



Havarikommisjonen
Accident Investigation Board Denmark

FINAL REPORT

Serious incident

25-1-2016

involving

ATR72 200

OY-LHA



Certain report data are generated via the EC common aviation database

FOREWORD

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

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

A reprint with source reference may be published without separate permit.

TABLE OF CONTENTS

SYNOPSIS	6
1 FACTUAL INFORMATION.....	8
1.1 History of the flight.....	8
1.2 Injuries to persons	10
1.3 Damage to aircraft.....	10
1.4 Other damage.....	10
1.5 Personnel information.....	10
1.5.1 The commander.....	10
1.5.1.1 License and medical certificate.....	10
1.5.1.2 Operator training.....	11
1.5.1.3 Flying experience.....	11
1.5.1.4 Duty time and rest periods.....	11
1.5.1.5 Aerodrome familiarization - EKKA	12
1.5.2 The first officer	12
1.5.2.1 License and medical certificate.....	12
1.5.2.2 Operator training.....	12
1.5.2.3 Flying experience.....	12
1.5.2.4 Duty time and rest periods.....	12
1.5.2.5 Aerodrome familiarization – EKKA.....	13
1.6 Aircraft information	13
1.6.1 General.....	13
1.6.2 Operational flight plan	14
1.6.3 Mass and balance	14
1.7 Meteorological information	14
1.7.1 Terminal aerodrome forecast (TAF)	14
1.7.2 Aviation routine weather report (METAR).....	14
1.7.3 Automatic terminal information service (ATIS).....	14
1.8 Aids to navigation	14
1.8.1 Notice to airmen (NOTAM) - EKKA	14
1.8.2 Extract of operator’s aerodrome chart.....	15
1.9 Communication.....	15
1.9.1 General.....	15
1.9.2 ATC voice recording.....	15
1.10 Aerodrome information	15
1.10.1 EKKA aerodrome	15
1.10.2 Joint civil and military aerodrome	16
1.10.3 ICAO aerodrome chart - EKKA	16
1.10.4 Runway inspection.....	16

1.10.5	Runway and taxiway lighting and intensity	16
1.10.5.1	EKKA ATC actual setting of lighting and intensity	16
1.10.5.2	Flight crew perception of centerline lighting brightness	16
1.10.5.3	Latest photometric aerodrome calibration	17
1.10.6	Intersection E at runway 27L	17
1.11	Flight recorders	18
1.11.1	Solid State Flight Data Recorder (SSFDR).....	18
1.11.2	Solid State Cockpit Voice Recorder (SSCVR)	18
1.12	AIB safety investigation	18
1.12.1	Damages to the aircraft	18
1.12.2	Damages to the runway lighting systems.....	19
1.12.3	Flight crew fatigue	20
1.12.3.1	Quote by the Australian Transport Safety Bureau (ATSB).....	20
1.12.3.2	Flight crew performance effectiveness	20
1.12.4	Inspection of EKKA by the DTCA.....	20
1.13	Medical and pathological information	20
1.14	Fire	21
1.15	Survival aspects	21
1.15.1	Seats and seatbelts.....	21
1.15.2	Evacuation.....	21
1.16	Tests and research	21
1.17	Organization and management information.....	21
1.17.1	Air traffic services (ATS) instruction	21
1.17.2	The Operator	22
1.17.2.1	General.....	22
1.17.2.2	Operations Manual.....	22
1.17.2.3	Aircraft Flight Manual (AFM).....	23
1.17.2.4	Weekly departures between EKKA and EKCH	23
1.18	Additional information.....	23
1.18.1	European Union (EU) terminology on low visibility operations	23
1.18.2	General ICAO applicability in Denmark	24
1.18.3	Aerodrome design and operations - ICAO annex 14 volume 1 (extract).....	24
1.18.3.1	Definitions	24
1.18.3.2	Taxiway centerline lights.....	24
1.18.3.3	Calibration of ATC settings of runway lighting intensity	25
1.18.4	ICAO aerodrome design manual - part 4 (extract).....	25
1.18.4.1	Additional marking of paved shoulders.....	25
1.18.5	Danish civil aviation regulation on flight and duty time (extract)	25
1.18.6	EU regulation number 83/2014 on flight and duty time (extract).....	25
1.18.7	Other runway misalignment occurrences.....	27
1.19	Useful or effective investigation techniques	29

2 ANALYSIS.....	30
2.1 Introduction.....	30
2.2 General.....	30
2.3 Weather.....	30
2.4 Flight crew fatigue.....	30
2.5 Complacency.....	32
2.6 Misaligned take-off roll.....	32
2.7 Physical environment of EKKA.....	33
3 CONCLUSIONS	35
3.1 Findings	35
3.2 Factors.....	36
3.3 Summary	37
4 SAFETY RECOMMENDATIONS	38
4.1 Safety recommendations.....	38
4.1.1 Motivation.....	38
4.1.2 Safety recommendation and initial response.....	38
4.2 Preventive actions	39
5 APPENDICES	39
5.1 Time sequence (from 05:16:11 hours until 05:18:20 hours).....	40
5.2 Time sequence (05:18:45 hours).....	41
5.3 Time sequence (from 05:19:16 until 05:19:37)	42
5.4 Time sequence (from 05:19:39 hours until 05:20:35 hours).....	43
5.5 Time sequence (05:20:48 hours until 05:20:59 hours)	44
5.6 The take-off roll sequence - FDR plot	45
5.7 Duty and rest periods	46
5.8 Operational flight plan	47
5.9 Mass and balance	49
5.10 Operator's aerodrome chart	50
5.11 ICAO aerodrome chart - EKKA	51
5.12 Runway edge lighting system	52
5.13 Military arrester cable mechanism.....	53
5.14 Schematic overview of the positioning of the runway lighting system	54
5.15 Performance effectiveness of the commander	56
5.16 Performance effectiveness of the first officer	57
5.17 Before take-off checklist - the operator	58
5.18 Before take-off checklist - the manufacturer	60

FINAL REPORT

General

File number: HCLJ510-2016-299
UTC date: 25-1-2016
UTC time: 05:20
Occurrence class: Serious incident
Location: Karup aerodrome (EKKA)
Injury level: None

Aircraft

Aircraft registration: OY-LHA
Aircraft make/model: ATR72 200
Current flight rules: Instrument Flight Rules (IFR)
Operation type: Commercial Air Transport Passenger Airline
Flight phase: Take-off
Aircraft category: Fixed Wing Aeroplane Large Aeroplane
Last departure point: Denmark EKKA (KRP): Karup (Civ/Mil)
Planned destination: Denmark EKCH (CPH): Kobenhavn/Kastrup
Aircraft damage: Minor
Engine make/model: PRATT & WHITNEY (CANADA) (PW 124B)

SYNOPSIS

Notification

All times in this report are UTC.

The Aviation Unit of the Danish Accident Investigation Board (AIB) was notified of the serious incident by the Area Control Centre (ACC) at Copenhagen Airport, Kastrup (EKCH) on 25-1-2016 at 06:20 hours.

On the day of the serious incident, the AIB established cooperation with the flight safety department of the Danish Armed Forces (DAF).

The Danish Transport and Construction Agency (DTCA), the French Accident Investigation Board (Le Bureau d'Enquêtes et d'Analyses - BEA), the European Aviation Safety Agency (EASA), the Directorate-General for Mobility and Transport (DG MOVE) and the International Civil Aviation Organization (ICAO) were notified on 26-1-2016.

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

Summary

In darkness and hazy weather conditions, the flight crew lined up the aircraft on the runway edge lights along the right-hand side of runway 27L instead of the runway centreline lights of runway 27L.

This resulted in a misaligned take-off roll over the elevated runway edge lights along the right-hand side of runway 27L leading to damages to the runway edge lights and the aircraft itself.

A combination of environmental, operational, and human factors contributed to the sequence of events:

- Dark night operation
- Reduced visibility
- Runway and taxiway environment, including an extra tarmac width on runway 27L, the absence of runway shoulder markings, the absence of taxiway centreline lighting, and the use of a displaced threshold
- Flight crew divided attention unintentionally provoked by the before take-off procedures and checks
- Flight crew fatigue

The serious incident occurred in dark night and under instrument meteorological conditions (IMC).

The AIB safety investigation resulted in a reference to a safety recommendation issued in 2015.

1 FACTUAL INFORMATION

1.1 History of the flight

The serious incident flight was a commercial IFR domestic passenger flight from EKKA to Copenhagen Kastrup (EKCH).

4 crewmembers and 65 passengers were onboard.

During the pre-flight planning phase, the flight crew experienced difficulties with the combination of:

- Weather pre-flight planning (foggy weather within the area of the scheduled operation)
- A newly operator implemented electronic flight back
- Operational flight planning back-up

The flight crew arrived at the aircraft later than intended.

There were no remarks to the aircraft pre-flight checks.

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

The serious incident flight had a departure slot time at 05:20 hours.

At 05:15:20 hours, Karup tower instructed the flight crew to taxi to the holding point at runway 27L via taxiway E, and the aircraft was cleared to cross runway 27R.

The first officer read back the taxi instruction to Karup tower, and the commander repeated the taxi instruction to the first officer.

The aircraft departed the civil apron and started taxiing towards the holding point at runway 27L.

While taxiing on taxiway E to the holding point at runway 27L, the flight crew performed the following tasks:

- Take-off briefing - from 05:16:11 hours until 05:16:50 hours. [See appendix 5.1](#)
- Air traffic control clearance (ATC) and cabin clear report - from 05:17:08 hours until 05:17:45 hours. [See appendix 5.1](#)
- Taxi checklist - from 05:17:50 hours until 05:18:20 hours. [See appendix 5.1](#)
- Runway 27R crossing check - 05:18:45 hours. [See appendix 5.2](#)

At 05:19:16 hours, the first officer reported to Karup tower that the aircraft was at the holding point to runway 27L (the category II holding point). The aircraft was cleared for take-off.

Karup tower reported the wind conditions to be 230° and 5 knots, the runway visual range (RVR) at the threshold of runway 27L to be 1700 meters, and the RVR at the midpoint of runway 27L to be 1600 meters. [See appendix 5.3.](#)

At 05:19:28 hours, the first officer read back the takeoff clearance to Karup tower, and the flight crew made a runway clear check of runway 27L. [See appendix 5.3.](#)

At 05:19:34 hours, Karup tower encouraged the flight crew to report, if they considered the runway lighting to be too bright. [See appendix 5.3.](#)

In the opinion of the flight crew, the intensity of the runway lighting was “*alright*” (reported to Karup tower at 05:19:37 hours). [See appendix 5.3.](#)

At 05:19:39 hours, the flight crew initiated the before take-off flows and checks. [See appendix 5.4.](#)

From time 05:19:56 hours until 05:20:01 hours, the flight crew performed the flight control check, which included a visual check of the aircraft spoiler system. [See appendix 5.4.](#)

In order to line up the aircraft on, what the commander thought were, the runway centerline lights, the commander made a sharp right turn.

From time 05:20:03 hours until 05:20:24 hours, the first officer read the before take-off checklist with 13 challenge and response items. A completion of the before take-off checklist included a runway heading and GPS alignment check, which was performed without remarks. [See appendix 5.4.](#)

While slowly taxiing on the underrun of runway 27L towards the threshold of runway 27L, the aircraft hit a runway edge light (red light) on the right-hand side of runway 27L.

At 05:20:28 hours and at the threshold of runway 27L, the commander added take-off power. [See appendix 5.4.](#)

From time 05:20:34 hours until 05:20:35 hours, take-off power was set and checked. [See appendix 5.4.](#)

During the initial take-off roll, the flight crew observed a thumping noise from the nose gear, and the commander realigned the nose gear slightly to the left, which was done to avoid the thumping noises caused by the nose gear hitting, what the flight crew thought, were the recessed runway centre line lights.

The right main gear hit elevated runway edge lights along the right-hand side of runway 27L.

When approaching the military arrester cable mechanism on the right-hand side of runway 27L, the commander realized that the aircraft was lined up on the runway edge lights along the right-hand side of runway 27L instead of the runway centreline lights of runway 27L.

At 05:20:48 hours, the commander aborted the take-off roll and manoeuvred the aircraft back to the centreline of the runway of runway 27L. [See appendix 5.5.](#)

At 05:20:59 hours, the commander reported to Karup tower, that the aircraft had aborted the take-off roll, but there was no need of any assistance. [See appendix 5.5.](#)

The flight crew observed that there were no visible or noticeable damage to the aircraft and that none on board had sustained any injuries.

The flight crew decided to taxi the aircraft back to the apron.

The take-off roll sequence (Flight Data Recorder (FDR) plot) - [see appendix 5.6.](#)

1.2 Injuries to persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Others</i>
Fatal			
Serious			
None	4	65	

1.3 Damage to aircraft

There were minor damages to the aircraft.

1.4 Other damage

Six elevated runway edge lights and two obstacle lights on top of the military arrester cable mechanism along the right-hand side of runway 27L were destroyed.

1.5 Personnel information

1.5.1 The commander

1.5.1.1 License and medical certificate

The commander (38 years) was the holder of a valid Danish Airline Transport Pilot License (ATPL (A)).

The ATPL contained the following type rating: ATR42/72/IR. The type rating was valid until 31-7-2016.

The PART-FCL medical certificate class 1 was valid until 3-12-2016.

1.5.1.2 Operator training

- On 7-7-2015, a combined ATR42/72 Operator Proficiency Check (OPC)/License Proficiency Check (LPC) was performed
- On 19-1-2016, an operator OPC was performed
- On 12-3-2015, the latest ATR42/72 line check was performed
- On 30-11-2015, the latest Crew Resource Management (CRM) training was performed

1.5.1.3 Flying experience

	Last 24 hours	Last 90 days	Total
All types	1	58	3514
This type	1	58	1134
Landings this type	1	41	902

1.5.1.4 Duty time and rest periods

From 2-1-2016 until 25-1-2016

In the period from 2-1-2016 until 16-1-2016, the commander was scheduled to be off duty.

For duty time and rest periods from 17-1-2016 until 25-1-2016 - [see appendix 5.7](#).

Be observant that the presented duty and rest periods refer to Danish local time.

Sleep pattern

The commander reported his normal sleep pattern to be 7-8 hours per night.

Sleep quality

The commander reported the quality of his sleep from 17-1-2016 until 24-1-2016 to be fair.

The commander reported the quality of his sleep the night before the serious incident to be poor.

Scheduled flight sectors

Within the flight duty period from 24-1-2016 until 25-1-2016, the total number of scheduled flight sectors were four.

1.5.1.5 Aerodrome familiarization - EKKA

The commander was very familiar with EKKA and was often scheduled to fly the domestic route from EKKA to EKCH.

1.5.2 The first officer

1.5.2.1 License and medical certificate

The first officer (35 years) was the holder of a valid Danish Commercial Pilot License (CPL (A)).

The CPL contained the following type rating: ATR42/72/IR CO-PILOT. The type rating was valid until 31-8-2016.

The PART-FCL medical certificate class 1 was valid until 22-10-2016.

1.5.2.2 Operator training

- On 13-8-2015, a combined ATR42/72/IR(A) CO-PILOT OPC/LPC was performed
- On 16-4-2015, the latest ATR42/72 line check was performed
- On 5-2-2015, the latest CRM training was performed

1.5.2.3 Flying experience

	Last 24 hours	Last 90 days	Total
All types	1	88	1530
This type	1	88	390
Landings this type	-	44	-

1.5.2.4 Duty time and rest periods

From 5-1-2016 until 25-1-2016

In the period from 5-1-2016 until 17-1-2016, the first officer was scheduled to be off duty.

For duty time and rest periods from 18-1-2016 until 25-1-2016 - [see appendix 5.7](#).

Be observant that the presented duty and rest periods refer to Danish local time. The presented duty periods include standby duty periods.

Sleep pattern

The first officer reported his normal sleep pattern to be 7 hours per night.

Sleep quality

The first officer reported the quality of his sleep from 18-1-2016 until 24-1-2016 to be good.

The first officer reported the quality of his sleep the night before the serious incident to be poor.

Scheduled flight sectors

Within the flight duty period from 24-1-2016 until 25-1-2016, the total number of scheduled flight sectors were four.

1.5.2.5 Aerodrome familiarization – EKKA

The first officer was very familiar with EKKA and was often scheduled to fly the domestic route from EKKA to EKCH.

1.6 Aircraft information

1.6.1 General

Registration:	OY-LHA
Type:	ATR72
Model:	200
Manufacturer:	ATR - GIE Avions de Transport Régional
Serial number:	508
Year of manufacture:	1996
Engine manufacturer:	Pratt & Whitney Canada Inc.
Engine type:	PW124B
Propellers:	Hamilton Standard Division, 14 SF-11E
Aircraft total flight hours:	22 821
Aircraft total flight cycles:	36 621
Airworthiness review certificate:	Valid until 12-8-2016
Technical flight log:	No remarks

1.6.2 Operational flight plan

The AIB has erased the names of the crew members and the name of the operator.

[See appendix 5.8.](#)

1.6.3 Mass and balance

The AIB has erased the names of the crew members and the name of the operator.

[See appendix 5.9.](#)

1.7 Meteorological information

1.7.1 Terminal aerodrome forecast (TAF)

ekka 250223z 2503/2524 21006kt 1500 -dz br bkn003 tempo 2503/2518 0100 fg vv001 becmg 2518/2520 21015kt 4000 br sct006 bkn120 tempo 2520/2524 2000 bkn004=

1.7.2 Aviation routine weather report (METAR)

ekka 250450z 23008kt 0400 r09/1200n r27/1600n fg vv002 07/07 q1019=

ekka 250520z 23007kt 0400 r09/1300n r27/1700n fg vv002 07/07 q1019=

1.7.3 Automatic terminal information service (ATIS)

This is Karup Airport information G. 0450. Expect radar vectoring for ILS approach. Runway in use 27L. Transition level 40. Wind 230° 7 knots. Visibility 400 meters. RVR TDZ 1600 meters - MID 1400 meters - STOP END 1200 meters. Fog. Vertical visibility 200 feet. Temperature 7. Dewpoint 7. QNH 1019.

1.8 Aids to navigation

1.8.1 Notice to airmen (NOTAM) - EKKA

m0009/16 notamn

a) ekka b) 1601250600 c) 1601291500

e) when instructed by atc mda/da (minimum descend altitude/decision altitude) for instrument approach procedures rwy 09r will be raised to 620ft, due to crane erected momentarily at psn

561813n0090450e up to elev 368ft amsl, hgt 214ft agl during wip in squadron area nw. Ils/dme, lpv and circling for rwy 09r noaffected.

m0018/16 notamn

a) ekka b) 1601250600 c) 1601291600
e) twy a and helipad squadron area nw clsd due to wip.

m0504/1s notamr m0503/15

a) ekka b) 1512150906 c) 1602291430
e) wip in squadron area nw psn 561813n0090450e. Workzone will be fenced. When cranes are erected they will be marked with light. Expect limitations in use of refueling hydrants.

1.8.2 Extract of operator's aerodrome chart

[See appendix 5.10.](#)

1.9 Communication

1.9.1 General

The flight crew were in radio contact with Karup tower (119.575 MHz).

1.9.2 ATC voice recording

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

1.10 Aerodrome information

1.10.1 EKKA aerodrome

Airport position (ARP):	56 17 50.85N 009 07 28E
Elevation:	171 feet
Magnetic variation:	2.0°E (December 2014)
Runway identifications:	09R, 27L, 09L, 27R, 03, 21, 14, and 32
Direction of runway 27L:	269.3° (GEO) and 267.3° (MAG)
Surface:	Asphalt/concrete
Runway dimensions:	2929 x 45 meters
Main landing aid:	Instrument landing system (ILS) category I/II - lowest RVR 300 m

1.10.2 Joint civil and military aerodrome

Except for the civil terminal building, the DAF owned, managed and maintained all aerodrome ground installations at EKKA.

1.10.3 ICAO aerodrome chart - EKKA

[See appendix 5.11.](#)

1.10.4 Runway inspection

On the day of the serious incident at 04:29 hours, aerodrome ground personnel at EKKA performed a runway inspection of runway 27L.

There were no remarks to the runway inspection.

1.10.5 Runway and taxiway lighting and intensity

1.10.5.1 EKKA ATC actual setting of lighting and intensity

Taxiway lights:	30% (halogen sockets)
Runway edge lights:	100% (halogen sockets)
Runway centerline lights :	30% (halogen sockets)
Runway approach lights:	10% (light emitting diode (LED) sockets))

ATC policy on activating the lighting system was the presence of weather conditions below 8 kilometers (visibility) and 1500 feet (clouds) or if required by other conditions like for instance blinding sunlight.

ATC setting of lighting and intensity was based on operational conditions and ATC operational experience.

1.10.5.2 Flight crew perception of centerline lighting brightness

Due to brightness, ATC had experienced some flight crew requests on dimming the runway centerline lighting in certain light and weather conditions.

1.10.5.3 Latest photometric aerodrome calibration

On 9-9-2015, the latest photometric aerodrome calibration of the runway lighting system (runway 27L) was performed. The conclusion of the photometric aerodrome calibration was that the lighting facilities after minor repairs were compliant with ICAO recommendations.

1.10.6 Intersection E at runway 27L

Runway 27L had an extra tarmac width (paved runway shoulder area) at intersection E, where the aircraft entered the runway. At the time of the serious incident, the area directly north of runway 27L was in darkness. The paved runway shoulder areas were not marked.



A taxiway lead-in line painted yellow lead from taxiway E to the center of the underrun of runway 27L.

Note. The time that the pictures were taken was not the same time of the serious incident.

1.11 Flight recorders

1.11.1 Solid State Flight Data Recorder (SSFDR)

Manufacturer: L-3 Aviation Communications, Part Number 2100-4043-00 (Serial Number 000357085)

The SSFDR appeared undamaged.

The recovered flight data were useful to the AIB safety investigation.

1.11.2 Solid State Cockpit Voice Recorder (SSCVR)

Manufacturer: L-3 Aviation Communications, Part Number 2100-1020-02 (Serial Number 000238506)

The SSCVR appeared undamaged.

The SSCVR data were recovered and were useful to the AIB safety investigation.

1.12 AIB safety investigation

1.12.1 Damages to the aircraft

There were damages to and several cuts on:

- The nose landing gear taxi lights
- Both right hand nose landing gear doors
- Two of the propeller blades on the left hand propeller
- The lower fuselage skin in front of the air conditioning ground connection panel
- The tyres of the nose landing gear and the right main landing gear



1.12.2 Damages to the runway lighting systems

During the sequence of events, the aircraft hit six elevated runway edge lights and two obstacle lights on top of the military arrester cable mechanism along the right-hand side of runway 27L.

The following elevated runway edge lights of runway 27L were destroyed:

S12, R94, 879, R90, R88, and R86 - [see appendix 5.12](#).

The following obstacle lights on top of the military arrester cable mechanism were destroyed:

64A - [see appendix 5.13](#).

For a schematic overview of the positioning of the runway edge lights and the military arrester cable mechanism along runway 27L - [see appendix 5.14](#).

Be observant that S14, R96, and R92 were recessed runway edge lights.

1.12.3 Flight crew fatigue

1.12.3.1 Quote by the Australian Transport Safety Bureau (ATSB)

Fatigue is a complex subject and has physical, mental and task-related elements.

Fatigue may be acute or chronic and may be due to sleep deprivation, circadian disruption or excessive activity. In relation to the lack of sleep, fatigue is often underappreciated and compared to people, who are well-rested; people who are sleep-deprived think and move slowly, make more mistakes and have memory difficulties.

1.12.3.2 Flight crew performance effectiveness

In order to perform an objective post-incident analysis, the AIB in cooperation with the flight safety department of the DAF used the Fatigue Avoidance Scheduling Tool (FAST) software to determine if flight crew fatigue may have contributed to the sequence of events.

Input data were:

- Duty periods (scheduled)
- Rest periods (scheduled and flight crew reported)
- Sleep quantity (flight crew reported)
- Sleep quality (flight crew reported)

The performance effectiveness of the commander - [see appendix 5.15](#).

The performance effectiveness of the first officer - [see appendix 5.16](#).

1.12.4 Inspection of EKKA by the DTCA

The DTCA performed inspections of EKKA on 27-10-2010, on 16-11-2011, on 14-6-2012, on 20-12-2013, on 16-12-2014, and on 11-12-2015.

On 27-10-2010 and with reference to the Danish civil aviation regulation (BL) 3-13, the DTCA performed the latest spot check of the runway lighting system. This inspection gave no rise to remarks.

From 2013, DTCA inspections with reference to BL 3-13 was no longer part of the DTCA inspection checklist.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

There was no fire.

1.15 Survival aspects

1.15.1 Seats and seatbelts

The crew and the passengers were using seatbelts.

Neither seats nor seatbelts were overstressed or suffered from malfunctioning.

1.15.2 Evacuation

On the basis of the sequence of events, the flight crew decided that evacuation of the aircraft was not necessary.

1.16 Tests and research

None.

1.17 Organization and management information

1.17.1 Air traffic services (ATS) instruction

The AIB has translated the below ATS instruction (extract) from Danish into English.

2.1.9 Low visibility procedures

2.1.9.1 When RVR values are below 800 meters, involved aircraft are to be informed that “low visibility procedures” are in force. When low visibility procedures cease, involved aircraft via the phraseology “low visibility procedures cancelled” are to be informed.

2.1.9.2 When low visibility procedures are in force, following precautions are to be taken:

- The number of persons and vehicles within the maneuvering area is to be limited to its minimum*
- Records of persons and vehicles within the maneuvering area are to be kept*
- At RVR values below 400 meters, secondary power supply is to be established in connection with aircraft departures, and only one aircraft at the time may operate within the maneuvering area*

1.17.2 The Operator

1.17.2.1 General

The operator provided a number of scheduled services as well as passenger charters and freight services.

The aircraft fleet consisted of twin-engine turboprop aircraft and medium-haul jet aircraft.

The area of operation (passengers, cargo and emergency medical service) were ICAO EUR, NAT, AFI, and MID/ASIA.

The operator's Air Operator Certificate (AOC) held an approved Operations Manual (OM) system containing operational documentation and limitations, and standard operating procedures (SOP).

1.17.2.2 Operations Manual

a) Operations Manual Part A

Flight time limitations (extracts)

Window of Circadian Low (WOCL):

The Window of Circadian Low (WOCL) is the period between 02:00 hours and 05:59 hours. Within a band of three time zones the WOCL refers to home base time. Beyond these three time zones the WOCL refers to home base time for the first 48 hours after departure from home base time zone and to local time thereafter.

7.4 Maximum daily flight duty period (FDP).

The maximum basic daily FDP is 13 hours.

These 13 hours will be reduced by 30 minutes for each sector from the third sector onwards. When the FDP starts in the WOCL, the maximum stated above will be reduced by 100 % of its encroachment up to a maximum of two hours. When the FDP ends in or fully encompasses the WOCL, the maximum FDP stated above will be reduced by 50 % of its encroachment.

7.8.1 Break on the ground.

Break on the ground shall be taken into account with 50%.

If a break exceeds 4 hours and the duration of this has been announced in advance, it shall be taken into account with 0%.

b) Operations Manual Part B.

Normal procedures - the before take-off checklist

[See appendix 5.17.](#)

Operator's comments to the runway heading check of the before take-off checklist

Meaning and roles regarding the text from OM-B ATR 2.5.2.5:

After line up CM1 shall cross check the heading on his RMI and EHSI with the runway published magnetic orientation. The EHSI on CM1's side is connected to AHRS (attitude heading reference system) 1 and the RMI on CM1's side is connected to AHRS 2. On the F/O's side this connection is the other way around. This crosscheck makes sure that none of the AHRS's are showing an invalid value. The rest of the text is only concerning aircraft equipped with KLN90B which is not the case for OY-LHA.

CM2's role in this is only monitoring and reading checklist.

1.17.2.3 Aircraft Flight Manual (AFM)

Normal procedures - the before take-off checklist

[See appendix 5.18.](#)

1.17.2.4 Weekly departures between EKKA and EKCH

In week four 2016, the total number of departures (this operator) between EKKA and EKCH was 29.

1.18 Additional information

1.18.1 European Union (EU) terminology on low visibility operations

EU OPS 1.435 - terminology.

Low visibility procedures (LVP):

Procedures applied at an aerodrome for the purpose of ensuring safe operations during Lower than Standard Category I, Other than Standard Category II, Category II and III approaches and low visibility take-offs.

Low visibility take-off (LVTO):

A take-off where the runway visual range (RVR) is less than 400 m.

1.18.2 General ICAO applicability in Denmark

The below text in italic is an extract of the Aeronautical Information Publication (AIP) Denmark.

AD 1.1 Aerodromes and Heliports Availability

2. Applicable ICAO Documents

The Standards and Recommended Practices of ICAO Annex 14, Volumes I and II, are generally applied.

1.18.3 Aerodrome design and operations - ICAO annex 14 volume 1 (extract)

1.18.3.1 Definitions

Aerodrome traffic density.

- a) Light. Where the number of movements in the mean busy hour is not greater than 15 per runway or typically less than 20 total aerodrome movements.*
- b) Medium. Where the number of movements in the mean busy hour is of the order of 16 to 25 per runway or typically between 20 to 35 total aerodrome movements.*
- c) Heavy. Where the number of movements in the mean busy hour is of the order of 26 or more per runway or typically more than 35 total aerodrome movements.*

1.18.3.2 Taxiway centerline lights

5.3.17 Taxiway centerline lights

Application

5.3.17.1 Taxiway centerline lights shall be provided on an exit taxiway, taxiway, de-icing/anti-icing facility and apron intended for use in runway visual range conditions less than a value of 350 m in such a manner as to provide continuous guidance between the runway centerline and aircraft stands, except that these lights need not be provided where the traffic density is light and taxiway edge lights and centerline marking provide adequate guidance.

The ICAO application on the installation of taxiway centerline lights was implemented in Denmark via BL 3-13.

1.18.3.3 Calibration of ATC settings of runway lighting intensity

ICAO annex 14 did neither state standards nor recommendations for calibration of ATC settings of runway lighting intensity.

1.18.4 ICAO aerodrome design manual - part 4 (extract)

1.18.4.1 Additional marking of paved shoulders

At intersections of taxiways and on other areas where, due to turning, the possibility for confusion between the side stripe markings and center line markings may exist or where the pilot may not be sure on which side of the edge marking the non-load bearing pavement is, the additional provision of transverse stripes on the non-load bearing surface has been found to be of assistance.

1.18.5 Danish civil aviation regulation on flight and duty time (extract)

The Danish regulation (BL 5-18) encompassed regulations on flight and duty time limitations and rest periods for crew members in commercial air transport.

5.4 Operations based on extended FDP (split duty) including a break, cf. Subpart Q, OPS 1.1105, paragraph 6.

5.4.1 As stated below, a break shall be taken into account for the calculation of the maximum daily FDP, cf. Subpart Q, OPS 1.1105.

5.4.2 Break on the ground

5.4.2.1 A break on the ground shall be calculated with 50%. If a break exceeds 4 hours and the duration has been given prior to the break commencing, it shall be calculated with 0%.

5.4.2.2 During a break the crew member shall have access to horizontal rest in a rest area on the ground.

1.18.6 EU regulation number 83/2014 on flight and duty time (extract)

On 16-2-2016, EU regulation 83/2014 on flight and duty time became effective in Denmark (informed by the DTCA).

ORO.FTL.205 Flight duty period (FDP)

(b) Basic maximum daily FDP.

(1) The maximum daily FDP without the use of extensions for acclimatised crew members shall be in accordance with the following table:

Maximum daily FDP — Acclimatised crew members

Start of FDP at reference time	1-2 Sectors	3 Sectors	4 Sectors	5 Sectors	6 Sectors	7 Sectors	8 Sectors	9 Sectors	10 Sectors
0600-1329	13:00	12:30	12:00	11:30	11:00	10:30	10:00	09:30	09:00
1330-1359	12:45	12:15	11:45	11:15	10:45	10:15	09:45	09:15	09:00
1400-1429	12:30	12:00	11:30	11:00	10:30	10:00	09:30	09:00	09:00
1430-1459	12:15	11:45	11:15	10:45	10:15	09:45	09:15	09:00	09:00
1500-1529	12:00	11:30	11:00	10:30	10:00	09:30	09:00	09:00	09:00
1530-1559	11:45	11:15	10:45	10:15	09:45	09:15	09:00	09:00	09:00
1600-1629	11:30	11:00	10:30	10:00	09:30	09:00	09:00	09:00	09:00
1630-1659	11:15	10:45	10:15	09:45	09:15	09:00	09:00	09:00	09:00
1700-0459	11:00	10:30	10:00	09:30	09:00	09:00	09:00	09:00	09:00
0500-0514	12:00	11:30	11:00	10:30	10:00	09:30	09:00	09:00	09:00
0515-0529	12:15	11:45	11:15	10:45	10:15	09:45	09:15	09:00	09:00
0530-0544	12:30	12:00	11:30	11:00	10:30	10:00	09:30	09:00	09:00
0545-0559	12:45	12:15	11:45	11:15	10:45	10:15	09:45	09:15	09:00

ORO.FTL.220 Split duty

The conditions for extending the basic maximum daily FDP due to a break on the ground shall be in accordance with the following:

(a) flight time specification schemes shall specify the following elements for split duty in accordance with the certification specifications applicable to the type of operation:

- (1) the minimum duration of a break on the ground; and*
- (2) the possibility to extend the FDP prescribed under point ORO.FTL.205(b) taking into account the duration of the break on the ground, the facilities provided to the crew member to rest and other relevant factors;*

(b) the break on the ground shall count in full as FDP;

(c) split duty shall not follow a reduced rest.

1.18.7 Other runway misalignment occurrences.

In 2014 a Gulfstream III aircraft commenced a misaligned take-off from Biggin Hill Airport (EW/2014/10/01).

Information available to the pilots allowed them to develop an incorrect mental model of their route from the holding point to the runway. Environmental cues indicating that the aircraft was in the wrong position for takeoff were not strong enough to alert the pilots to the fact that they had lost situational awareness. One safety recommendation was being made.

Safety recommendation GB-SIA-2015-0038:

It is recommended that the International Civil Aviation Organisation initiate the process to develop within Annex 14 Volume 1, 'Aerodrome Design and Operations', a standard for runway edge lights that would allow pilots to identify them specifically, without reference to other lights or other airfield features.

In 2012 an Airbus A330 aircraft commenced a take-off from Abu Dhabi International Airport while lined up with the left-hand edge lights of runway 31 Left (GCAA, 2012). The runway misalignment occurred at night in low visibility. The flight crew stated that they had not been able to see the green taxiway lead-in lights as they entered the runway. The curved taxiway lead-in route was through a wide intersection that crossed the runway edge line at a shallow angle and did not cross the runway threshold. The flight crew rejected the take-off due to the thumps heard as the aircraft ran over the elevated edge lights.

In 2011 a Bombardier Challenger aircraft lined up on the right-hand edge lights at Dubai International Airport (GCAA, 2011). The investigation report concluded that the flight crew had been confused by the runway centerline and edge lights and had lost situational awareness due to being overwhelmed by activities within the cockpit as they were lining up.

A similar misalignment involved a Boeing 747 at Los Angeles International Airport in 2011. The incident was described in an internal company safety magazine article titled 'On the edge – runway misalignment at night'. The article concluded that the experienced flight crew had had an issue with their visual processing as they taxied into position for take-off from a displaced threshold.

In 2011 a Bombardier Q300 lined up on the left-hand edge lights at Auckland Airport on runway 23 Left after entering from taxiway A2. The operator's report to the CAA concluded that the pilot had not been familiar with new progressive lenses in his glasses and misjudged the turn onto the runway.

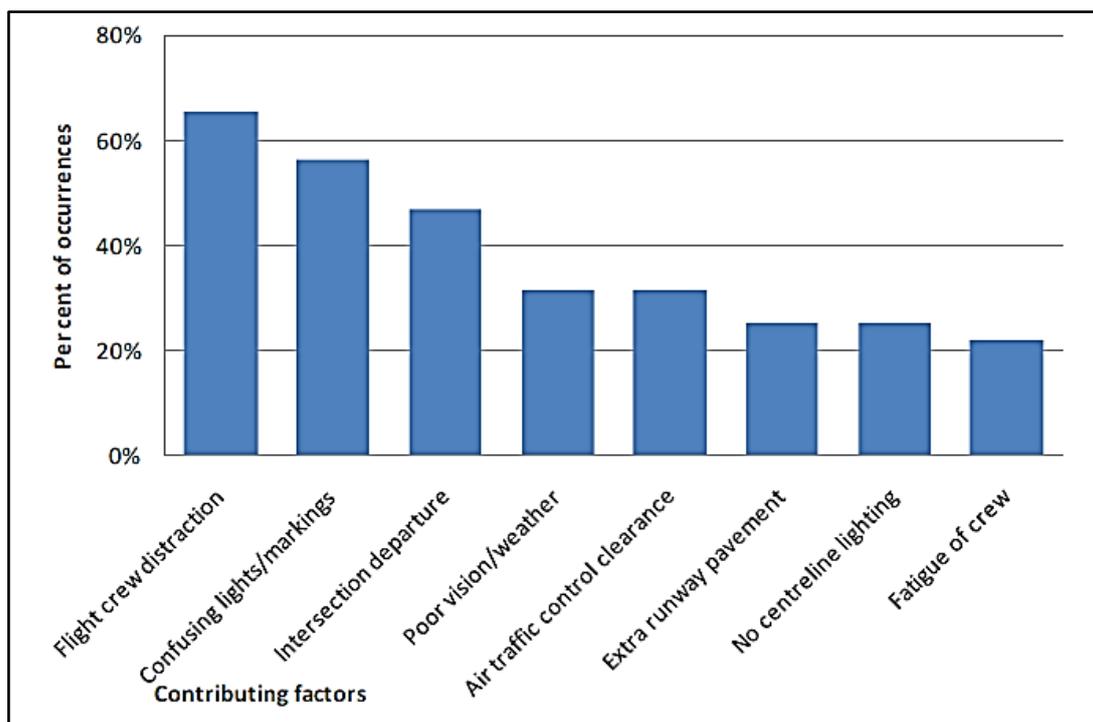
In 2006 an Airbus A319 lined up on the runway edge lights at McCarran International Airport in Las Vegas (TSB, 2006). The investigation report concluded that the taxiway centerline had curved around to join up with the runway edge line instead of the runway centerline and that the rolling take-off had reduced the pilot's time to recognize or correct the error.

In 2002 an Aerospatiale ATR 72-200 lined up on the runway edge lights at Dresden Airport in Germany (BFU, 2002). The investigation report concluded that "the pilot-in-command confused the runway centerline lighting of runway 22 with the left runway edge lighting" and the first officer had not noticed this.

The Australian Transport Safety Bureau carried out a systemic investigation into a group of runway misalignment incidents (ATSB, 2009) and concluded that the following factors increased the risk of a runway misalignment:

- *Night-time operations*
- *The runway and taxiway environment, including confusing runway entry markings or lighting, areas of additional pavement on the runway, the absence of runway centerline lighting, and flush-mounted runway edge lighting*
- *Flight crew distraction or inattention*
- *Bad weather or reduced visibility*
- *Displaced threshold or intersection departure*
- *The provision of an air traffic control clearance when aircraft are entering the runway or still taxiing*
- *Flight crew fatigue.*

Factors contributing to misaligned take-off occurrences.



1.19 Useful or effective investigation techniques

None.

2 ANALYSIS

2.1 Introduction

A misaligned take-off roll partially off the intended runway by a large aircraft is a serious incident.

These events are rare, but the potential contributory factors identified in the ATSB's study are often present and some were identified in this serious incident.

In this case the aircraft undercarriage remained on the strengthened runway shoulder, so there was no damage to the runway surface and therefore a low risk of major damage to the aircraft.

2.2 General

The licenses and qualifications held by the flight crew, the documented technical and known maintenance status of the aircraft, the aircraft mass and balance and the operational flight planning had, in the AIB's opinion, no influence on the sequence of events.

2.3 Weather

The actual weather conditions caused a reduction of visibility. The reduced visibility did neither dictate operator low visibility operations nor ATC low visibility procedures.

However, reduced visibility in combination with a dark night operation most likely impaired flight crew visual acuity.

2.4 Flight crew fatigue

On 24-1-2016 at 21:00 hours (local Danish time), the flight crew checked in for flight duty.

The flight duty period contained a rest period from 24-1-2016 at 23:50 hours until 25-1-2016 at 05:15 hours (local Danish time).

On 25-1-2016 at 09:35 hours (local Danish time) the flight crew was scheduled to check out.

The total number of scheduled flight sectors within the flight duty period were four.

Regarding flight and duty time limitations, the Operations Manual was in compliance with the Danish regulation (BL 5-18) on flight and duty time.

	<u>BL 5-18</u>	<u>EU regulation 83/2014</u>
Actual maximum daily FDP (four sectors). Check in at 21:00 hours local Danish time.	10:00 hours	10:00 hours
Maximum daily FDP (example - two sectors). Check in at 21:00 hours local Danish time.	11:00 hours	11:00 hours
Actual scheduled FDP (four sectors) Check in at 21:00 hours local Danish time.	7:10 hours	12:35 hours
FDP (example - two sectors) Check in at 21:00 hours local Danish time.	5:05 hours	10:30 hours

With reference to BL 5-18 and the Operations Manual, the actual scheduled FDP (containing four flight sectors) of 7:10 hours did not violate the maximum daily FDP of BL 5-18 (10:00 hours).

EU regulation number 83/2014 (effective in Denmark after the date of the serious incident) was meant to neutralize - among other things - flight crew fatigue consequences of split duty.

Taking into consideration the EU regulation 83/2014 and a similar scheduled FDP like the serious incident flight, the total number of scheduled flight sectors would have been limited to two. But in the opinion of the AIB, the EU regulation 83/2014 would not have eliminated the risk of flight crew fatigue as a consequence of a short night rest period.

In general, flight crew fatigue is a complex subject.

But by using a generic fatigue evaluation tool and taking into consideration the actual duty and rest period and the flight crew reported sleep quantity and quality, the AIB considers the flight crew to be fatigued in the morning on 25-1-2016. With reference to the output data of the fatigue evaluation tool, the commander might have suffered from accumulated fatigue, and the first officer due to his circadian rhythm might have suffered from acute fatigue.

Due to the recent sleep and the time of day, flight crew performance was impaired equivalent to more than 0.05% blood alcohol concentration. For that reason, flight crew vigilance and reaction times might significantly have been impaired.

Furthermore, flight crew fatigue might have impacted the flight crew decision making process and the flight crew night vision adaptation and visual acuity.

2.5 Complacency

The flight crew was very familiar with flight operations in EKKA. It was a routine morning flight towards EKCH. Mental expectations might unknowingly have overshadowed the external information flow and inadvertently lowered the vigilance and the positional awareness of the flight crew.

It is possible that the combination of routine, familiarity and flight crew fatigue might have provoked flight crew complacency.

2.6 Misaligned take-off roll

Though, the flight crew was preoccupied with time-consuming flight planning tasks before engine start and had a departure slot time, the AIB in relation to the sequence of events does not attach critical importance to these tasks.

After the issue of the ATC take-off clearance, the flight crew initiated the before take-off flows and checks dividing the attention of the flight crew in head-down inside cockpit activities (mostly the first officer) and a visual lookout (mostly the commander).

From that moment until the before take-off checklist was completed on the runway, the first officer was probably focussed on activities inside the cockpit, and the first officer most likely missed the important phase of assessing the external environment and monitoring the entry to the runway.

At a critical point of time, the flight crew performed the flight control check, which included a visual check of the aircraft spoiler system dividing the attention of the commander from lining up the aircraft.

When the commander looked back outside to continue the turn onto the underrun of runway 27L, he probably presumed the line of high intensity runway lights at a distance were the centreline lights and aligned the aircraft with them. The tight turn to align suggests that the commander at that point had lost his lead-in cues (lead-in painted yellow taxiway centerline).

Once aligned, the runway lights should have appeared as three white lines converging at a single point in the distance. But a continuously rolling taxi on the underrun of runway 27L (displaced threshold) in partial darkness, in reduced visibility with an extra tarmac width (runway shoulder areas with no markings), and with high intensity runway lights at a distance might have provoked a visual and a mental illusion of having lined up the aircraft on the centreline.

Completing checklists is a normal and necessary part of the departure phase of flight, but it might also be a distracter to the critical runway line-up phase.

The operator before take-off procedure included before take-off flows and checks and the reading of 13 challenge and response items. The AIB considers the divergence on handling the before take-off checks between the AFM and the Operations Manual Part B as having potentially prolonged the divided attention of the flight crew and thereby weakening the strength of flight crew team resource management.

In order to avoid runway misalignments, the AIB finds a flight crew mental review and check of the runway environment to be of utmost importance and to be one of the final safety barriers before the take-off roll.

In the opinion of the AIB the operator before take-off runway heading and GPS check appeared to be a system check and not a runway environmental check leaving out flight crew proactive challenge and interaction.

The operator runway heading check did not encourage the first officer to respond or challenge the callout of the commander. After completion of the before take-off checklist including a runway heading check, and when the flight crew looked outside, the external visual references fulfilled the mental expectations, and the flight crew initiated the take-off roll.

2.7 Physical environment of EKKA

Runway 27L had an extra tarmac width with no markings (for instance a provision of transverse stripes) at intersection E, where the aircraft entered the underrun of runway 27L.

In dark night and reduced visibility, the areas of additional not marked tarmac around the runway threshold area of runway 27L might have provided erroneous visual cues for the flight crew. Operating from a runway with a greater width than most standard runways might have led to a belief of being in the center of the runway when the aircraft was actually lined up on the edge.

In general, flight crews using a displaced threshold - while lining up the aircraft - will due to distance not be able to see the normal threshold marking, such as the runway number, which provides important cues during the line-up phase of the flight.

If taxiway centerline lights - leading in to the runway centerline - are not provided, it may in dark night be less evident to the flight crew that the aircraft is lined up on the edge lighting given the limited cues available from the displaced threshold.

Though a distinct curved lead-in taxiway centerline marking to the runway centerline and distinct red runway edge lights in the underrun area were at place (runway 27L), a combination of dark night, a

partial dark underrun area, reduced visibility, no markings of the runway shoulder areas, and essential flight crew tasks apparently suppressed the effect of the available cues.

This serious incident identifies the necessity for following any available lead-in line to maximize the opportunity for the flight crew to correctly align the aircraft on the runway for take-off.

In Denmark, standards and recommended practices of ICAO annex 14, volumes I and II, are generally applied.

EKKA was a combined civil and military aerodrome with scheduled domestic flights, ad-hoc charter flights, and military activities offering low visibility flight operations (ILS category II - lowest RVR 300 meters).

Except for the civil terminal building, EKKA was owned, managed and maintained by the DAF, and the DAF as a military organization was not obliged to comply with ICAO annex 14. However, the AIB finds the installed and investigated runway lighting system to be in compliance with ICAO annex 14.

With reference to ICAO annex 14, volume I, chapter 5.3.17.1, taxiway centerline lights shall be provided on an exit taxiway, taxiway, de-icing/anti-icing facility and apron intended for use in runway visual range conditions less than a value of 350 meters. This ICAO standard was applicable for civil aerodromes offering similar low visibility operations like in EKKA.

But these taxiway centerline lights needed not to be provided where the traffic density was light and taxiway edge lights and centerline marking provided adequate guidance.

The AIB considers the general traffic density at EKKA to be light, and from that point of view, taxiway centerline light needed not to be provided.

The above ICAO text passage paves the way for a discussion of the relation between traffic density and the need of flight crews to be provided with adequate guidance during taxiing, because these events may occur irrespectively of the level of traffic density.

From a flight safety point of view, the AIB supports any proactive aid that might reduce the risk of reoccurrences, which in this serious incident would have been a proactive provision of taxiway centerline lights.

A systemic calibration of ATC intensity settings of the whole runway lighting system in order to assure a uniform and balanced approach and runway lighting system was not an ICAO standard.

The ATC intensity settings of the actual provided runway lighting appeared to be appropriate, and in this serious incident, the use of runway lighting halogen sockets was consistent.

In 2010, the DTCA performed the latest spot check of the runway lighting system, which gave no rise to remarks.

The AIB does not consider the runway lighting system of runway 27L at EKKA to have contributed directly to the sequence of events, because:

- the latest photometric aerodrome calibration of the runway lighting system (runway 27L) revealed compliance with ICAO recommendations
- in the morning on 25-1-2016, there were no remarks to the runway inspection
- neither EKKA ATC nor the flight crew reported runway lighting system anomalies
- the area directly north of runway 27L was in darkness and thereby not contributing to flight crew visual illusions and loss of positional awareness
- the flight crew reported the actual ATC setting of runway lighting intensity to be appropriate

3 CONCLUSIONS

3.1 Findings

1. A misaligned take-off roll partially off the intended runway by a large aircraft is a serious incident
2. There was no damage to the surface of the runway shoulder of runway 27L and therefore a low risk of major damage to the aircraft
3. The licenses and qualifications held by the flight crew, the documented technical and known maintenance status of the aircraft, the aircraft mass and balance and the operational flight planning had no influence on the sequence of events
4. It was a dark night operation in reduced visibility
5. The reduced visibility did neither dictate operator low visibility operations nor ATC low visibility procedures
6. The latest photometric aerodrome calibration of the runway lighting system (runway 27L) revealed compliance with ICAO recommendations
7. In the morning on 25-1-2016, there were no remarks to the runway inspection
8. Neither EKKA ATC nor the flight crew reported runway lighting system anomalies
9. The area directly north of runway 27L was in darkness
10. The flight crew reported the actual ATC setting of runway lighting intensity to be appropriate
11. Regarding flight and duty time limitations, the Operations Manual was in compliance with BL 5-18
12. The actual flight and duty time of the flight crew did not violate any flight and duty time requirements
13. As a consequence of fatigue, flight crew performance was impaired equivalent to more than 0.05% blood alcohol concentration impairing flight crew vigilance and reaction times

14. The AIB considers the flight crew to be fatigued in the morning on 25-1-2016
15. Flight crew fatigue might have impaired the flight crew decision making process and the flight crew night vision adaption and visual acuity.
16. The flight crew was very familiar with flight operations in EKKK
17. It was a routine morning flight towards EKCH
18. A combination of routine, familiarity and flight crew fatigue might have provoked flight crew complacency
19. The flight crew was preoccupied with non-critical time-consuming flight planning tasks before engine start and had a departure slot time
20. After the issue of the ATC take-off clearance, cockpit tasks divided the attention of the flight crew
21. Due to cockpit tasks, the first officer most likely missed the important phase of assessing the external environment and monitoring the entry to the runway
22. At a critical point of time, the flight crew performed the flight control check, which included a visual check of the aircraft spoiler system dividing the attention of the commander from lining up the aircraft
23. The operator before take-off procedure included before take-off flows and checks and the reading of 13 challenge and response items
24. A divergence on handling the before take-off checks between the AFM and the Operations Manual Part B might potentially have prolonged the divided attention of the flight crew
25. The operator before take-off runway heading and GPS check appeared to be a system check and not an environmental check
26. Environmental factors might have provoked a visual and a mental illusion of having lined up the aircraft on the centreline
27. The external visual references fulfilled the mental expectations of the flight crew, and the flight crew initiated the take-off roll
28. A misaligned take-off roll over the elevated runway edge lights along the right-hand side of runway 27L led to damages to the runway edge lights and the aircraft itself

3.2 Factors

1. It was a dark night operation in reduced visibility
2. The AIB considers the flight crew to be fatigued in the morning on 25-1-2016
3. After the issue of the ATC take-off clearance, cockpit tasks divided the attention of the flight crew
4. The operator before take-off runway heading and GPS check appeared to be a system check and not an environmental check
5. Environmental factors might have provoked a visual and a mental illusion of having lined up the aircraft on the centreline

3.3 Summary

In darkness and hazy weather conditions, the flight crew lined up the aircraft on the runway edge lights along the right-hand side of runway 27L instead of the runway centreline lights of runway 27L.

This resulted in a misaligned take-off roll over the elevated runway edge lights along the right-hand side of runway 27L leading to damages to the runway edge lights and the aircraft itself.

A combination of environmental, operational, and human factors contributed to the sequence of events:

- Dark night operation
- Reduced visibility
- Runway and taxiway environment, including an extra tarmac width on runway 27L, the absence of runway shoulder markings, the absence of taxiway centreline lighting, and the use of a displaced threshold
- Flight crew divided attention unintentionally provoked by the before take-off procedures and checks
- Flight crew fatigue

The serious incident occurred in dark night and under instrument meteorological conditions (IMC).

4 SAFETY RECOMMENDATIONS

4.1 Safety recommendations

4.1.1 Motivation

Worldwide safety investigations of similar occurrences revealed coincident contributing factors like summed up in the ATSB report.

The AIB supports a holistic and systemic approach to safety investigations, which requires not individual, but organizational action plans.

For that reason, the AIB refers to the safety recommendation (EW/C2014/10/01 (GB.SIA-2015-0038)) issued on 3-12-2015 by the British Air Accidents Investigation Branch (AAIB).

The AAIB motivation for the issue of their safety recommendation was:

The dominant common factor between this accident and other misaligned takeoffs is that a visually compelling line of edge lights was visible to the crew and was assumed to be centerline lighting. There is nothing inherent in an individual edge light that distinguishes it from a centreline light when viewed along the axis of the bi-directional element. It is the pattern of edge lights, and the relationship of this pattern to the pattern of other lights and to other visual cues, which identifies them as edge lights. If this complex relationship becomes disrupted or misinterpreted, perhaps for the reason highlighted in the ATSB report, pilots can lose situational awareness. If individual edge lights could be identified as such directly, rather than through a process of interpretation, a crew would notice their error more easily should they line up for takeoff incorrectly. Modern lighting technology offers more options to identify lights directly than does the tungsten lighting technology on which the current standards are based. Global aerodrome lighting standards are, in general, derived from ICAO Annex 14, Volume 1, 'Aerodrome Design and Operations'.

4.1.2 Safety recommendation and initial response

The AAIB issued the following safety recommendation (GB-SIA-2015-0038):

It is recommended that the International Civil Aviation Organization initiate the process to develop within Annex 14 Volume 1, 'Aerodrome Design and Operations', a standard for runway edge lights that would allow pilots to identify them specifically, without reference to other lights or other airfield features.

On 26-1-2016, ICAO responded:

ICAO states that Safety Recommendation 2015-038 will be referred to the Aerodrome Design and Operations Panel (ADOP) within ICAO for further study. In reviewing the recommendation, the ADOP, including its various specialized working groups, will take into account possible contributing factors such as additional pavement width at the beginning of the runway and the need for appropriate fog dispersal at aerodromes. The next meeting of the relevant ADOP Working Group is scheduled for the first quarter of 2016.

The AAIB initial assessment was:

Not adequate - Open

4.2 Preventive actions

Due to this serious incident, the operator issued proactive safety initiatives on:

- The line-up procedures
- A reduction of items in the before take-off checklist
- An enhancement of the runway and runway position check (including an environmental check and confirmation by both pilots)

5 APPENDICES

- 5.1 Time sequence (from 05:16:11 hours until 05:18:20 hours)
- 5.2 Time sequence (05:18:45 hours)
- 5.3 Time sequence (from 05:19:16 until 05:19:37)
- 5.4 Time sequence (from 05:19:39 hours until 05:20:35 hours)
- 5.5 Time sequence (05:20:48 hours until 05:20:59 hours)
- 5.6 Take-off roll sequence - FDR plot
- 5.7 Duty and rest periods
- 5.8 Operational flight plan
- 5.9 Mass and balance
- 5.10 Operator's aerodrome chart
- 5.11 ICAO aerodrome chart – EKKA
- 5.12 Runway edge lighting system
- 5.13 Military arrester cable mechanism
- 5.14 Schematic overview of the positioning of the runway lighting system
- 5.15 Performance effectiveness of the commander
- 5.16 Performance effectiveness of the first officer
- 5.17 Before take-off checklist - the operator
- 5.18 Before take-off checklist - the manufacturer

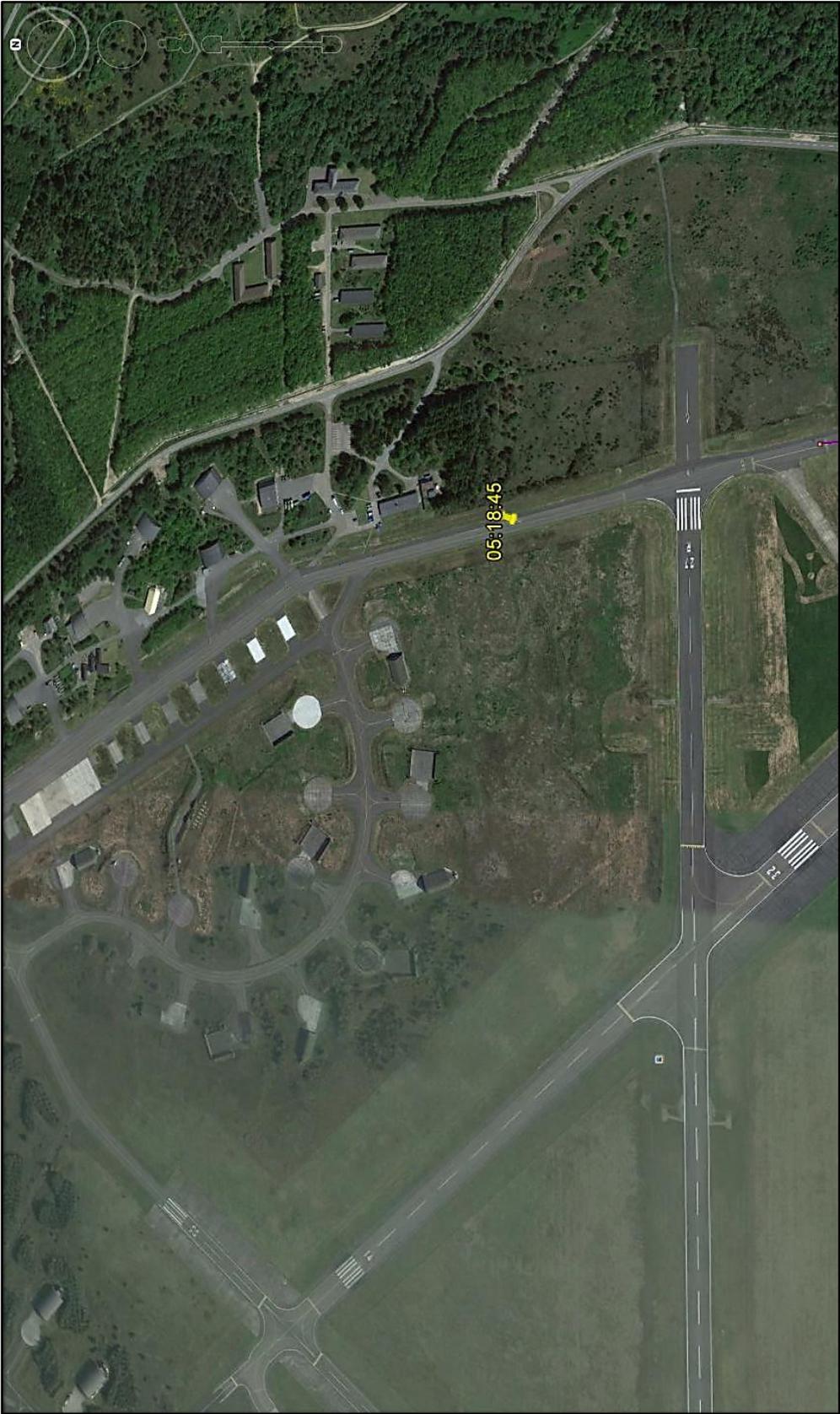
5.1 Time sequence (from 05:16:11 hours until 05:18:20 hours)

[Return to chapter](#)



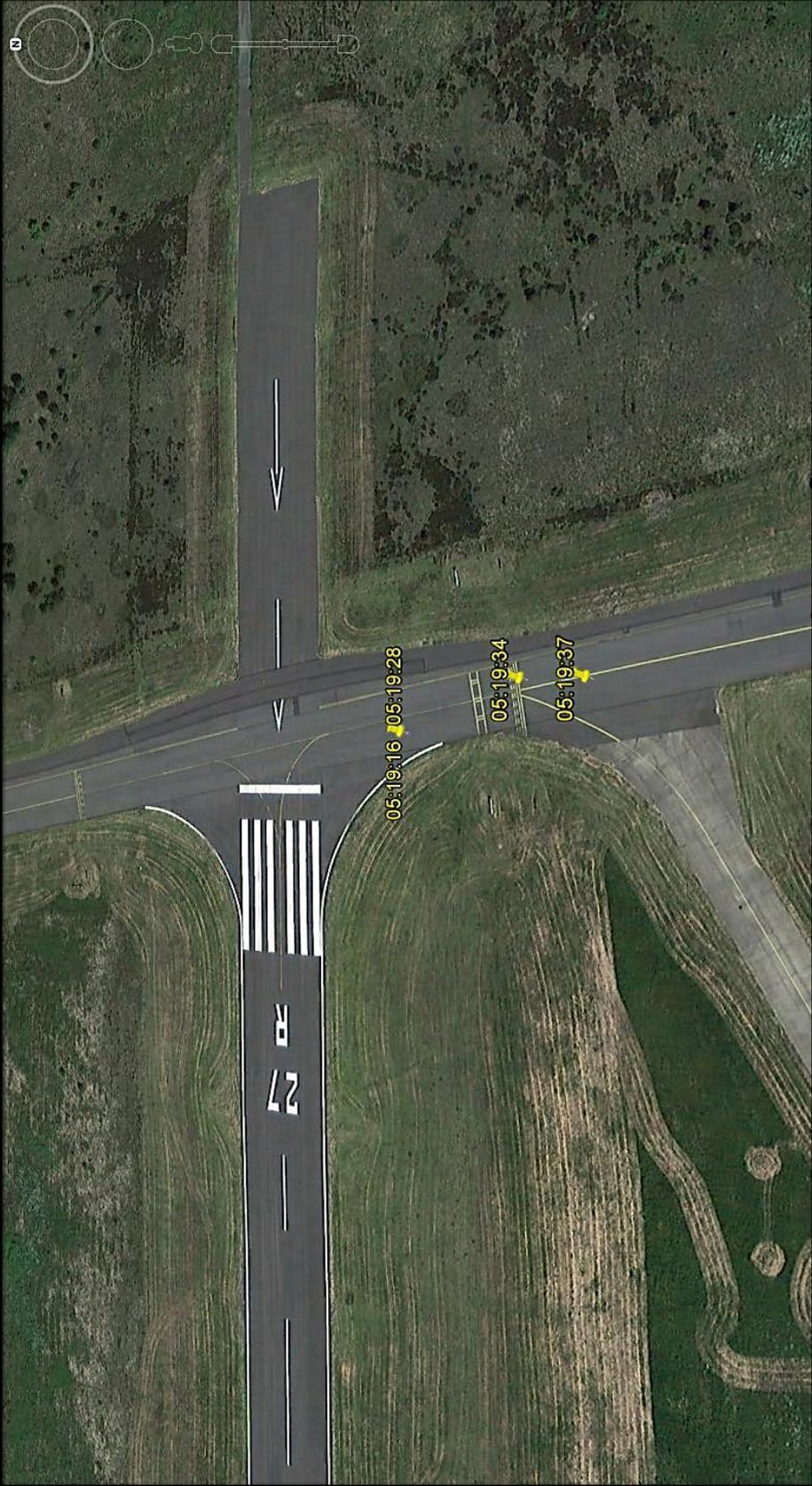
5.2 Time sequence (05:18:45 hours)

[Return to chapter](#)



5.3 Time sequence (from 05:19:16 until 05:19:37)

[Return to chapter](#)



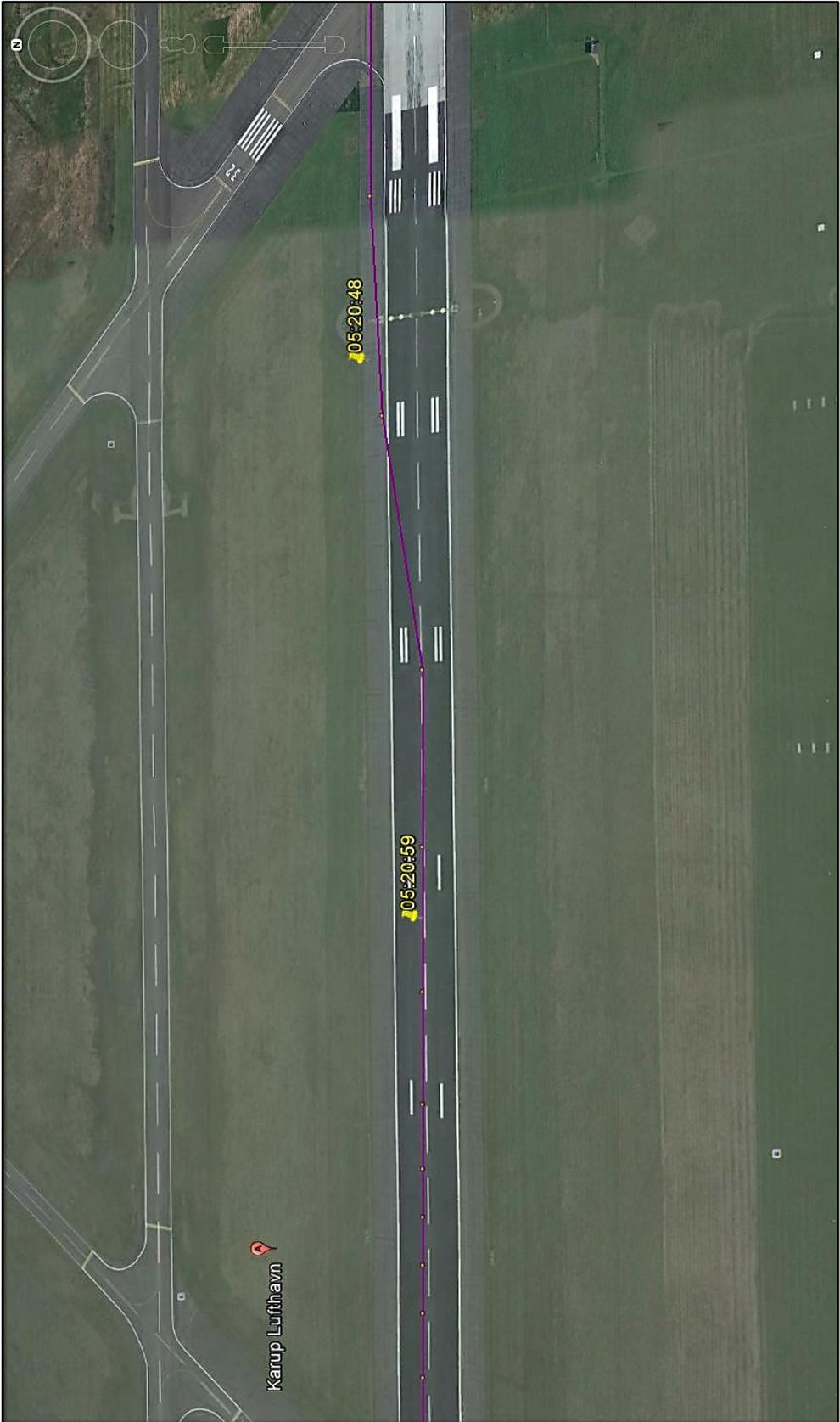
5.4 Time sequence (from 05:19:39 hours until 05:20:35 hours)

[Return to chapter](#)



5.5 Time sequence (05:20:48 hours until 05:20:59 hours)

[Return to chapter](#)



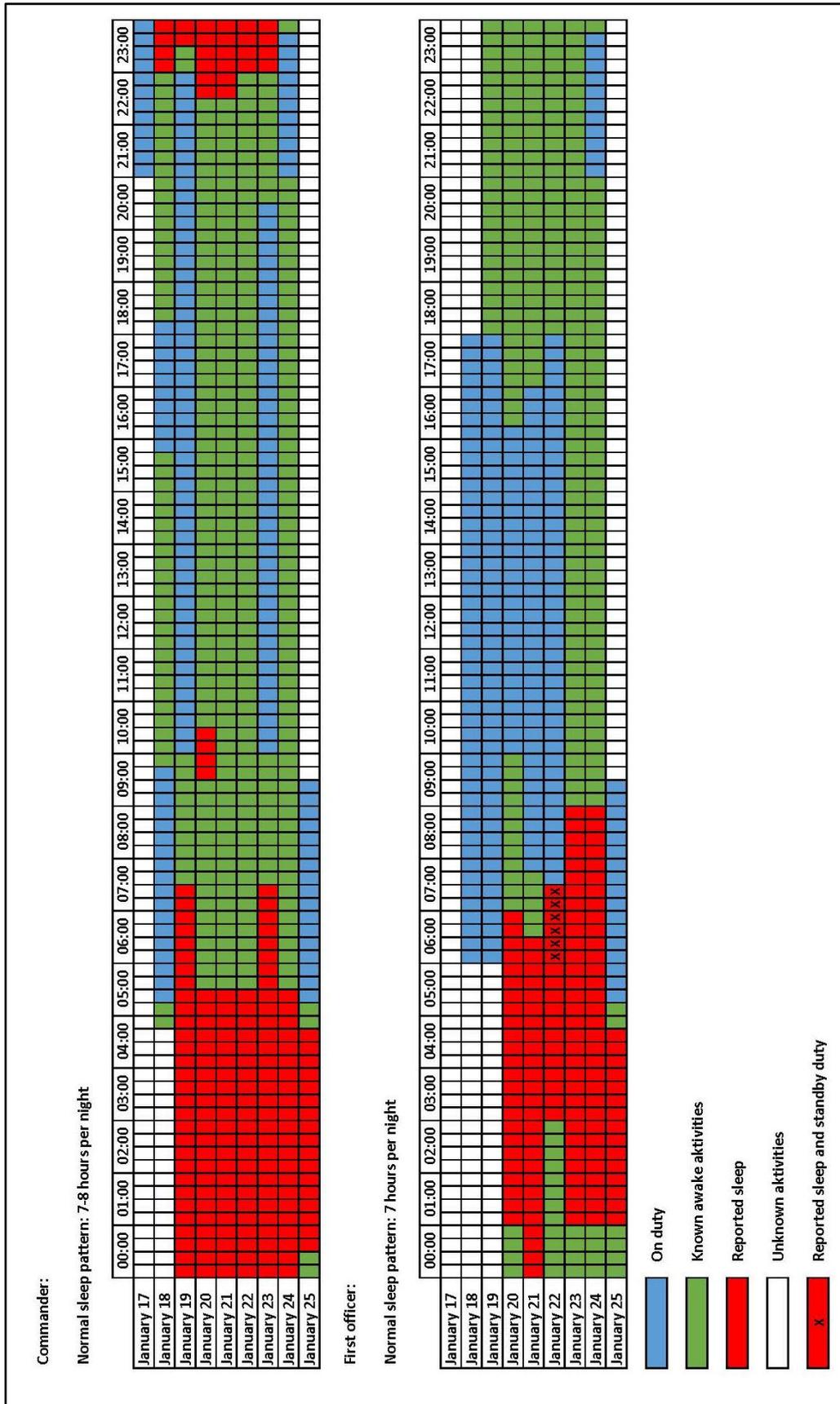
5.6 The take-off roll sequence - FDR plot

[Return to chapter](#)



5.7 Duty and rest periods

[Return to chapter \(commander\)](#) [Return to chapter \(first officer\)](#)



WPC	IDENT	T	FRBQ	AIR	FL	MA	MT	DIST	DIST	TIME	TIME	ETA	AFO	GS	W/V	TSA	FUEL	FUEL	---	---	MREQ	MREQ
				WAY			MT	Leg	Leg	INT	ACC.	ETA	AFO	GS	W/V	TSA	FLOW	USED	ACT	REMAIN	+/-	DIF
Alternate EPGD BALOX L983 DOMAG T240 OGDVAV																						
BALOX	EPGD	BALOX	L983	DOMAG	T240	OGDVAV																
				DCT	CLB	26	139	54		13	0:49						562	565			782	
JELMO	EPGD	BALOX	L983	CEB	25	083		24		6	0:55						562	625			723	
GIROR	EPGD	BALOX	L983	CLB	15	084		10		3	0:58						562	650			698	
RONNE	EPGD	BALOX	L983	D	11	200		12		3	1:01						562	680			668	
FIR RUMAR	EPGD	BALOX	L983	230	15	086		45		11	1:12						562	791			556	
GEVAR	EPGD	BALOX	L983	230	11	089		8		2	1:14						562	811			537	
DOMAG	EPGD	BALOX	L983	DSC	27	088		48		11	1:25						562	930			417	
OGDVAV	EPGD	BALOX	L983	DSC	27	129		15		4	1:29						562	968			380	
GDANSK/LECH	EPGD	BALOX	L983	DSC	27	142		45		11	1:40						562	1079			269	
Alternate EDDH KOPEX T504 MIC N850 BOGMU BOGMU2A																						
KOPEX	EDDH	KOPEX	T504	MIC	N850	BOGMU	BOGMU2A															
FIR LOMPU	EDDH	KOPEX	T504	CEB	26	224		66		18	0:54						541	615			583	
NETLA	EDDH	KOPEX	T504	CLB	19	199		24		6	1:00						541	682			516	
MICHAELSDORF	EDDH	KOPEX	T504	CLB	19	199		6		2	1:02						541	699			500	
NUSETA	EDDH	KOPEX	T504	DSC	19	200		13		3	1:05						541	735			464	
NIGAD	EDDH	KOPEX	T504	DSC	19	229		12		9	1:08						541	769			430	
BOGMU	EDDH	KOPEX	T504	DSC	18	230		11		3	1:11						541	799			399	
HAMBURG	EDDH	KOPEX	T504	DSC	24	230		9		3	1:14						541	824			374	
				DCT	DSC	24	205	38		10	1:24						541	930			269	
ICAO NAME WIND FL NM MT TIME FUEL ---BLOCK---																						
ESMS	MMX	MALMO	322/	36	70	49	098	0:15	260	1:21	1005											
BKRR	RKE	COPENHAGEN/ROSK	324/	35	60	43	262	0:14	260	1:20	1005											
ESMK	KID	KRISTIANSTAD	322/	43	130	77	067	0:22	265	1:28	1010											
ESDF	RNE	RONNEBY	324/	48	210	121	063	0:33	375	1:39	1120											
EKAH	AAR	AARHUS	312/	38	180	105	300	0:30	331	1:36	1076	ERA										
Climb : 46 NM in 0:12 hrs 184 Kg Descent: 47 NM in 0:12 hrs 107 Kg																						
AF72 / OYLHA DOF FLT NO STD DEST BURN MIN FUEL COMMANDER																						
NEXT FLT	160125	0630	EKRN	323	1046																	

5.9 Mass and balance

[Return to chapter](#)

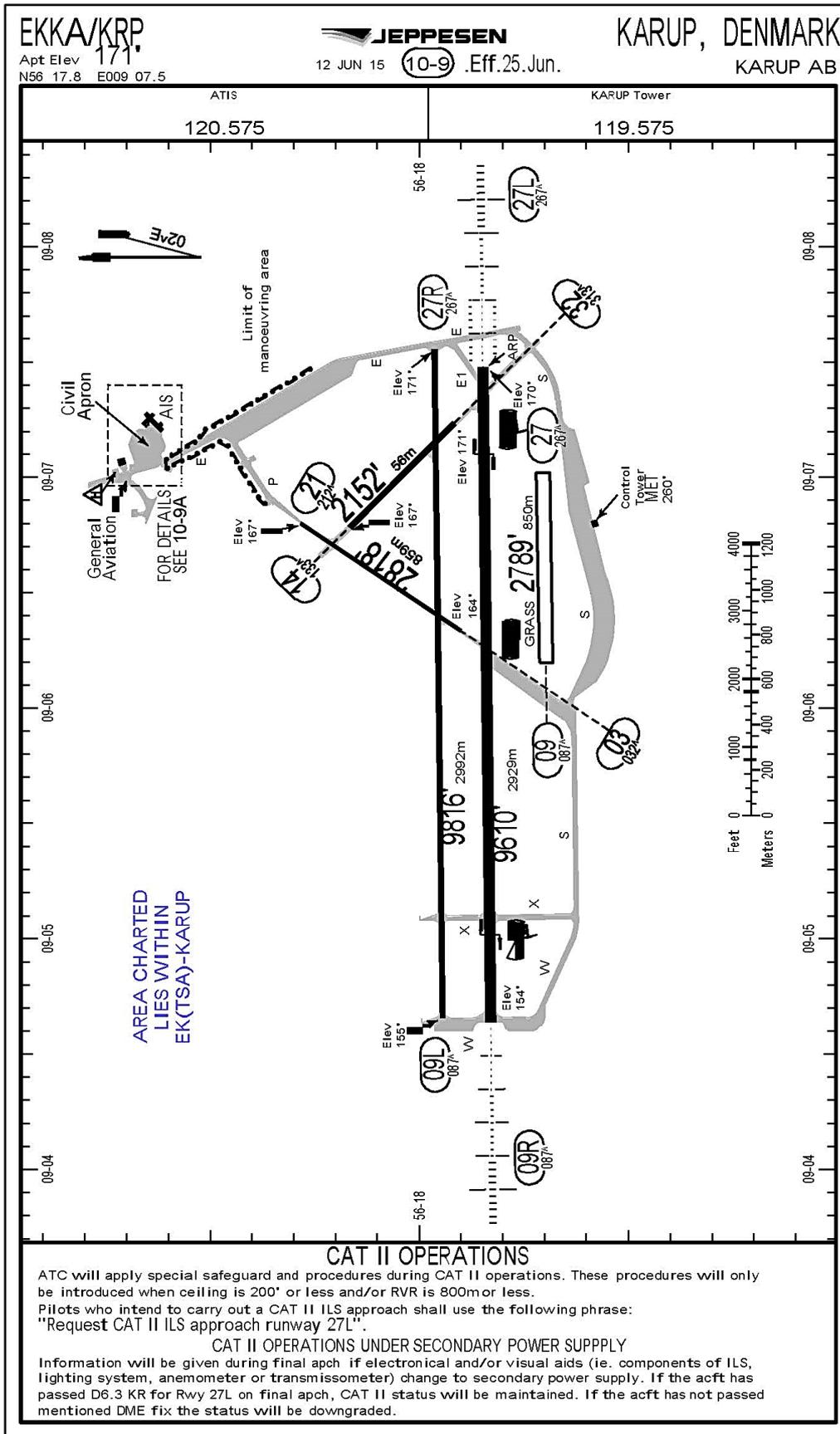
FROM	TO	FLIGHT	A/C REG	VARIATION	CONFIG
EKKA	EKCH		OYLHA	66 PAX	11
LOAD SHEET					
ALL WEIGHTS IN KILOS					
DATE 2016-01-25T05:15:00Z					
LOAD IN COMPARTMENTS	WEIGHT	DISTRIBUTION			
PASSENGERS / CABIN BAG	330	- 220 - - 110 0			
TOTAL TRAFFIC LOAD	5253	TTL 65			
DRY OPERATING WEIGHT	13509				
ZERO FUEL WEIGHT	19092	MAX 19700			
TAKE OFF FUEL	1798	MAX 21050			
TAKE OFF WEIGHT	20792	MAX 21350			
TRIP FUEL	481				
LANDING WEIGHT	20391				

BALANCE AND SEATING CONDITIONS					
DOI	-15.9				
LIZFW	-5.52				
LITOW	-2.69				
LILW	-3.36				
MACZFW	23.12				
MACTOW	24.16				
MACLW	23.93				
THS					
PAX	0 20 27 18	258			
UNDERLOAD BEFORE LWC					

NOTOC	NO				

5.10 Operator's aerodrome chart

[Return to chapter](#)



5.12 Runway edge lighting system

[Return to chapter](#)



S12



R94



879



R90



R88



R86

5.13 Military arrester cable mechanism

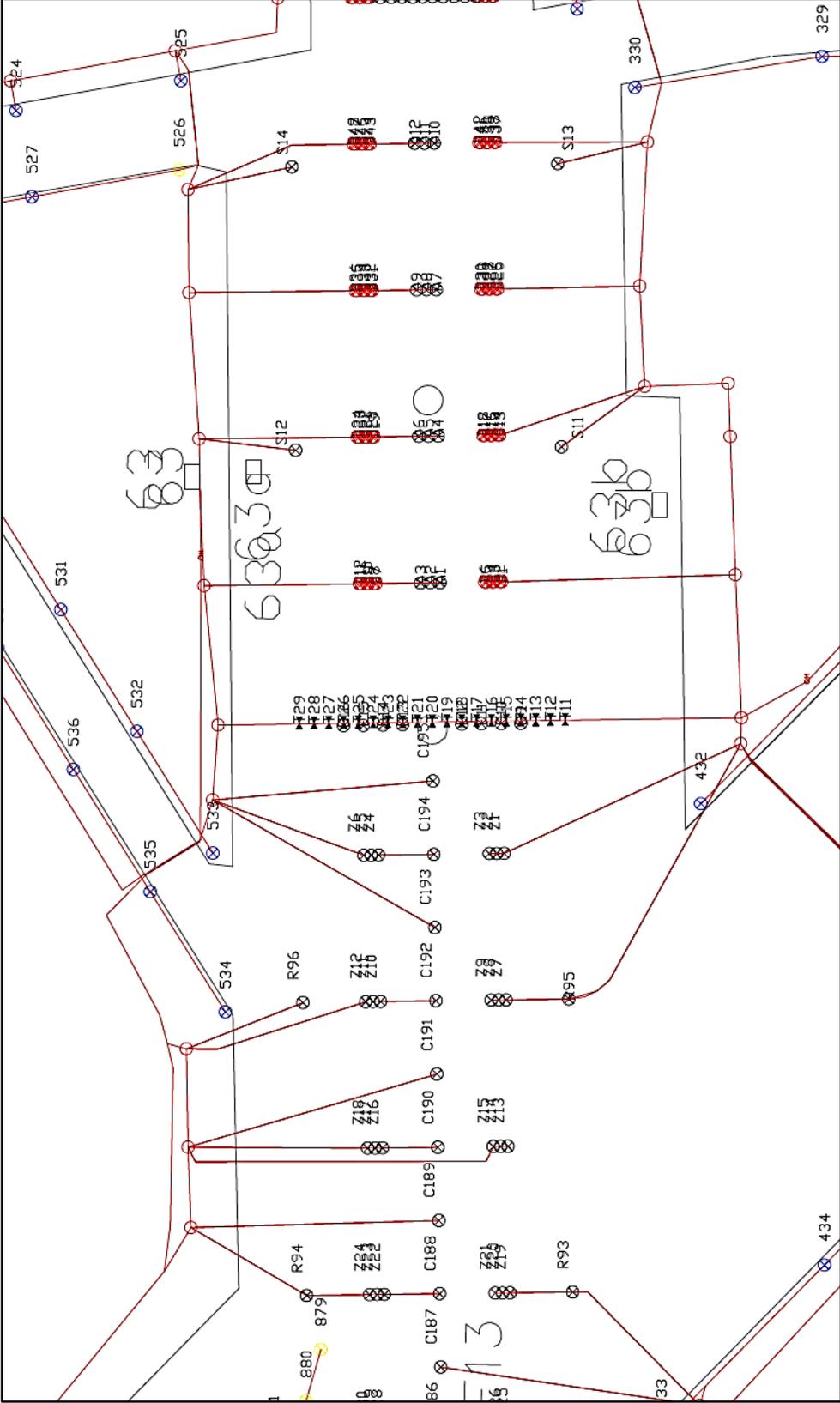
[Return to chapter](#)

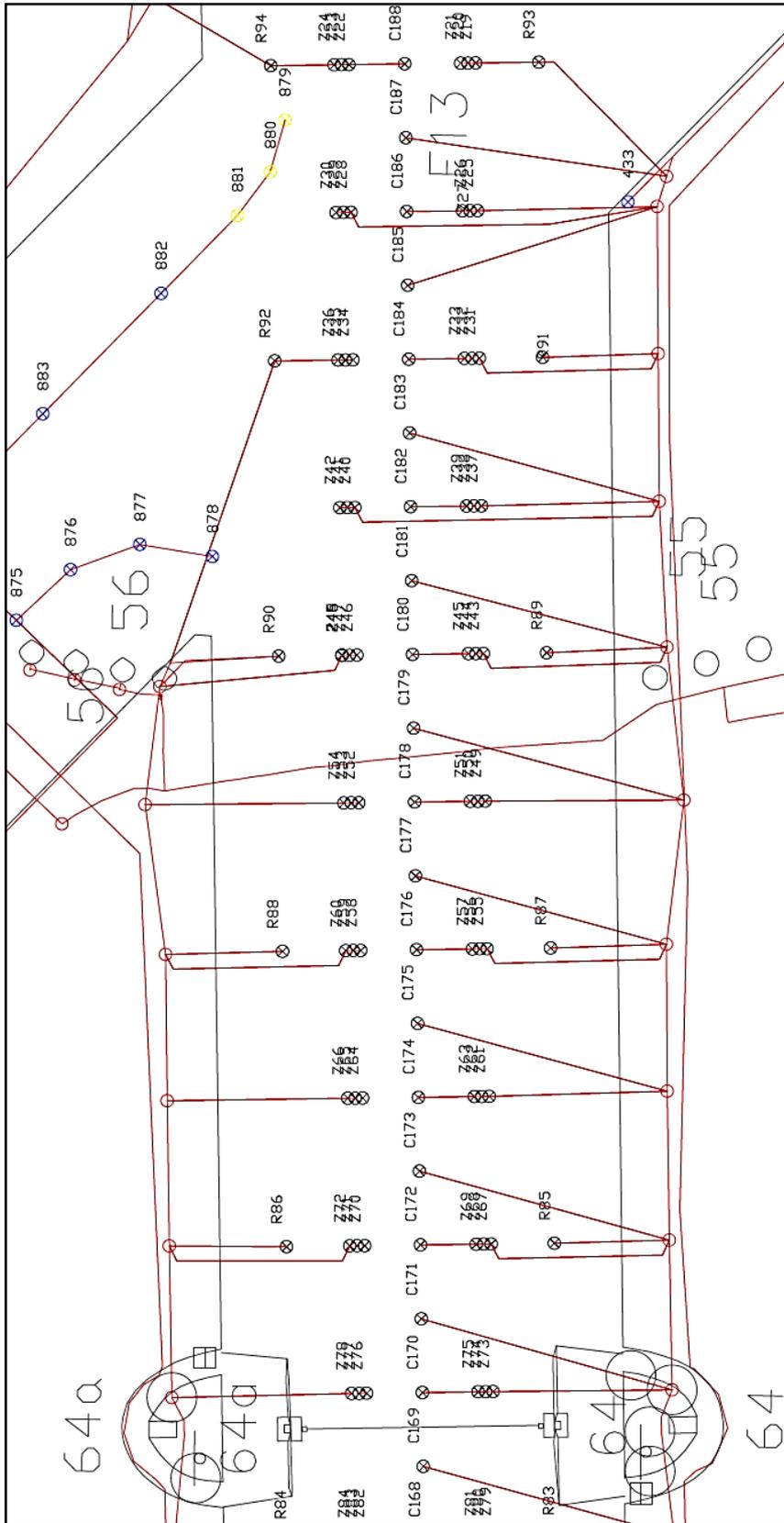


64A

5.14 Schematic overview of the positioning of the runway lighting system

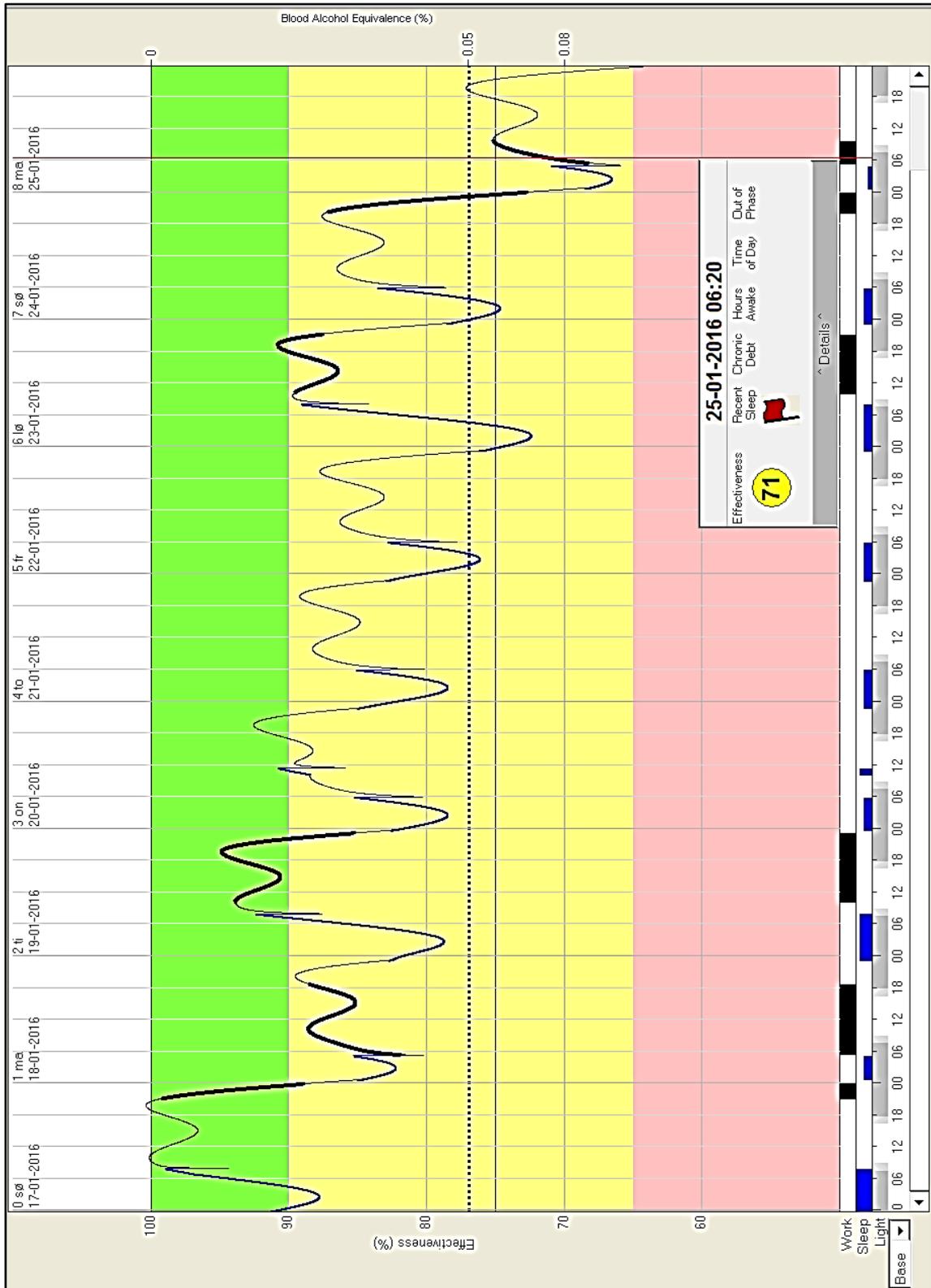
[Return to chapter](#)





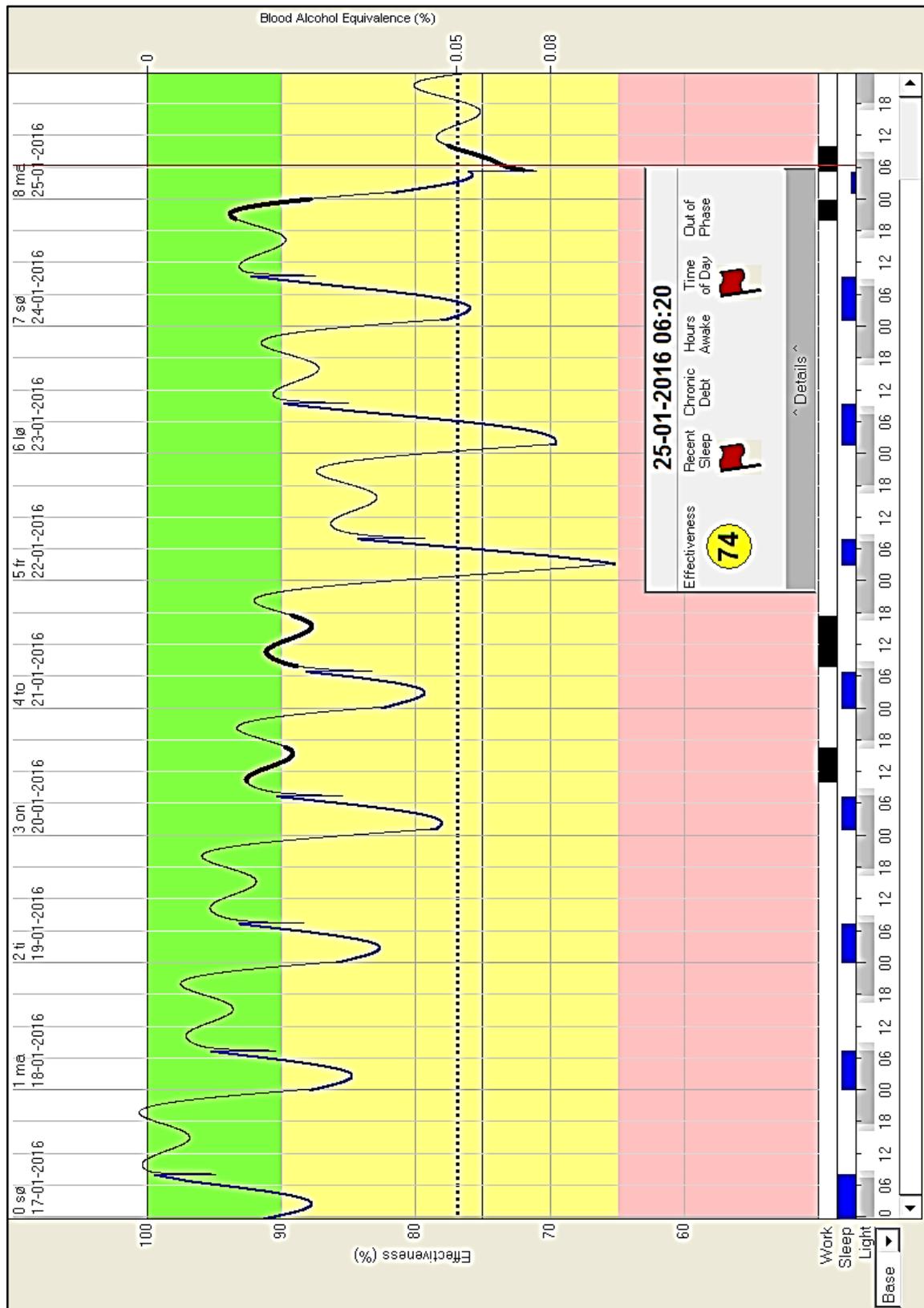
5.15 Performance effectiveness of the commander

[Return to chapter](#)



5.16 Performance effectiveness of the first officer

[Return to chapter](#)



5.17 Before take-off checklist - the operator

[Return to chapter](#)

2.5.2.2 BEFORE TAKE-OFF CHECKLIST

ACCOMPLISH WHEN CLEARED TO ENTER ACTIVE RUNWAY

BEFORE TAKE-OFF

1....	AIR COND. FLOW	NORMAL	CM2-
2....	BLEED VALVES	AS REQ	CM2-
3....	ANTI-ICING LVL 2	AS REQ	CM2-
4....	CABIN CREW	ADVISED	CM2-
5....	STROBE LT	ON	CM1-
6....	GUSTLOCK	RELEASED	CM2-
7....	FLIGHT CONTROLS	CHKD	CM2-
8....	TRANSPONDER (AT72-202/212)	ALT	CM2-
	TRANSPONDER (AT72-201)	T/RA	CM2-
9....	RUDDER CAM	CENTERED	CM1-
10..	CONDITION LEVERS (PEC)	AUTO	CM1-
	CONDITION LEVERS (nonPEC)	MAX RPM	CM1-
11..	CCAS	T.O. INHI	CM1-
12..	RUNWAY HDG & GPS	CHKD	CM1-
13..	LANDING LT	ON	CM1-
14..	CONT RELIGHT (nonPEC)	ON	CM1-

The before take-off checklist is a Do and Read checklist with Challenge and Response items.

When instructed to line up by ATC, CM1 calls "**BEFORE TAKE-OFF checklist**". CM2 completes his items and then reads the before take-off checklist in a challenge and response manner. When the checklist is completed, CM2 calls "**BEFORE TAKE-OFF checklist completed**".

2.5.2.3 BEFORE TAKE-OFF FLOWS

CM 1 FLOWS:

Select Strobe light ON when cleared to line up and/ or entering a runway - Check full rudder travel - Check condition levers MAX RPM(non PEC) / AUTO(PEC) - CCAS T.O. INHI - Rudder cam centred - Check RWY heading and confirm GPS alignment - Select the Landing lights ON and Continuous relight ON(non PEC) when actually cleared for take-off by ATC

CM2 FLOWS:

Air condition normal flow - Bleed valves OFF(AT43) / AS REQ(AT45/72) - Level 2 ON if req. - Cabin crew advised - Gust lock released - Flight controls check (aileron, spoiler and elevator) - Transponder ALT / T/RA(AT72-201) - align GPS on RWY by selecting "Direct to" first waypoint (if req.)

[Return to chapter](#)

2.5.2.4 CHECKING FLIGHT CONTROLS - CALLOUTS AND ACTIONS

ACTION/NOTE	CALLOUT	BY
Check full freedom of the rudder then center the rudder cam, and call:	<i>"Rudder is free"</i>	L/P
Release the gust lock while holding the control wheel, push the control wheel fully forward then apply left aileron.		R/P
Visually check left spoiler, and call:	<i>"Spoiler left"</i>	L/P
Look at the spoiler light panel, check that left spoiler is illuminated. Then turn the control wheel to the right, and check that the right spoiler light is illuminated, and call:	<i>"Two spoiler lights"</i>	R/P
Visually check the right spoiler, and call:	<i>"Spoiler right"</i>	R/P
Center the aileron and pull the control wheel fully back to check the elevator, and finally center the elevator and check that the spoiler lights are extinguished.		R/P

2.5.2.5 CHECKING RUNWAY HEADING AND ALIGNING GPS

Runway heading and GPS alignment shall be checked when lined up on the runway. CM1 gives the response after having checked and compared own RMI and own EHSI. When operating on aircraft with KLN 90B installed, CM2 has to press "Direct to" the first waypoint on a LNAV departure.

5.18 Before take-off checklist - the manufacturer

[Return to chapter](#)

 A320 F.C.O.M.	NORMAL PROCEDURES	2.03.13		
	BEFORE TAKE OFF	P 1	001	
				NOV 11

AA

R Philosophy of use :

All items "up to the line", can be done any time before entering the runway.
 "Below the line" items must be done when clear to line up.

CM2 - GUST LOCK RELEASE

ALL - FLIGHT CONTROLS CHECK
 Check full travel and freedom movement in PITCH, ROLL, YAW
 For ROLL, check spoiler lights illuminate

CM2 - TCAS AUTO CHECK

CM2 - XPDR ALT

CM2 - WEATHER RADAR AS RQD

CM2 - APM rotary selector (if installed) SELECT T/O WEIGHT

CM2 - AIR FLOW NORM

CM1 - CCAS RCL

CM1 - CCAS TO INHIB

CM1 - OVERHEAD PANEL SCAN
 Check all light extinguished except ANTI ICING if required.

CM2 - LINE UP CLEARANCE OBTAINED

CM2 - BLEED VALVES AS RQD

CM1 - LANDING LIGHT & STROBE ON

When lined up

ALL - LATERAL FD BAR CENTERED
 Check HDG = RWY HDG.

CM1 - RUDDER CAM CENTERED

ALL - BEFORE TAKE OFF C/L PERFORM