	-	3	15	00:00	00:00	00:00	00:00	00:00	00:00	00:00				10	-	-	-	-	-	-	-	-	-	-	00:00
20 Jul 2019	13	5	1	-	-	-	4	16	04:17	02:53	00:00	00:00	00:00	00:00	03:00				10	-	-	-	-	-	-	-	-	-	-	00:00
21 Jul 2019	13	5	1	-	-	-	4	16	00:00	00:00	00:00	00:00	00:00	00:00	00:00				10	-	-	-	-	-	-	-	-	-	-	00:00
24 Jul 2019	13	5	1	-	-	-	4	16	00:00	00:00	00:00	00:00	00:00	00:00	00:00				10	-	-	-	-	-	-	-	-	-	-	00:00
25 Jul 2019	13	5	1	-	-	-	4	16	00:00	00:00	00:00	00:00	00:00	00:00	00:00				10	-	-	-	-	-	-	-	-	-	-	00:00
26 Jul 2019	13	5	1	-	-	-	4	16	00:00	00:00	00:00	00:00	00:00	00:00	00:00				10	-	-	-	-	-	-	-	-	-	-	00:00
27 Jul 2019	13	5	1	-	-	-	4	16	00:00	00:00	00:00	00:00	00:00	00:00	00:00				10	-	-	-	-	-	-	-	-	-	-	00:00
28 Jul 2019	13	5	1	-	-	-	4	16	00:00	00:00	00:00	00:00	00:00	00:00	00:00				10	-	-	-	-	-	-	-	-	-	-	00:00
29 Jul 2019	13	5	1	-	-	-	4	16	00:00	00:00	00:00	00:00	00:00	00:00	00:00				10	-	-	-	-	-	-	-	-	-	-	00:00
30 Jul 2019	13	5	1	-	-	-	4	16	00:00	00:00	00:00	00:00	00:00	00:00	00:00				10	-	-	-	-	-	-	-	-	-	-	00:00
31 Jul 2019	14	5	1	-	-	-	4	17	06:08	02:26	00:00	00:00	00:00	00:00	00:00				11	-	-	-	-	-	-	-	-	-	-	00:00
Jul 2019	14	5	1	0	0	0	4	17	97:00	47:21	00:00	00:00	00:00	00:00	15:20				15:20	112:20	11	0	7	00:00						
Aug 2019																														
02 Aug 2019	1	-	-	-	-	-	1	1	04:57	02:48	00:00	00:00	00:00	00:00	00:00				-	-	-	-	-	-	-	-	-	-	-	00:00
03 Aug 2019	2	1	-	-	-	-	-	2	07:12	02:34	00:00	00:00	00:00	00:00	00:00				1	-	-	-	-	-	-	-	-	-	-	00:00
04 Aug 2019	3	2	-	-	-	-	-	3	03:53	02:16	00:00	00:00	00:00	00:00	00:00				2	-	-	-	-	-	-	-	-	-	-	00:00
05 Aug 2019	4	2	-	-	-	-	-	4	16:24	06:14	00:00	00:00	00:00	00:00	00:00				3	-	-	-	-	-	-	-	-	-	-	00:00
Aug 2019	4	2	0	0	0	0	0	4	32:26	13:52	00:00	00:00	00:00	00:00	00:00				00:00	32:26	3	0	0	00:00						
Total	18	7	1	0	0	0	4	21	129:26	61:13	00:00	00:00	00:00	00:00	15:20				15:20	144:46	14	0	7	00:00						
REPORT TOTAL	18	7	1	0	0	0	4	21	129:26	61:13	00:00	00:00	00:00	00:00	15:20				15:20	144:46	14	0	7	00:00						

5.3 Operational flight plan and mass and balance

Return to the operational flight plan and mass and balance

```
Flt no        : DCAWM  DOF :05/08-2019    ATIS DEP        CAPT:
Departure     : ENGM OSLO/GARDERMOEN                      COP :
Destination   : EKAH AARHUS
Aircraft      : C56X                      ATIS ARR
Flight time   : 0:41
Block Fuel    : 2623 Lbs

ATC Routing : TOR DCT UNVUG

V1:    Vr:    V2:    Vref Return:    Vref ARR
```

	BLOCK	AIR
ARR		
DEP	2143	2168
TIME		

CORRECTIONS:

FL	WC	TIME	TRIP
430	-7	42.7	1117
400	-8	41.4	1088
380	-8	41.7	1110
360	-9	41.1	1140
340	-10	40.6	1168
320	-12	41.4	1200

(TIME IN MINUTES/FUEL IN Lbs)

AIR WAY	MA	FL	IDENT ENGM	T	FREQ 681ft	MT	TAS	GS	DIST. INT	DIST. ACC	TIME. INT	TIME. ACC	ETA	ETO	ATO	FUEL USED	FUEL MREQ	FUEL ACT	W/V	ISA	REMARKS
VEMIN	42	CLB	C1700	S		009	346	343	2	2	0	0:00	2149			213	2310		232/005	3	
VEMIN	42	CLB	TH346	S		000	346	343	0	2	0	0:00				213	2310		232/005	3	
VEMIN	42	CLB	TH301	S		321	346	343	1	3	0	0:00				220	2303		232/005	3	
VEMIN	42	CLB	TH268	S		284	346	343	1	4	0	0:00	48			227	2296		232/005	3	
VEMIN	42	CLB	VEMIN	S		258	346	343	8	12	1	0:01	49			280	2243		232/005	3	1008
VEMIN	41	CLB	GM614	S		234	346	343	7	19	1	0:02	50			327	2196		232/005	3	
VEMIN	41	CLB	NANON	S		190	346	343	35	54	6	0:08	56			561	1962		232/005	3	
VEMIN	34	CLB	TOR	D	113.85	190	346	343	26	80	5	0:13	2261			734	1788		232/005	3	
DCT	34	370	UNVUG	O		174	429	415	73	153	11	0:24	12			1021	1502		195/015	2	
DCT	28		EKAH		82ft	172	312	285	99	252	17	0:41	29			1310	1213		241/024	5	
Alternate EKOD ODN																					
DCT	28	DSC	ODN	D	115.50	175	380	370	43	295	8	0:49				1567	956		244/024	5	
STAR	22	DSC	FE	N	423.00	238	380	356	7	302	1	0:50				1609	914		244/024	5	
DCT	22	DSC	EKOD			238	380	356	5	307	1	0:51				1639	884		244/024	5	

Appendices

Return to the operational flight plan and mass and balance

AIR WAY	MA	FL	IDENT	T	FREQ	MT	TAS	GS	DIST. INT	DIST. ACC	TIME. INT	TIME. ACC	ETA	ETO	ATO	- FUEL - USED	- FUEL - MREQ	- FUEL - ACT	W/V	ISA	REMARKS
Alternate			EKBI GELBA																		
DCT	28		DSC GELBA	S		239	380	353	69	321	13	0:54				1716	949		239/027	5	
STAR	22		DSC OSLAS	S		085	380	404	5	326	1	0:55				1745	919		239/027	5	
DCT	23		DSC EKBI			083	380	404	6	332	1	0:56				1781	884		239/027	5	

Climb : 94 NM in 0:16 hrs 828 Lbs Descent: 73 NM in 0:13 hrs 206 Lbs

FUEL TIME	Lbs	LMC
Trip 0:41	1110	
Alt1 0:10	329	
Alt2 0:15	470	
MCF 0:05	100	
Hold 0:45	884	
Min 1:41	2423	
Taxi	200	
Ramp min	2623	
Ext 2:40	1877	
Ramp 4:21	4500	
4000	104	
20kt 0:01	52	

FUEL UPLIFT: 4500

UNDERLOAD 724

UNDERLOAD DET. FACTOR MZFM

WEIGHT AND BALANCE :

PAX		Lbs	LUG	Lbs	FUEL	Lbs
1	1	200	Tail	84	Main	4500
2	1	200		0		0
3	1	200		0		0
4	1	200		0		0
5	2	400		0		0
6	1	200		0		0
7		160		0		
				0		

WEIGHT	Lbs	MAX
BOW	12892	
ZFW	14376	15100
TOW	18676	20200
ELW	17566	18700
RAMP	18876	20400

ARM	MIN	ACT	MAX
	17.0	20.5	30.0
	20.2	22.2	29.4
	19.4	21.8	29.6

SIG.PIC.

TAKEOFF AND LANDING

	Wind	Temp	Pres	Elev
Start	0	15	1013	681
Dest	0	15	1013	82
Alt1	0	15	1013	56
Alt2	0	15	1013	247

Take off x 0.00 RWYL.

Start	3226	0	11800
Landing	x 1.67	RWYL	
Dest	2803	4681	9100
Alt1	2767	4621	6500
Alt2	2730	4559	10100

RVSM Check completed: Y ✓ N ___

BOW: 12892
\+ PAYLOAD: 1644
ZFW: 14536
\+ T/O FUEL: 4300
TOW: 18836

T/O RUN REQ: 3700
T/O DIST AVAIL: 11800
LDG RUN REQ: 4700
LDG DIST AVAIL: 7665

Appendices

5.4 ILS Approach - Normal/Single Engine

Return to the Operating Manual

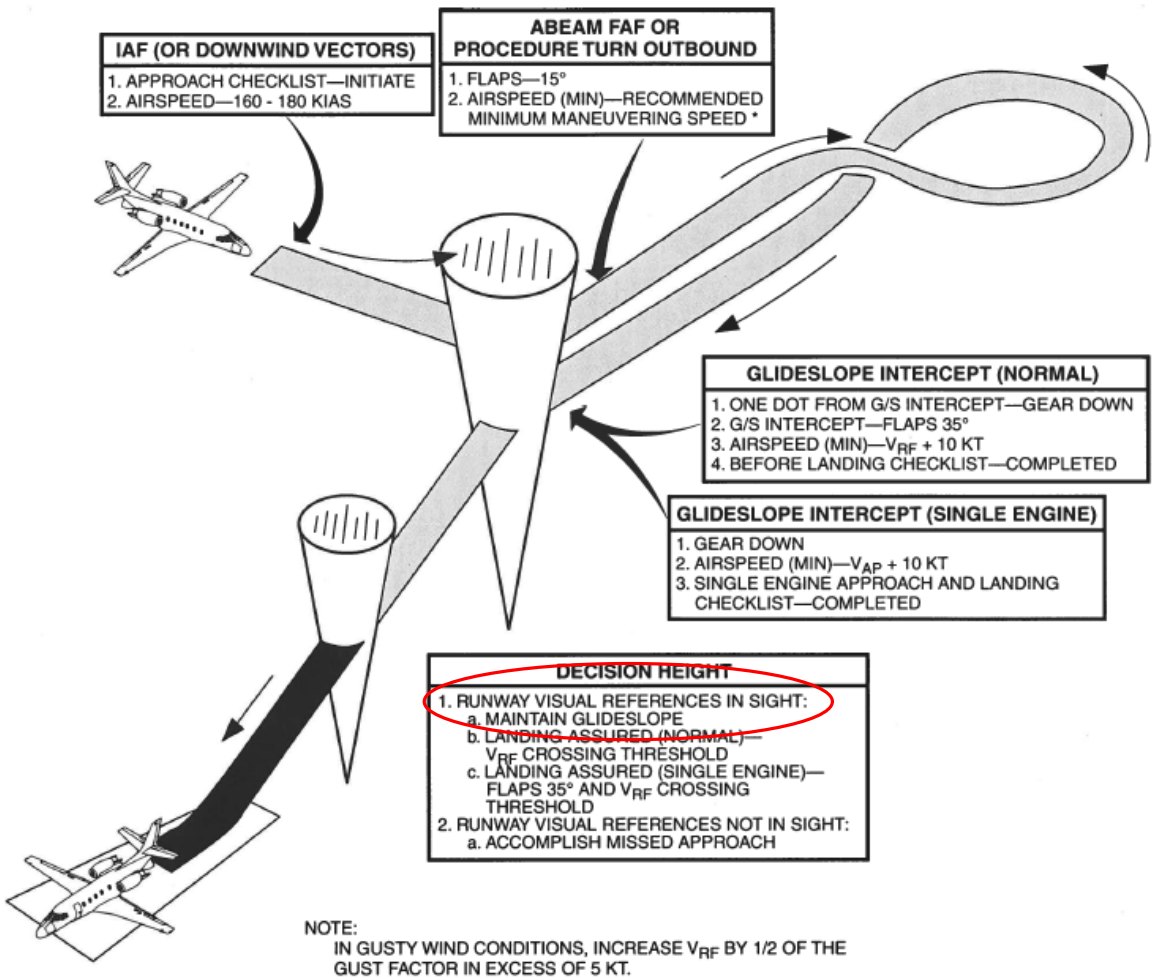
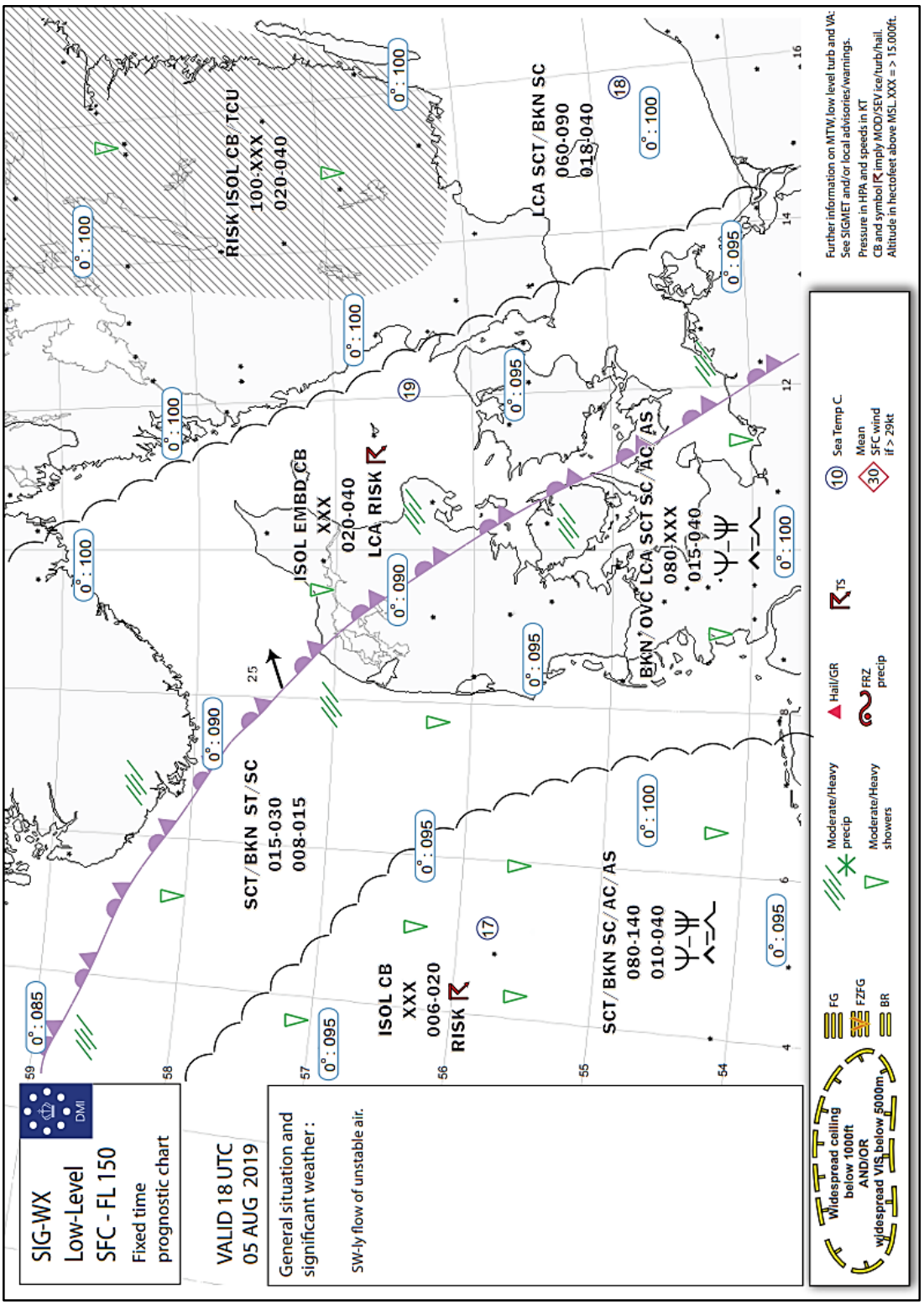


Figure 18-12. ILS Approach—Normal/Single Engine

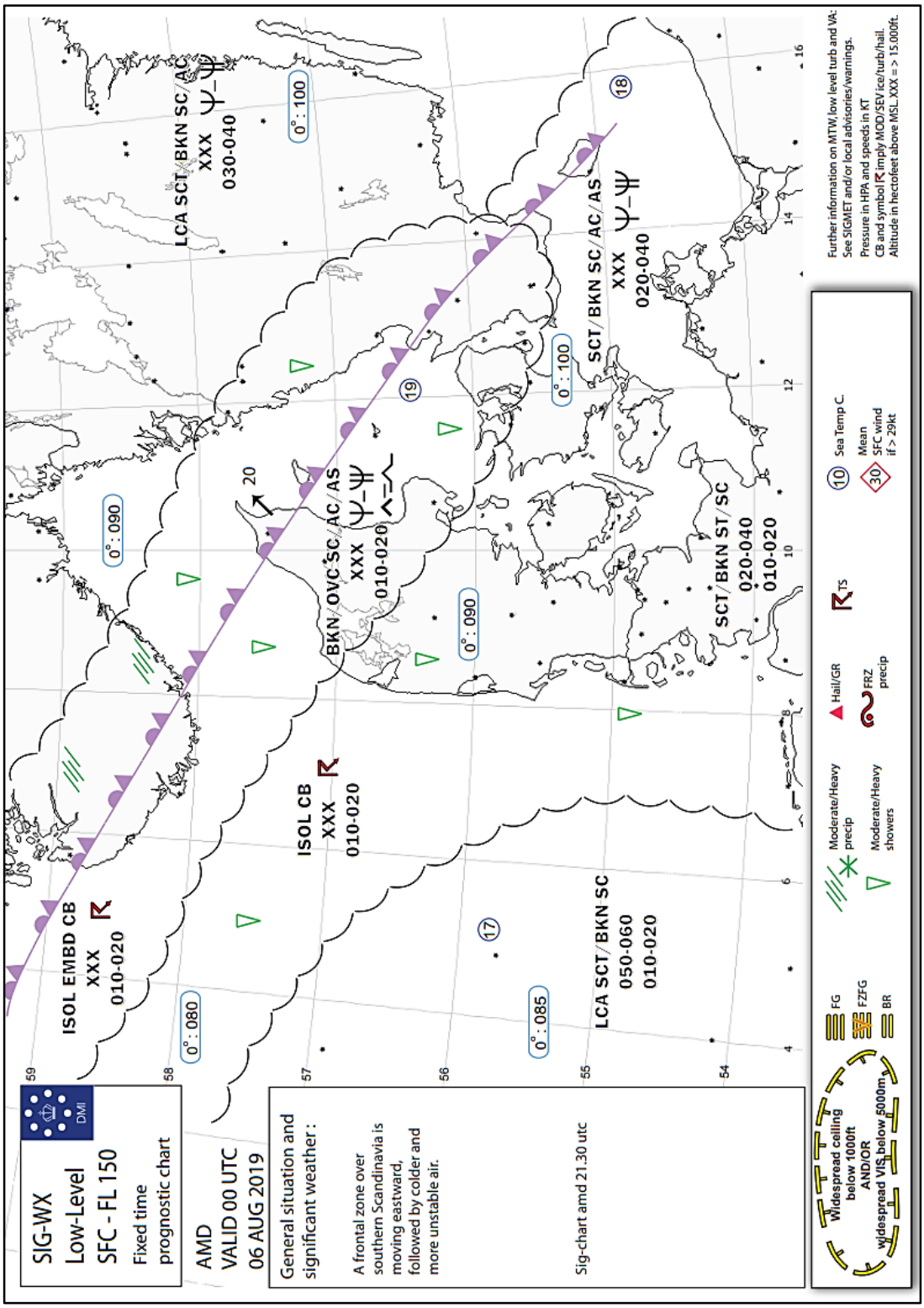
5.5 SIGWX valid on 5-8-2019 at 18:00 hrs

Return to significant weather charts



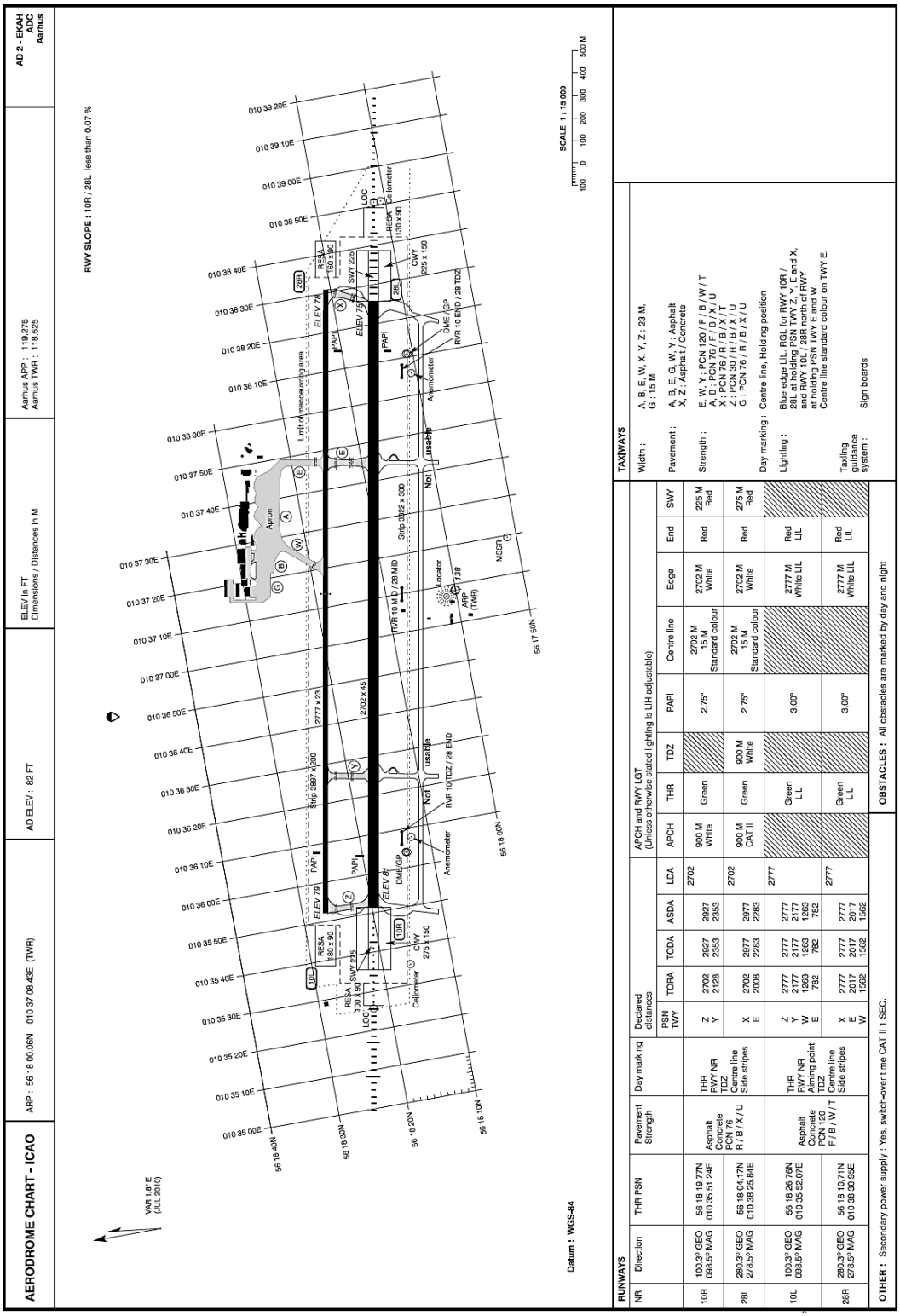
5.6 SIGWX valid on 6-8-2019 at 00:00 hrs

Return to significant weather charts



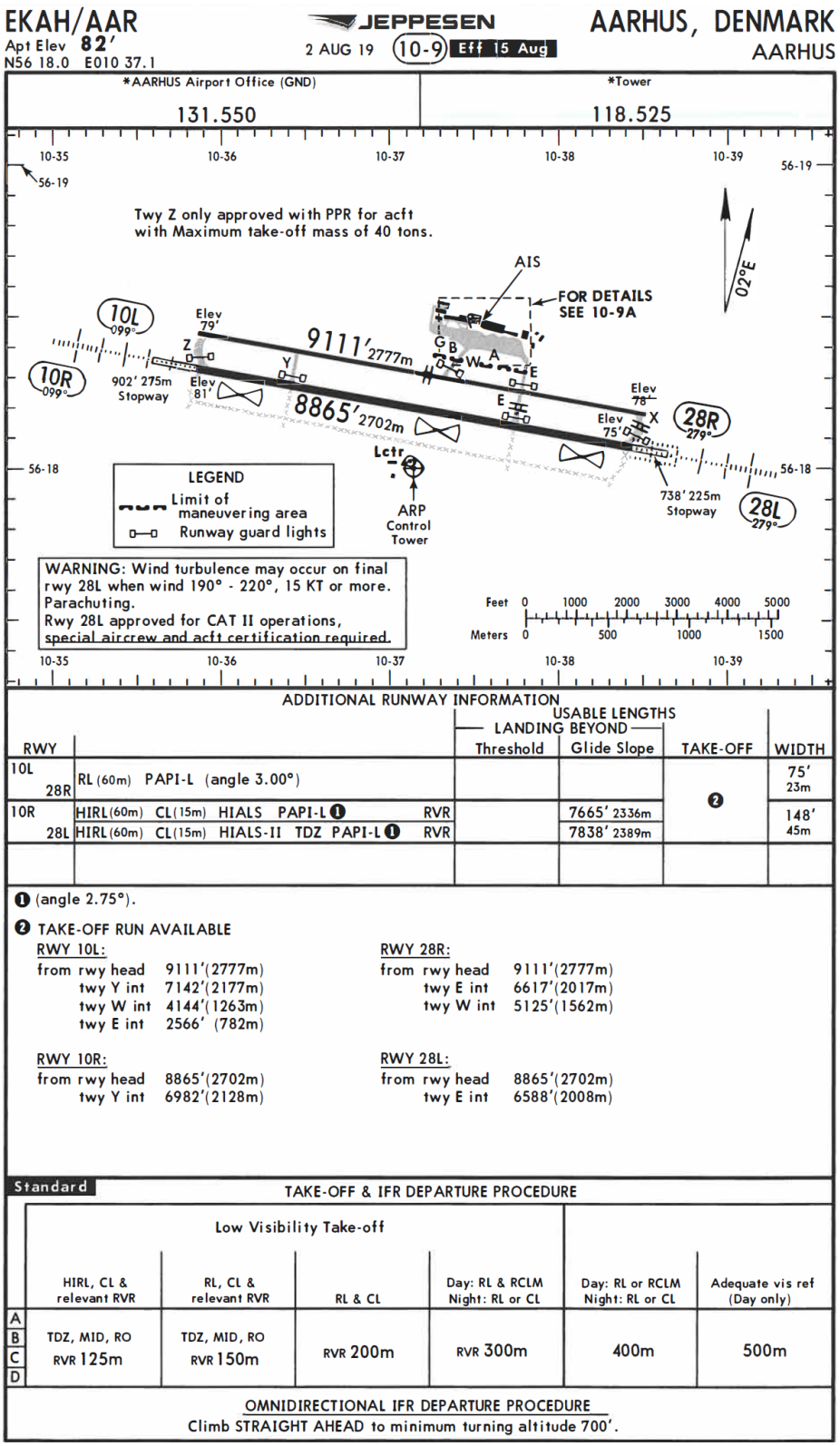
5.7 Aerodrome chart for EKAH

Return to aerodrome chart for EKAH



5.8 Operator's aerodrome chart

Return to operator´s aerodrome chart for EKAH



ADDITIONAL RUNWAY INFORMATION

RWY		USABLE LENGTHS — LANDING BEYOND — Threshold	Glide Slope	TAKE-OFF	WIDTH
10L 28R	RL (60m) PAPI-L (angle 3.00°)			❷	75' 23m
10R	HIRL(60m) CL(15m) HIALS PAPI-L❶ RVR		7665' 2336m		148' 45m
28L	HIRL(60m) CL(15m) HIALS-II TDZ PAPI-L❶ RVR		7838' 2389m		

❶ (angle 2.75°).

❷ TAKE-OFF RUN AVAILABLE

RWY 10L:
from rwy head 9111'(2777m)
twy Y int 7142'(2177m)
twy W int 4144'(1263m)
twy E int 2566' (782m)

RWY 10R:
from rwy head 8865'(2702m)
twy Y int 6982'(2128m)

RWY 28R:
from rwy head 9111'(2777m)
twy E int 6617'(2017m)
twy W int 5125'(1562m)

RWY 28L:
from rwy head 8865'(2702m)
twy E int 6588'(2008m)

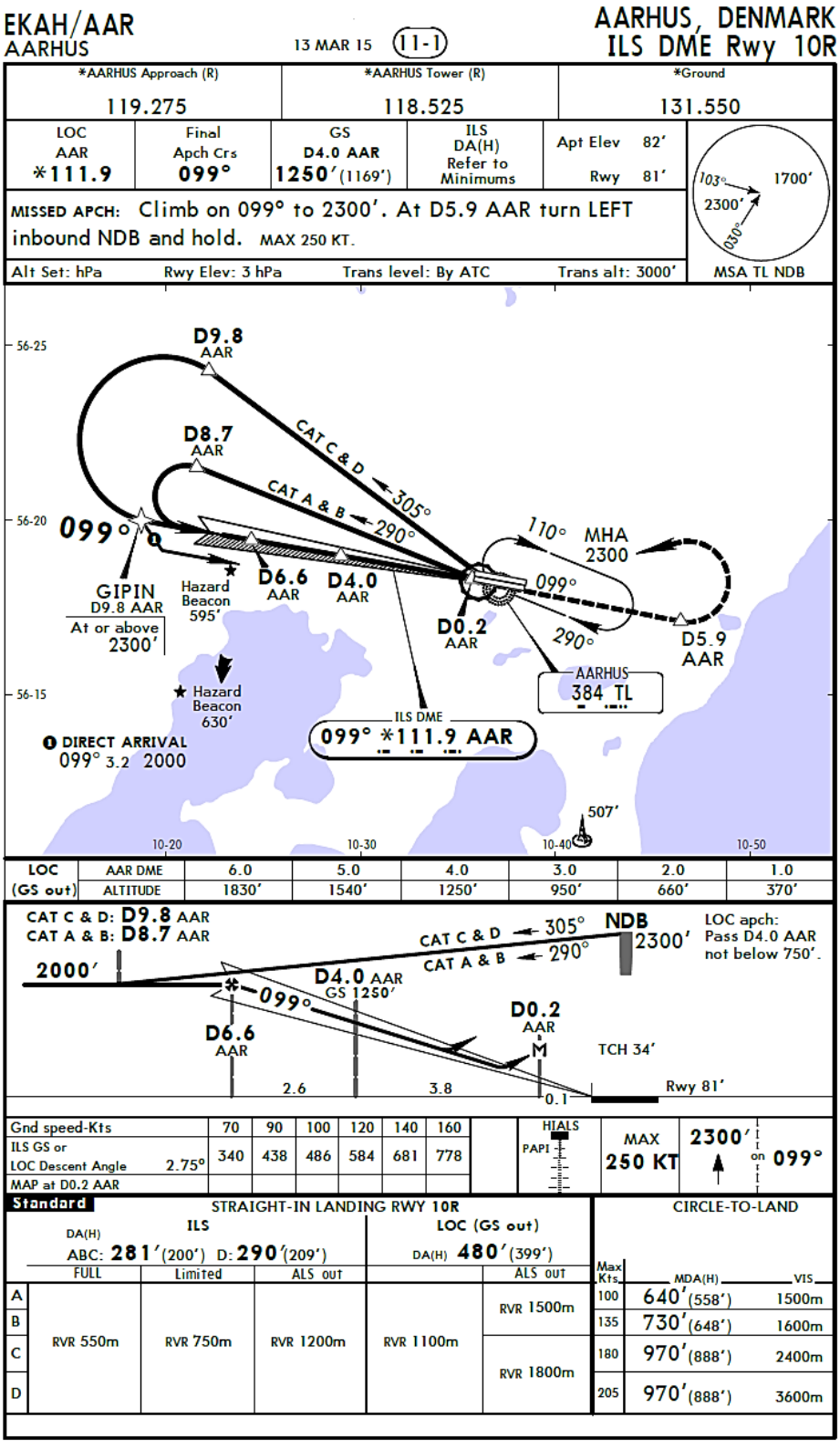
Standard TAKE-OFF & IFR DEPARTURE PROCEDURE

	Low Visibility Take-off					
	HIRL, CL & relevant RVR	RL, CL & relevant RVR	RL & CL	Day: RL & RCLM Night: RL or CL	Day: RL or RCLM Night: RL or CL	Adequate vis ref (Day only)
A B C D	TDZ, MID, RO RVR 125m	TDZ, MID, RO RVR 150m	RVR 200m	RVR 300m	400m	500m

OMNIDIRECTIONAL IFR DEPARTURE PROCEDURE
Climb STRAIGHT AHEAD to minimum turning altitude 700'.

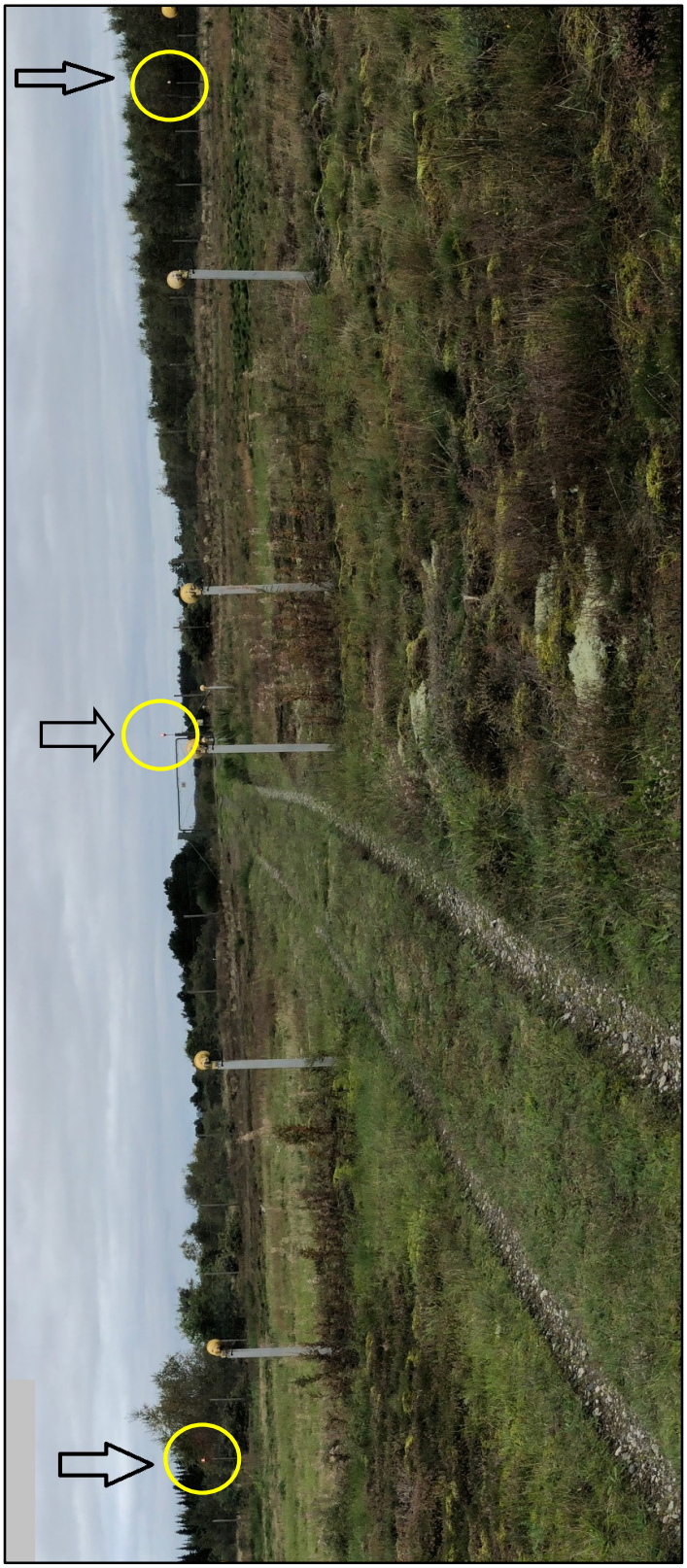
5.9 Operator's IAC

Return to operator's IAC



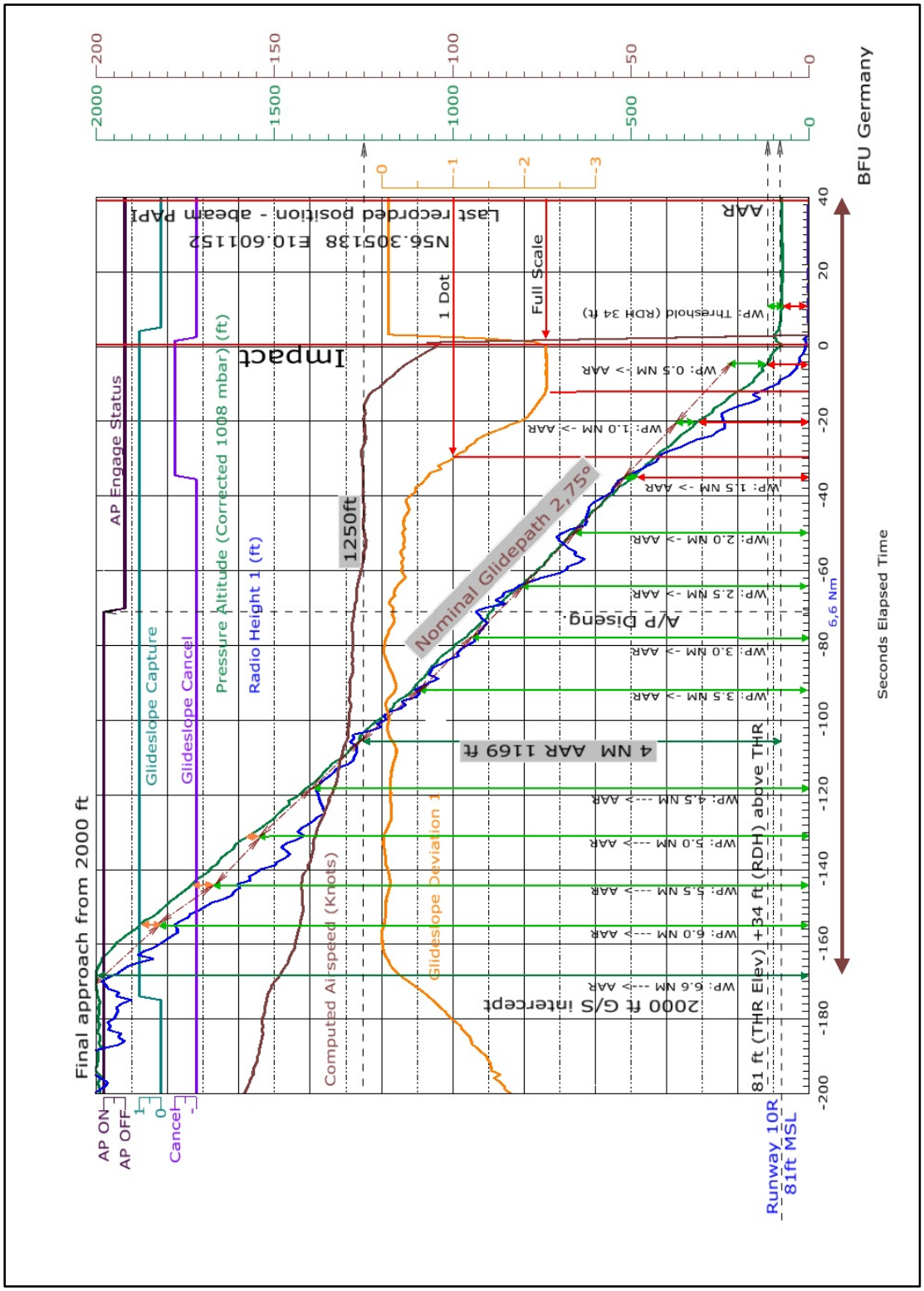
5.10 Aerodrome fence obstacle lights

Return to aerodrome fence obstacle lights



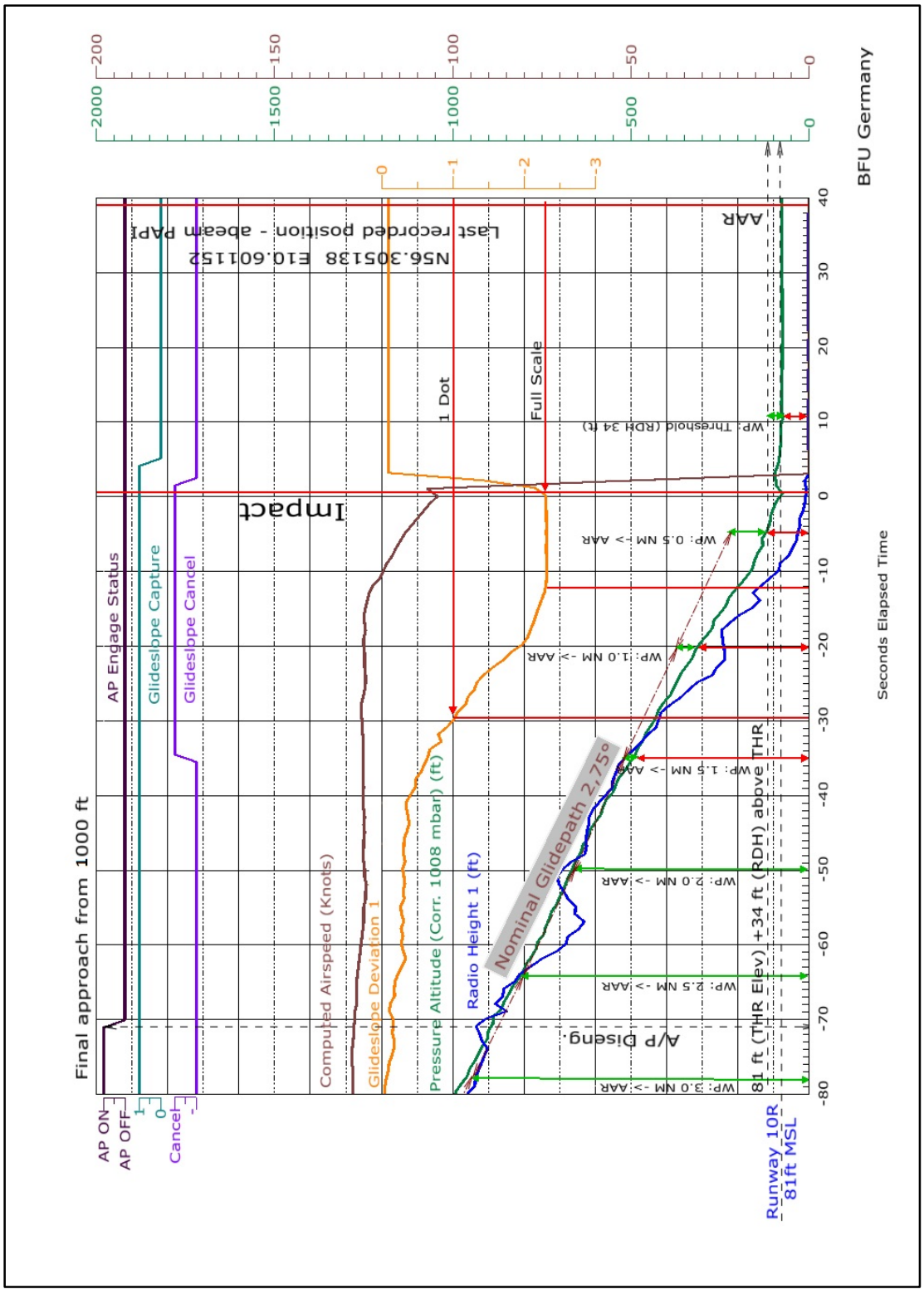
5.11 Final approach from 2000 ft

Return to flight recorders



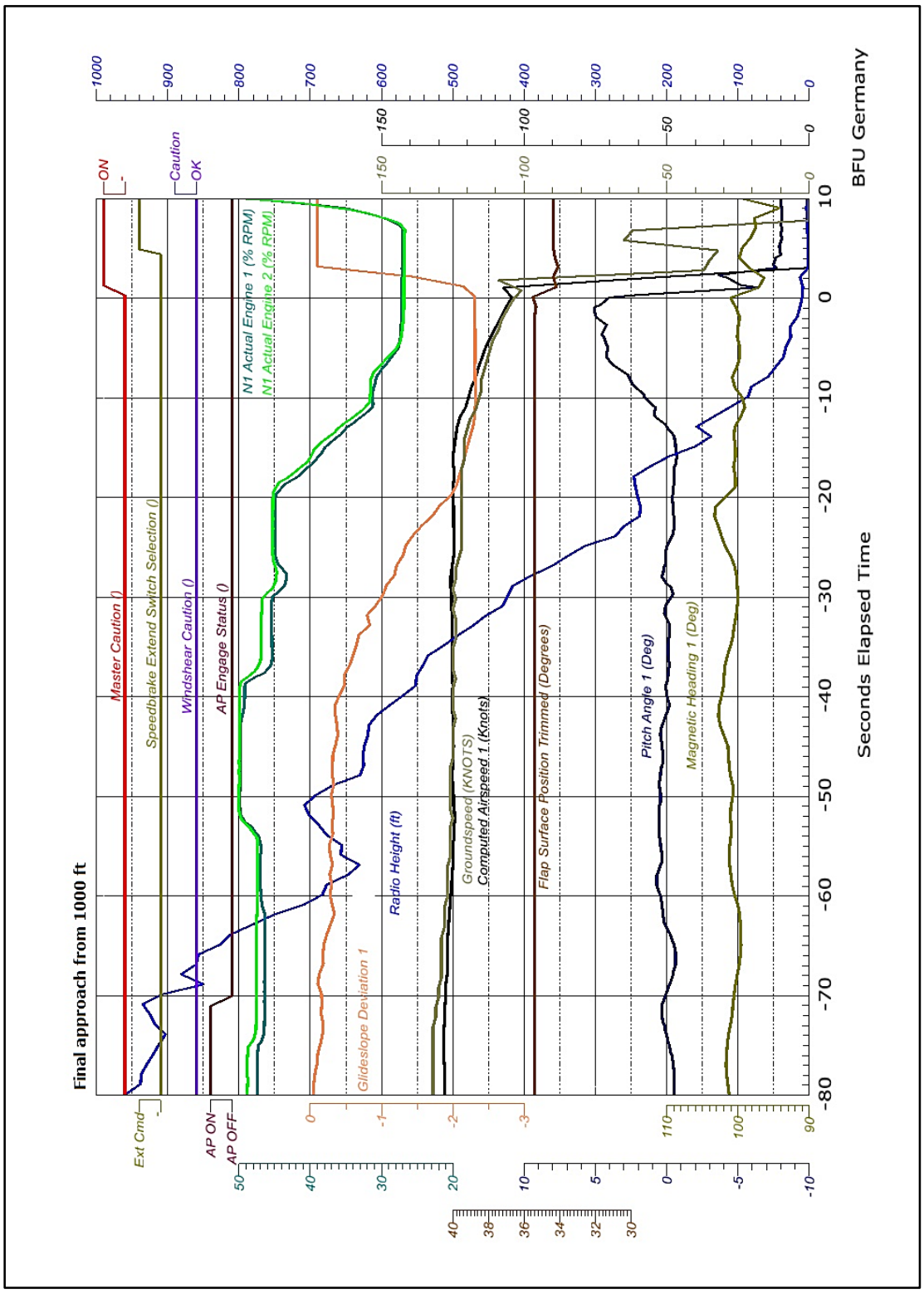
5.12 Final approach from 1000 ft

Return to flight recorders



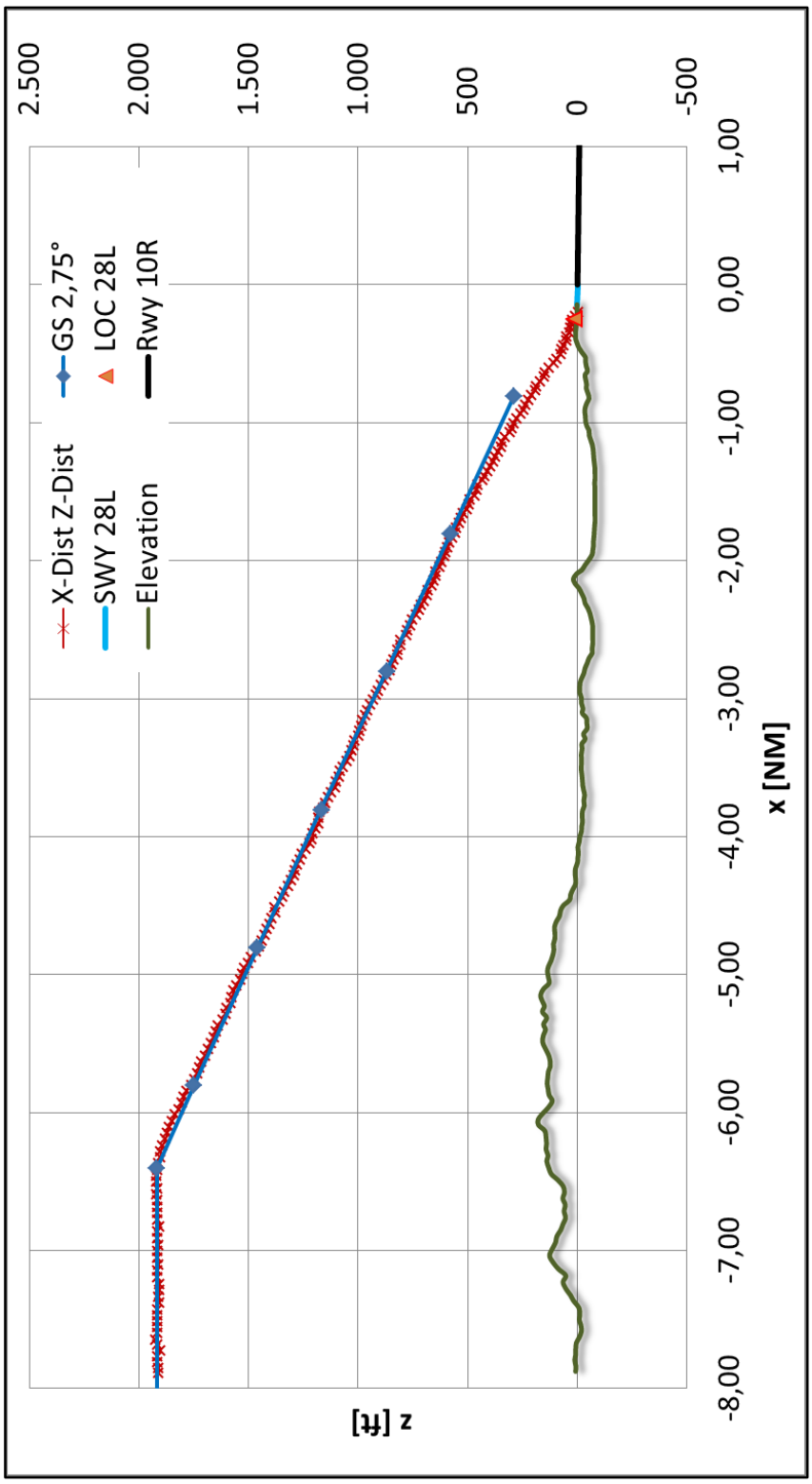
5.13 AIB selected parameters from 1000 ft

Return to flight recorders



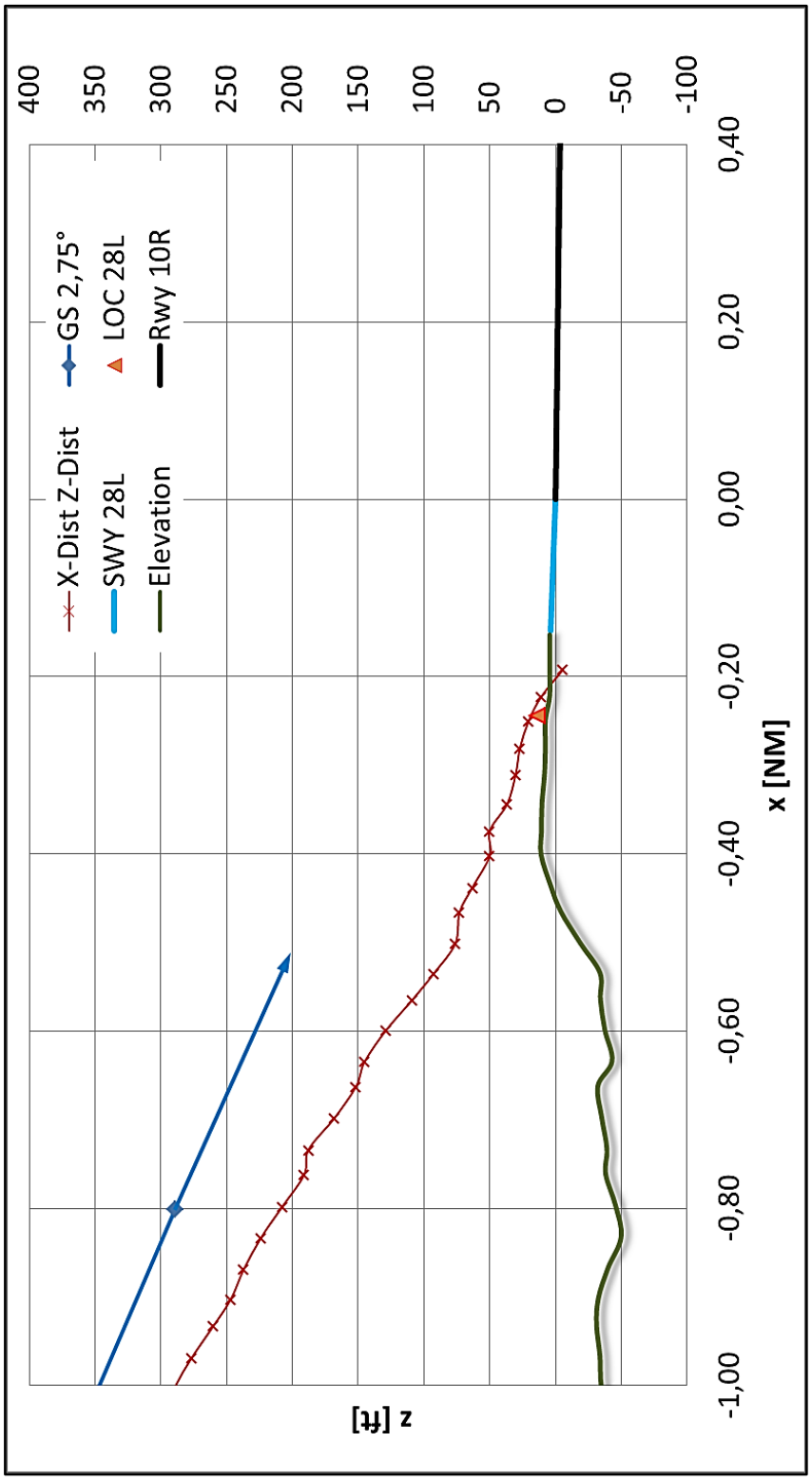
5.14 SSFDR reconstruction no. 1

Return to flight recorders



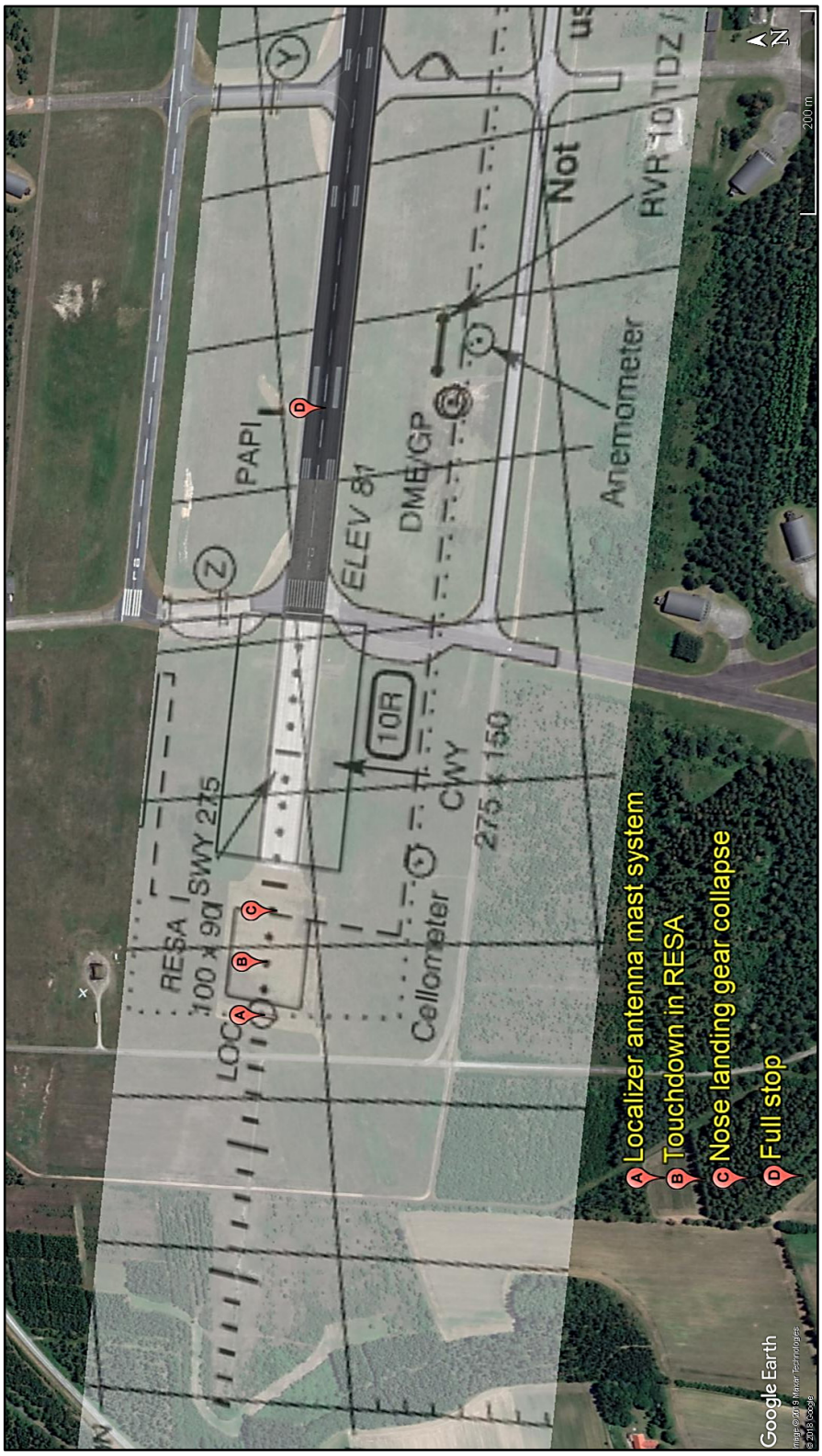
5.15 SSFDR reconstruction no. 2

Return to flight recorders



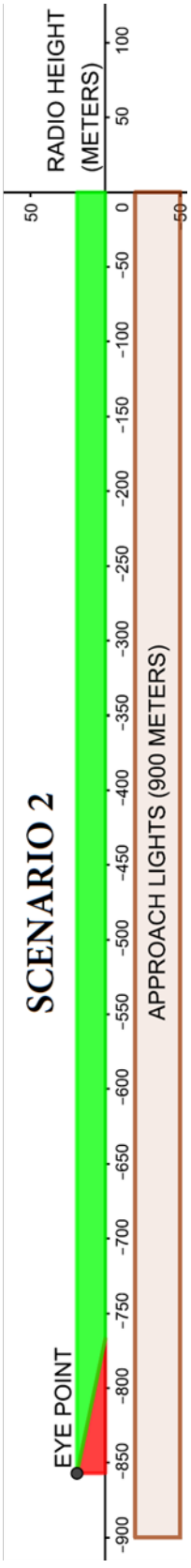
5.16 Wreckage trail

Return to wreckage and impact information



5.17 Flight crew field of vision over aircraft nose

Return to flight crew field of vision over aircraft nose



5.18 AIB drone photo no. 1

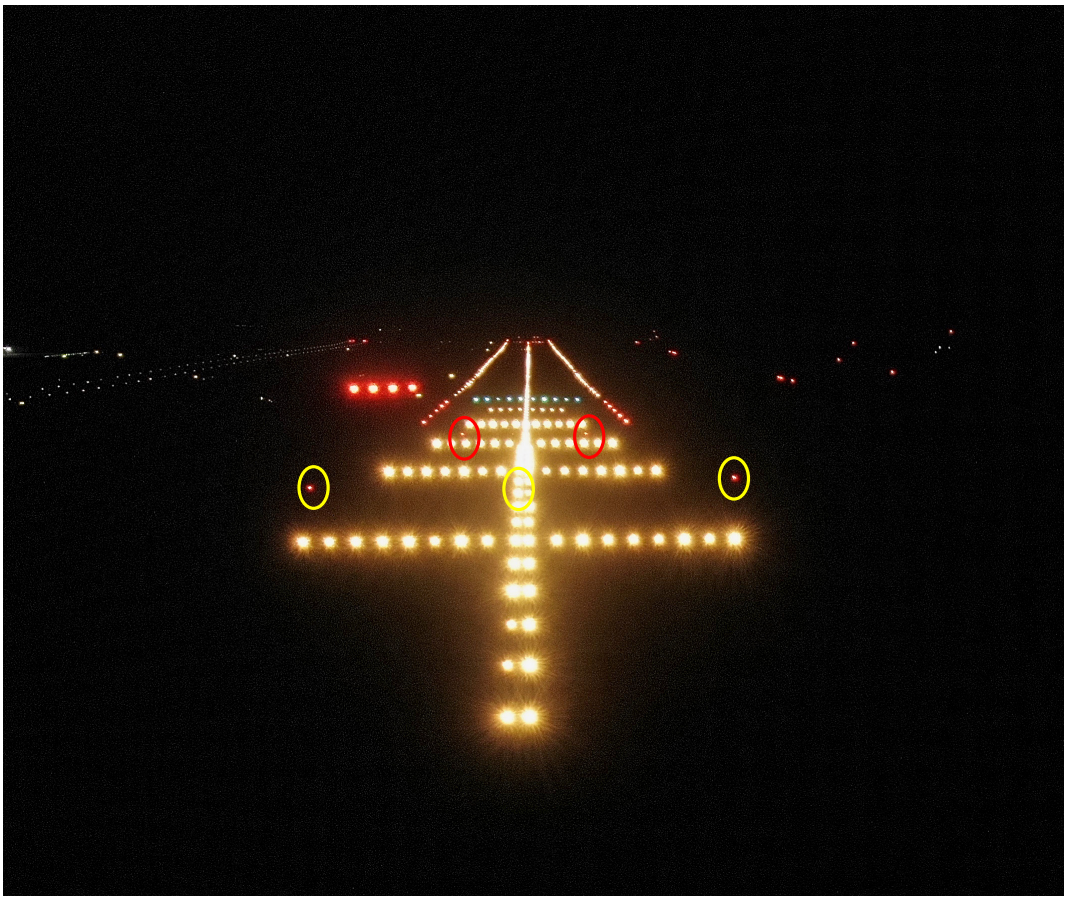
Return to on short final and established on the ILS

5.19 AIB drone photo no. 2

Return to on short final at a height above ground of 134 ft

5.20 AIB drone photo no. 3

Return to a zoom in of appendix 5.19

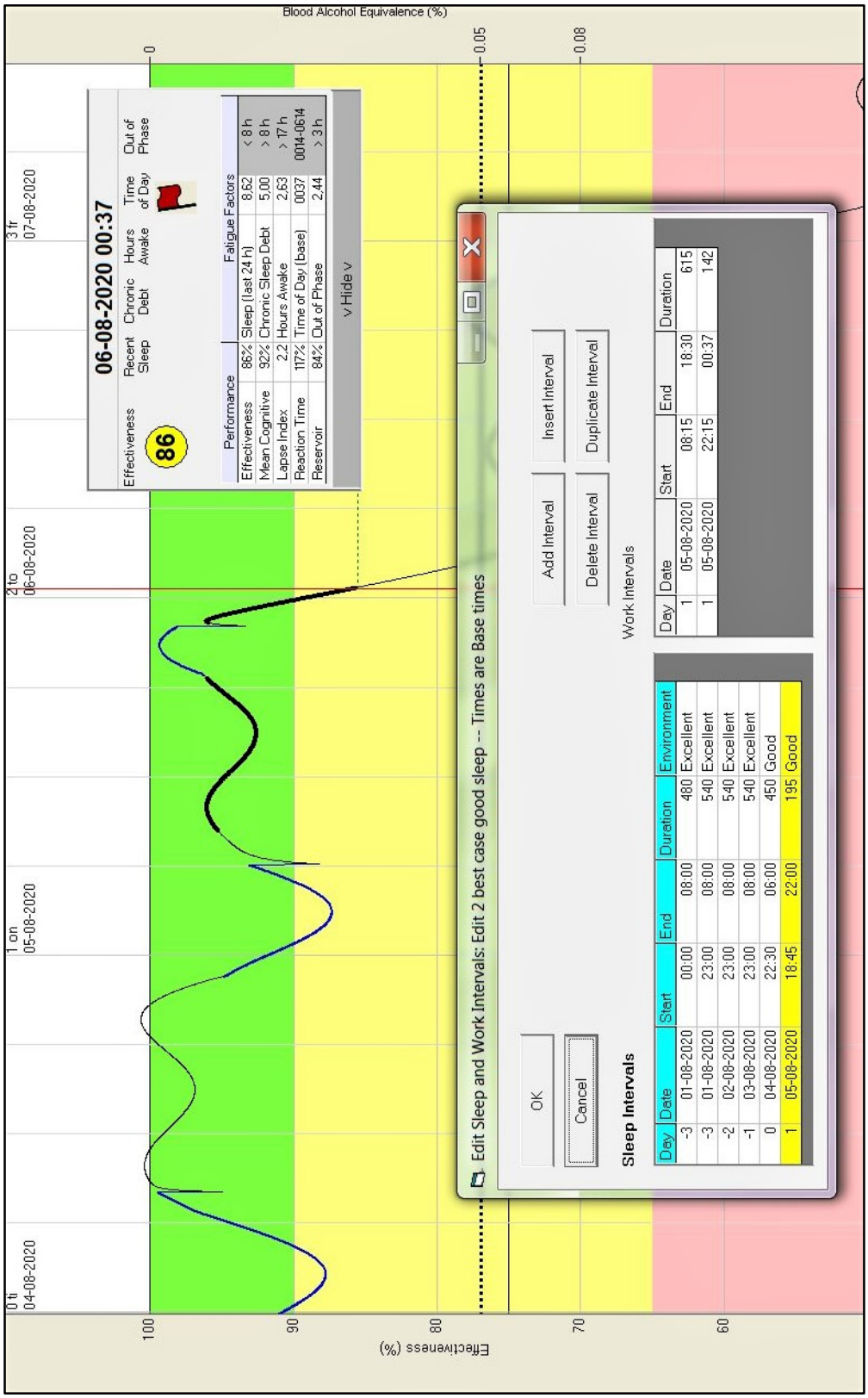


Note.

One of the red illuminated omnidirectional aerdrome fence obstacle lights (in the middle of the visible two, in yellow circles, red illumiated omnidirectioanl aerdrome fence obstacle lights) was located in the row of the approach centerline lights and for that reason not visible in this AIB drone photo.

5.21 Optimum sleep in Oslo

Return to optimum sleep in Oslo



5.22 No sleep in Oslo

Return to no sleep in Oslo