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**Service suisse d'enquête de sécurité SESE**
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**Swiss Transportation Safety Investigation Board STSB**

Aviation Division

# Final Report No. 2246 by the Swiss Transportation Safety Investigation Board STSB

concerning the serious incident involving the Airbus A320-214 aircraft, registration HB-IOR,

operated by Belair Airlines under flight plan call sign AB7785

on 1 October 2013

at Porto Airport, Portugal

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## Ursachen

Der schwere Vorfall ist darauf zurückzuführen, dass das Flugzeug die notwendigen Flugleistungen beim Start nicht erreichte, weil die Flugbesatzung den Start von einer Rollwegabzweigung (*intersection*) aus mit einer Triebwerkleistung durchführte, die für die gesamte Pistenlänge berechnet worden war.

Folgende Faktoren haben zum schweren Vorfall beigetragen:

- der Umstand, dass sich der Kommandant während der Startvorbereitungen durch äussere Umstände ablenken liess;
- die unvollständige Überprüfung der *takeoff data* im Rahmen der Prüfliste *before start*;
- Verfahrensvorgaben, die einzelne Überprüfungen nur unter der Bedingung vorsahen, dass diese auch notwendig seien;
- die stillschweigende (*silent*) Ausführung essentieller Überprüfungen.

# General information on this report

This report contains the Swiss Transportation Safety Investigation Board's (STSB) conclusions on the circumstances and causes of the serious incident which is the subject of the investigation.

In accordance with Article 3.1 of the 10th edition, applicable from 18 November 2010, of Annex 13 to the Convention on International Civil Aviation of 7 December 1944 and Article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident/incident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the German language.

All information, unless otherwise indicated, relates to the time of the serious incident.

All times in this report, unless otherwise indicated, follow the coordinated universal time (UTC) format. At the time of the serious incident, Azores Summer Time (AZOST) applied as local time (LT) in Portugal. The relation between LT, AZOST and UTC is:

LT = AZOST = UTC + 1 hour.

# Contents

# Final Report

## Synopsis

| | |
|---|---|
| Owner | IGAL MSN 4033 LIMITED, Hardcourt Street, Dublin, Ireland |
| Operator | Belair Airlines AG, Sägereistrasse 27, 8152 Glattbrugg, Switzerland |
| Manufacturer | Airbus S.A.S., Toulouse, France |
| Aircraft type | A320-214 |
| Country of registration | Switzerland |
| Registration | HB-IOR |
| Location | Porto Airport (LPPR), Portugal |
| Date and time | 1 October 2013, 15:43 UTC |

## Investigation

The serious incident occurred on 1 October 2013 at 15:43 UTC. The notification was received on 24 October 2013. Portugal delegated the investigation of the serious incident to Switzerland. The investigation was opened on 22 November 2013 by the former Swiss Accident Investigation Board (SAIB). Portugal appointed an authorised representative, who assisted with the investigation.

The present final report is published by the Swiss Transportation Safety Investigation Board.


## Summary

After a flight from Palma de Mallorca to Porto, the crew of the Airbus A320-214 aircraft, registration HB-IOR, prepared the aircraft for the return flight. The necessary engine power for a takeoff on runway 17 was also calculated for the entire available runway length of 3480 m.

The crew then decided to takeoff from the intersection Foxtrot with an available runway length of 1900 m because air traffic control offered them the opportunity to overtake another aircraft, rolling in front of them, in the startsequence. The subsequent takeoff took place with the engine power which had previously been calculated for the entire runway length. This engine power was sufficient for a normal takeoff, but in the event of engine failure did not meet the operational requirements for allowing the takeoff to be continued or rejected within the remaining runway length.

There was no damage. Flight AB7785 to Palma de Mallorca continued as planned.


## Causes

The serious incident is attributable to the fact that the aircraft did not reach the necessary flight performance on takeoff, because the flight crew performed the takeoff from a runway intersection with an engine power which had been calculated for the entire length of the runway.

The following factors contributed to the serious incident:

- the fact that the commander was distracted by external circumstances during takeoff preparations;
- the uncomplete examination of the takeoff data within the frame of the "before start" checklist;

- procedures which stipulated individual checks only *„if required”*;
- the fact that essential checks were performed in silence.

**Safety recommendations**

Within the frame of the investigation no safety recommendations were issued.

# 1 Factual information

## 1.1 Prehistory and history of the flight

### 1.1.1 General

For the following description of the prehistory and the history of the serious incident the statements of the flight crew members, as well as the recordings of the quick access recorder and the electronic flight bags (EFB) were used. The radiocommunication transcript and the recordings of the radar data and flight recorders were no longer available.

For the entire flight the commander was pilot flying (PF) and the copilot was pilot not flying (PNF).

### 1.1.2 Prehistory

After a flight from Palma de Mallorca to Porto, which arrived 13 minutes late, the crew prepared HB-IOR for the return flight under the flight plan call sign AB7785.

As part of these preparations, the commander initially assumed an estimated takeoff mass of 66 800 kg. The calculation of the necessary engine power, which was based on this mass, was performed at 15:14 UTC and indicated that an intersection takeoff on runway 17 from the intersection Foxtrot, in order to save the time required to taxi to the start of the runway was only possible with maximum engine power. To protect the engines he therefore planned to takeoff from the start of the runway (full-length takeoff) with reduced engine power. He performed the relevant calculation at 15:15 UTC.

The commander then received the loadsheet with the final data. This indicated a takeoff mass of 62 811 kg and included a time stamp for 15:10 UTC. The operational flight plan (OFP) included the planned flight route and indicated a mass of 63 320 kg.

At 15:20 UTC the commander used the information provided by the loadsheet to recalculate the engine power for the entire available runway length of 3480 m (takeoff run available – TORA), which offered the maximum possible protection for the engines. In the event of an engine failure and continued takeoff a takeoff run (TOR) of 2076 m was thereby determined and a value of 2463 m (takeoff distance – TOD) for the corresponding takeoff run to a height of 35 ft. For the required runway length in case of a rejected takeoff (accelerate stop distance – ASD) a value of 2394 m was determined (see Figure 2). For a takeoff from intersection Foxtrot the TORA was 1900 m.

According to this calculation the commander then programmed the flight management and guidance system (FMGS) and conducted the takeoff briefing for the planned full-length takeoff together with the copilot.

During the takeoff briefing, when it emerged that the takeoff mass was lower than initially estimated, the commander resolved to re-assess the option of an intersection takeoff.

At 15:25 UTC, after successfully preparing for a full-length takeoff, the commander performed the calculation for an intersection takeoff as he had resolved to do. This calculation was based on a takeoff mass of 63.0 tons and then checked by the copilot. The commander initially recorded the results on a piece of paper and postponed the associated FMGS reprogramming as he was distracted by the handling agent.

The handling agent informed the flight crew of a missing passenger. The commander then left the cockpit to take care of this matter and returned approximately ten minutes later. Shortly after, the flight crew received clearance from air traffic control to push back the aircraft and start the engines.

The task of reprogramming the FMGS, which had previously been postponed, was no longer performed. The commander later gave the following statement [translated from German]: *„Normally I program the conservative variant, by which I mean the intersection takeoff, in the FMGS and write down the full-length performance on a piece of paper, but I postponed this until later."* The copilot gave the following statement with regard to this situation [translated from German]: *„I was of the opinion that the intersection takoff data had been programmed on the FMGS after we had agreed that this would be the most sensible way to save time. When we started the engines I was convinced that everything was properly prepared for an intersection takeoff."*

### 1.1.3 History of the serious incident

At 15:36 UTC, after a delay of 21 minutes from the time scheduled on the flight plan, the aircraft was pushed back and the engines started. During the subsequent taxiing, the flight crew requested clearance from air traffic control to takeoff from the intersection Foxtrot.

Air traffic control issued clearance to the aircraft taxiing in front of HB-IOR to taxi on the runway to the beginning of the runway for an imminent full-length takeoff. Air traffic control therefore asked the flight crew of HB-IOR if they were prepared for an immediate takeoff from intersection Foxtrot ahead of this aircraft. After the flight crew replied in the affirmative, takeoff clearance was granted immediately.

At 15:43 UTC, HB-IOR began its takeoff roll from intersection Foxtrot with 153 passengers on board and with an engine power which had been planned for a full-length takeoff. Although this reduced engine power was sufficient for a normal takeoff, however, according to the manufacturer's official performance calculations, it did not meet the following two requirements (cf. chapter 1.18.1):

- to bring the aircraft to a standstill on the remaining available runway length in case of a takeoff abortion until reaching the decision speed;
- to continue the takeoff in case of an engine failure after reaching the decision speed.

During the takeoff roll, both pilots made the observation that the remaining length of the runway was unusually short. No use was made of the possibility to use the throttles to increase the engine power to the maximum level during takeoff roll.

The decision speed of 140 knots was achieved 700 m before the end of the runway, when level with the taxiway Delta intersection. The aircraft took off when level with the taxiway Charlie intersection, 350 m before the end of the runway. The radioaltimeter registered a height of 104 ft above the end of the runway (see Figure 1).

After takeoff, the copilot explained to the commander the observation he had made during takeoff roll. There then followed a brief discussion between the pilots, during which the error still remained unnoticed; operational aspects of the imminent flight path required their attention. Flight AB7785 to Palma de Mallorca then continued as planned.

After the end of his flight duty, the commander became aware of a possible error and informed the copilot and the operator's flight safety officer about. Based on the data available to him, he was able to confirm that the takeoff in Porto had been performed with insufficient engine power.

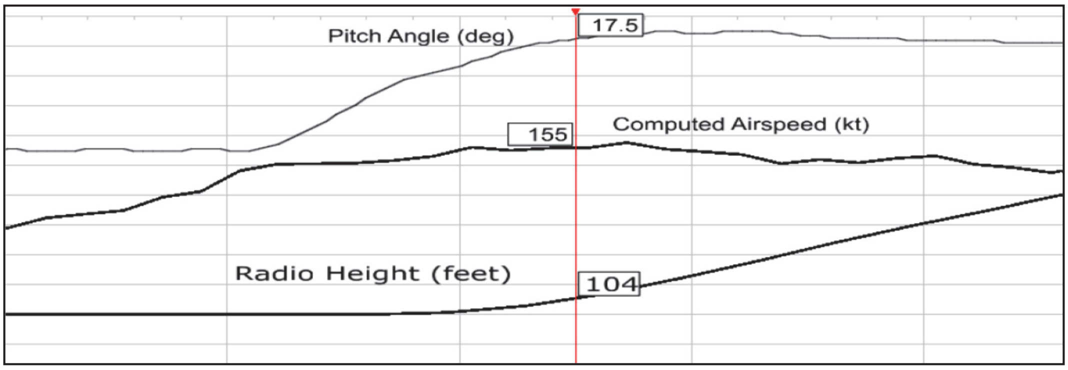


**Figure 1:** Pitch angle, computed airspeed and radio height at the time the aircraft passed the end of the runway (marked in red).

1.1.4 Location and time of the serious incident

| | |
|---|---|
| Location | Runway 17 Porto Airport (LPPR), Portugal |
| Date and time | 1 October 2013, 15:43 UTC |
| Lighting conditions | Daylight |
| Coordinates | 41° 14‘ 55" N, 8° 40‘ 53" W (WGS 84) |
| Height | 60 m AMSL |

## 1.2 Injuries to persons

Not affected.

## 1.3 Damage to aircraft

Not affected.

## 1.4 Other damage

Not affected.

## 1.5 Personnel information

1.5.1 Commander

| | | |
|---|---|---|
| Person | Swiss citizen, born 1967 | |
| Licence | Airline transport pilot licence aeroplane (ATPL(A)) in accordance with European Aviation Safety Agency (EASA) | |
| Flying experience | Total | 9611 hours |
| | on the type involved in the incident | 1624 hours |
| | during the last 90 days | 125 hours |
| | of which on the type involved in the incident | 125 hours |

All available evidence suggests that the commander started duty well-rested and in good health. There are no indications that fatigue played a role at the time of the serious incident.

1.5.2 Copilot

| | | |
|---|---|---|
| Person | Swiss citizen, born 1980 | |
| Licence | ATPL(A) in accordance with EASA | |
| Flying experience | Total | 2185 hours |
| | on the type involved in the incident | 1335 hours |
| | during the last 90 days | 148 hours |
| | of which on the type involved in the incident | 148 hours |

All available evidence suggests that the copilot started duty well-rested and in good health. There are no indications that fatigue played a role at the time of the serious incident.

## 1.6 Aircraft information

1.6.1 General

| | |
|---|---|
| Registration | HB-IOR |
| Aircraft type | A320-214 |
| Characteristics | Twin-engine short-haul and medium-haul aircraft with turbofan propulsion |
| Manufacturer | Airbus S.A.S., Toulouse, France |
| Owner | IGAL MSN 4033 LIMITED, Hardcourt Street, Dublin, Ireland |
| Operator | Belair Airlines AG, Sägereistrasse 27, 8152 Glattbrugg, Switzerland |
| Engines | CFM International CFM56-5B4/P |
| Max. permitted masses | Takeoff 77 000 kg<br>Landing 65 500 kg |

1.6.2 Loading

HB-IOR's loading consisted of 153 passengers, 6 crew members, 1987 kg of luggage and 5700 kg of fuel. The calculated takeoff mass was therefore 62 811 kg. Both the mass and centre of gravity were within the permitted limits according to the aircraft flight manual (AFM) at the time of the serious incident.

1.6.3 System for calculating the necessary engine power for takeoff

The flight crew must execute the takeoff performance calculation on an electronic flight bag (EFB). Both pilots have an EFB for this purpose. The devices are located in the cockpit on the outboard side of the pilots below the sliding side window.

The necessary inputs for this calculation on the EFB include the takeoff mass, meteorological data and the takeoff runway information including the intended intersection. The results must be read off from the EFB screen (see Figure 2) and entered into the aircraft's FMGS using the multipurpose control and display unit (MCDU) keyboard. Both pilots have an MCDU.

During takeoff, the FMGS adjusts the engine power to the value which corresponds to the previous entries of the flight crew on one of the two MCDUs.

Each of the calculations performed on an EFB is stored in its memory to ensure traceability.

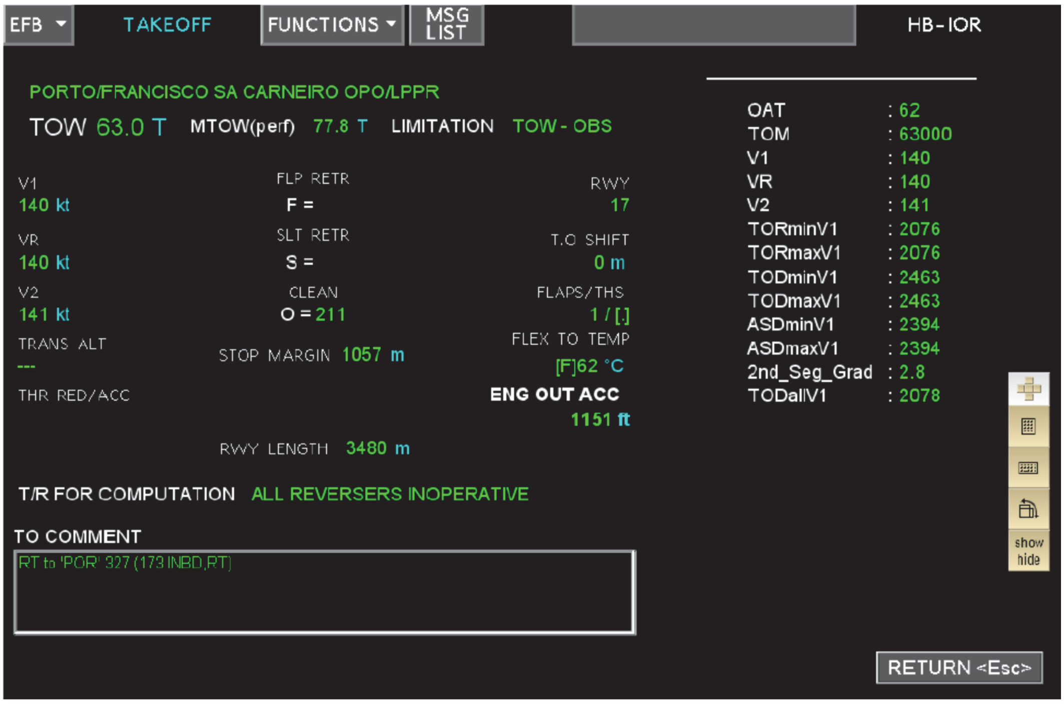


**Figure 2:** Results of the takeoff performance calculation on the screen of an EFB

## 1.7 Meteorological information

### 1.7.1 General meteorological situation

A low to the west of Ireland was directing a cold front across the north of Portugal. Behind the weakening frontal zone, slightly drier air was reaching the Iberian Peninsula. Along the coast, convergent winds and a temperature inversion were leading to extended stratus clouds with a low base.

### 1.7.2 Weather at Porto Airport at the time of the serious incident

The aerodrome meteorological report for Porto Airport at 15:00 UTC was:

LPPR 011500Z 23008KT 9999 SCT007 BKN012 20/18 Q1009=

This means: on 1 October 2013, shortly before the 15:00 UTC issue time of the aerodrome meteorological report, the following weather conditions were observed at Porto Airport:

| | |
|---|---|
| Wind | 8 knots from 230° |
| Meteorological visibility | 10 km or over |
| Cloud | 3/8 - 4/8 at 700 ft above ground-level<br>5/8 - 7/8 at 1200 ft above ground-level |
| Temperature | 20 °C |
| Dewpoint | 18 °C |
| Atmospheric pressure (QNH) | 1009 hPa (atmospheric pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere) |

This aerodrome weather report was available to the crew for flight preparations. The weather conditions did not change until the time of the serious incident at 15:43 UTC.

1.7.3 Astronomical information

| | |
|---|---|
| Position of the sun: | Azimuth: 224°, Elevation: 35° |
| Lighting conditions: | Daylight |

## 1.8 Aids to navigation

Not affected.

## 1.9 Communications

No radiocommunication transcripts were available.

According to the statement of the flight crew, radiocommunication with air traffic control in Porto was performed properly and without difficulty.

## 1.10 Aerodrome information

Porto Airport is located 11 km north of the city centre, close to sea level. It is the second largest commercial airport in Portugal after Lisbon. The system comprises a single runway 17/35, which runs parallel to the Atlantic coast and is 3480 m long.

The taxiway system ends at the intersection Foxtrot, which means that for takeoffs from runway 17 it is necessary to taxi on the runway itself to the start of the runway. If the runway is occupied by another aircraft taxiing to the start of the runway, the runway is no longer available for landings, though it is available for takeoffs in a southerly direction from the intersection Foxtrot.

A runway length of 1900 m is available for takeoffs from runway 17 from the intersection Foxtrot. The area beyond the end of the runway cannot be used as a stopway in the event of a rejected takeoff.

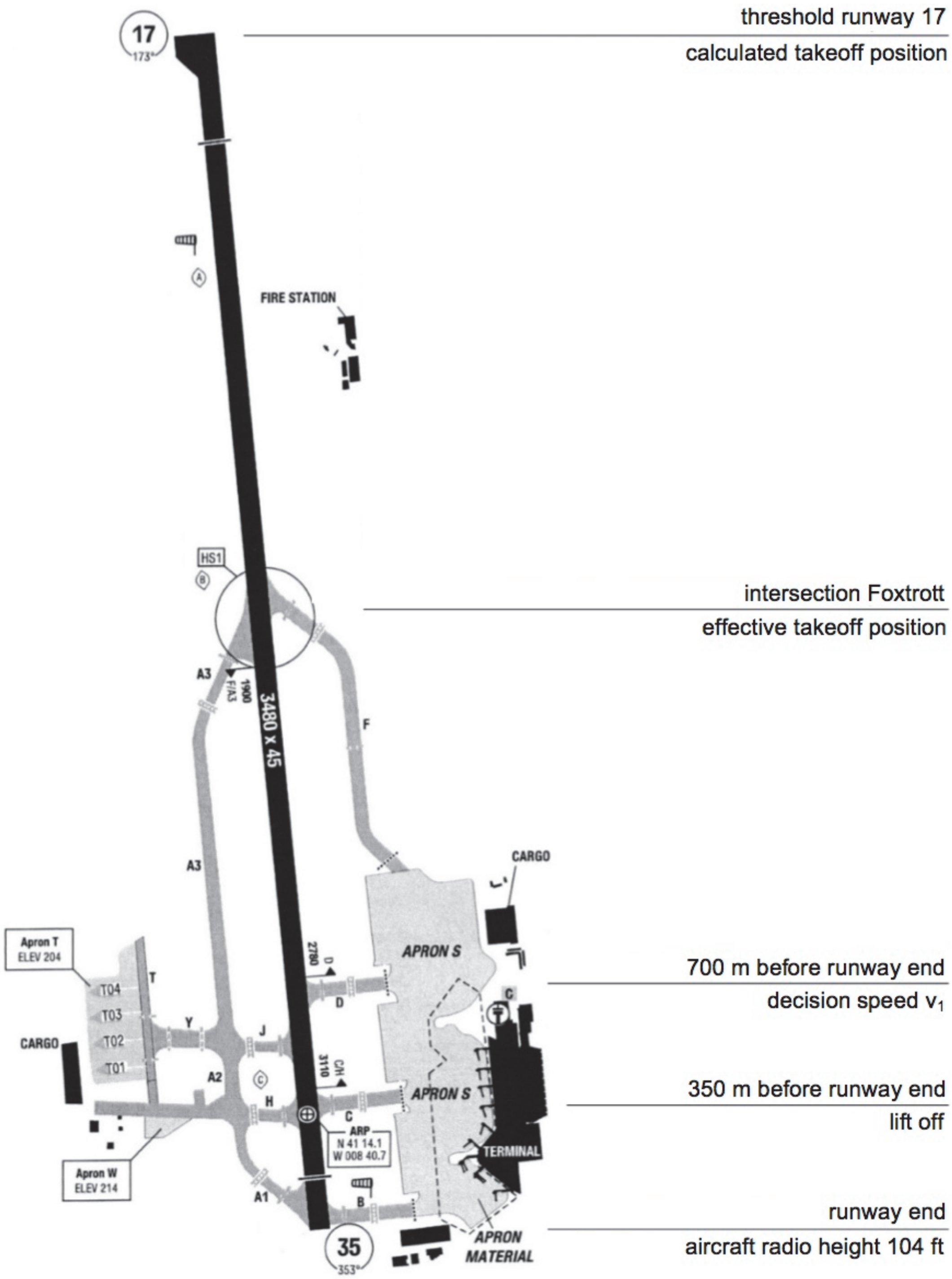


**Figure 3:** Runway and taxiways at Porto Airport and takeoff sequence of HB-IOR

The following distances are specifically for flight operations on runway 17:

| | TORA[1] | TODA[2] | ASDA[3] | LDA[4] |
|---|---|---|---|---|
| from the start of the runway | 3480 m | 3480 m | 3480 m | 3180 m |
| from intersection F | 1900 m | 1900 m | 1900 m | --- |

[1] Takeoff run available
[2] Takeoff distance available
[3] Accelerate-stop distance available
[4] Landing distance available

## 1.11 Flight recorders

Due to the late notification of the serious incident, the data from both the flight data recorder and the voice recorder were no longer available.

## 1.12 Wreckage and impact information

Not affected.

## 1.13 Medical and pathological information

Not affected.

## 1.14 Fire

Not affected.

## 1.15 Survival aspects

Not affected.

## 1.16 Tests and research

Not affected.

## 1.17 Organizational and management information

### 1.17.1 Relevant procedures defined by the operator

#### 1.17.1.1 General

The relevant operating procedures for making the takeoff performance calculation and entering the results into the MCDU are contained in various publications. These primarily include Belair's operation manuals (OM) OM A and OM B. OM A contains general procedures, while OM B contains procedures for Airbus A320 series aircraft.

Belair's OM B generally refers to the applicability of the aircraft manufacturer Airbus' 4410-page flight crew operating manual (FCOM): *„Generally, the standard Airbus FCOM is used for Belair Operations.”* However, it supplements the FCOM with additional procedures: *„In some areas of operation the Belair SOPs* [standard operating procedures] *are complementary to Airbus procedures and represent our unique philosophy.”*

The FCOM in turn supplements the aircraft manufacturer's aircraft flight manual (AFM). In this respect it is already tailored to the needs of the operator, as it refers to the airberlin group's company data manual (CDM) for additional or alternate procedures: *„AB group has not amended the Airbus FCOM chapters except for added notes to indicate differences between AB Group SOP and Airbus SOP or when additional information are required. These notes include the reference linked to the corresponding chapter within the Company Data Manual (CDM).”*

The manufacturer's flight crew training manual (FCTM) is used as an additional supplement to the FCOM, especially for educational purposes. For the flight crew's daily work in the cockpit, the aircraft manufacturer's quick reference handbook (QRH) is additionally available; this contains a synopsis (in the form of checklists) of the FCOM section Normal Procedures, which is relevant in the present case. Both the FCTM and the QRH contain references to the CDM.

The FCOM references the CDM as follows with regard to the use of the QRH: *„AB group: Use of QRH chapters as a guideline: (Refer to CDM/FCOM-PRO-*

*NOR-SOP-AB Group Modification-Use of QRH)."* The referenced location in the CDM stipulates the following:

*„Normally the SOP items are performed by memory. There is no need to use the QRH-Normal Operation chapters to perform the items.* […] *But it is also allowed to use the QRH as a guideline, for example during:*
*- Preliminary Cockpit Preparation*
*- Cockpit Preparation*
*Ensure that all items are completed in the correct sequence."*

The QRH is the only document which the pilots have to hand in paper form. The other documents are available in electronic form on the EFB and are linked via cross-references. This manual therefore contains the following declaration for use of the CDM: *„So there is no need for the flight crews to use this manual directly. Links are implemented in the FCOM and FCTM and guide the flight crew to the corresponding company procedure in this manual."*

Belair stipulates the instructions for use of the EFB in a less paper concept manual (LPC manual).

1.17.1.2 Cockpit preparation

The takeoff performance calculation and the associated FMGS programming takes place as part of the cockpit preparation procedure. In the QRH this process is represented in the form of a checklist. It stipulates the acquisition of airfield data by the PF as the first relevant step.

| PF | PNF |
|---|---|
| * AIRFIELD DATA..........................................................OBTAIN | |

**Figure 4:** Acquisition of airfield data procedure. Excerpt from the cockpit preparation procedure in the QRH.

Airfield data includes information on the runway currently in use and weather data, which together with the information on the aircraft load are required for the takeoff performance calculation.

The next relevant procedure is FMGS data insertion, which is also performed by the PF.

| PF | PNF |
|---|---|
| * FMGS DATA INSERTION:<br>ZFWCG, ZFW, BLOCK FUEL..........................................INSERT<br>TAKEOFF DATA.............................................................INSERT<br>PRESET SPEEDS........................................................AS RQRD | |

**Figure 5:** FMGS data insertion procedure. Excerpt from the cockpit preparation procedure in the QRH.

FMGS data insertion includes entering the aircraft's load data („ZFWCG, ZFW, BLOCK FUEL") and the results of the takeoff performance calculation („TAKEOFF DATA") into the FMGS.

In the event that the information on the aircraft load is not yet available, the FCOM stipulates in the detailed description of the FMGS data insertion procedure that a preliminary input based on estimates is possible: *„If ZFW and ZFWCG are unavailable, it is acceptable to enter the expected values in order to obtain predictions. Similarly, the flight crew may enter the expected fuel on board, if refueling has not been completed at that time."*

During this phase of the cockpit preparation the PNF is usually not in the cockpit but is performing the exterior walk-around. After the PNF returns to the cockpit („*when both pilots are seated*"), he must conduct the following FMGS data confirmation.

| PF | PNF |
|---|---|
| | * FMGS DATA CONFIRMATION: |
| | AIRFIELD DATA........................CONFIRM |
| ATC CLEARANCE.................... | ..........................OBTAIN (CM2) |
| | IRS ALIGN........................CHECK |
| | GROSS WEIGHT INSERTION........................CHECK |
| | TO DATA........................ CHECK |
| | F-PLN A........................CHECK |
| * FUEL QTY ........................CHECK | * ATC CODE........................SET |
| * TAKEOFF BRIEFING........................PERFORM | * FUEL QTY ........................CHECK |

**Figure 6:** FMGS data confirmation procedure. Excerpt from the cockpit preparation procedure in the QRH.

As part of the FMGS data confirmation procedure the PNF checks the previously obtained airfield data and the entries made by the PF. The following detailed description of this procedure from the FCOM is the first time the execution of a takeoff performance calculation is explicitly mentioned: *„The PNF calculates and checks takeoff data."*

**FMGS DATA CONFIRMATION**

Ident.: PRO-NOR-SOP-06-00011253.0001001 / 18 NOV 11
**Applicable to: ALL**

* AIRFIELD DATA........................CONFIRM
* ATC CLEARANCE........................OBTAIN
* IRS ALIGN........................CHECK

*On the POSITION MONITOR page, check that the IRS are in NAV mode, and check that the distance between each IRS and the FMS position is lower than 5 nm. Select ND in ROSE-NAV or ARC mode, and confirm that the aircraft position is consistent with the position of the airport, the SID and the surrounding NAVAIDs.*

* GROSS WEIGHT INSERTION........................ CHECK

*The PNF checks FMGS data.*

* TO DATA........................CALCULATE/CHECK

*The PNF calculates and checks takeoff data.*

* F-PLN A page........................ CHECK

- *Select the EFIS CSTR pushbutton switch on.*
- *Ensure that the inserted F-PLN agrees with planned routes.* Refer to PRO-NOR-SRP-01-10 FMGS Initialization
- *Use the scroll key to check the whole F-PLN thoroughly, using ND in PLAN mode as necessary. Tracks and distances between waypoints are displayed on the second line from the top of the MCDU. SID and EOSID tracks and distances must be checked from the appropriate navigation charts.*
- *Check speed and altitude constraints. Add new speed or altitude constraints if required.*

**Figure 7:** FMGS data confirmation procedure. Detailed description in the FCOM.

Following the FMGS data confirmation procedure, the PF conducts the takeoff briefing, thereby completing the cockpit preparation. The FCOM does not make any reference to the content of the takeoff briefing; these are included in the FCTM and include the recommendation for both flight crew members to cross-check again the FMGS programming: *„The takeoff briefing should be relevant, concise and chronological. When a main parameter is referred to by the PF, both flight crewmembers must crosscheck that the parameter has been set or programmed correctly."*

With regard to the relevant tasksharing between the pilots for the cockpit preparation, the FCOM identifies a regulation which deviates from precisely this manual for the airberlin group:

**INTRODUCTION**

Ident.: PRO-NOR-SOP-06-00011153.0001001 / 20 AUG 12
**Applicable to: ALL**

Items marked by (*) are the only steps to be completed during a transit stop.

Note: *AB group: Tasksharing customized (Refer to CDM/FCOM-PRO-NOR-SOP-AB GROUP MODIFICATIONS-COCKPIT PREPARATION-TASKSHARING).*

The PF and PNF should perform the cockpit preparation according to the panel scan sequence defined below (*Refer to Panel Scan Sequence*), and the task sharing defined in the QRH (*Refer to QRH/Task Sharing for Abnormal/Emergency Procedures*).

**Figure 8:** Note on tasksharing for cockpit preparation in the FCOM

A reference to the regulation which deviates from this can be found in the CDM before the manufacturer's stipulation that tasksharing should be performed in accordance with the QRH. This reveals that the procedures which are allocated to the PNF according to Airbus guidelines are to be performed by the PF on airberlin and Belair aircraft, while on Niki aircraft the procedures allocated to the PF are to be performed by the copilot:

**TASKSHARING**

| airberlin | Belair | Niki |
|---|---|---|
| Performed by PF. | | Items by PF are transferred to CM2. |

**Figure 9:** Note on tasksharing for cockpit preparation in the CDM

According to the operator's statement, figure 9 is to be interpreted so that tasksharing for cockpit preparation for Air Berlin and Belair pilots is done according to the FCOM respectively QRH.

In another addition to the cockpit preparation in the FCOM, the CDM includes the following procedure for LPC cockpit preparation. This stipulates explicitly the execution of a provisional (i.e. based on an estimated load and to be performed by the PF) takeoff performance calculation: *„PRELIMINARY T/O PERF……… COMPUTE and CROSSCHECK"*.

**LPC COCKPIT PREPARATION**

Applicable to: ALL

| PF | PNF |
|---|---|
| AIRFIELD DATA........................................ OBTAIN | |
| ERM CHARTS........................................PREPARE | ERM CHARTS........................................PREPARE |
| **•If loadsheet (W&B) application is used:** | |
| PRELIMINARY LOADING...COMPUTE and CROSSCHECK | |
| PRELIMINARY T/O PERF.. COMPUTE and CROSSCHECK | |
| MCDU ZFWCG/ZFW........................................INSERT | |
| MCDU BLOCKFUEL........................................INSERT | |
| MCDU TAKEOFF DATA..................................INSERT(1) | |
| TAKEOFF BRIEFING (using MCDU).................. PERFORM | TAKEOFF BRIEFING (using departure charts)......... CHECK |

(1) *May be delayed until final load figures received.*

**Figure 10:** Short form of LPC cockpit preparation in the CDM

This procedure does not stipulate the basis upon which the takeoff mass required for this preliminary calculation should be estimated (see Figure 11).

The two subsequent points stipulate the input of estimated load data into the MCDU. According to the detailed description of procedures in the CDM the information from the operational flight plan (OFP) should be used as an estimate.

There is then an instruction for the PF to transfer the results of the preliminary takeoff performance calculation from the EFB (designated in Figure 11 as LPC) into the MCDU together with a note that this transfer may be delayed until the final load figures are received.

**LPC COCKPIT PREPARATION**

Applicable to: ALL

**PRELIMINARY PERFORMANCE DETERMINATION**

The PF computes the preliminary takeoff performance data in accordance with the technical condition of the aircraft and/or any other criteria that may impact the performance data (e.g. NOTAM, runway condition, aircraft configuration).

AIRFIELD DATA........................................OBTAIN | PF

*Obtain airfield data that will be used for preliminary takeoff performance computation.*

ERM CHARTS........................................ PREPARE | BOTH

*Prepare for departure briefing by choosing charts.*

PRELIMINARY TAKEOFF PERF............................ COMPUTE AND CROSSCHECK | PF

*In the TAKEOFF application, enter the parameters in accordance with the estimated departure conditions :*

- *In the panel of the runway computation, enter the runway characteristics. Any NOTAM affecting the airport data should be considered.*

  Note: *In anticipation of a possible runway change, select multiple runways, as applicable in the MULTIPLE RWY panel.*

- *In the CONDITIONS panel, enter the outside conditions (WIND, OAT, QNH, etc ...), check or enter the aircraft TOW (and TOCG for A320 aircraft), and the aircraft configuration (e.g. CONF, anti–ice, air conditioning, etc ...)*
- *For the aircraft status, check or select the MEL/CDL items, if any.*

*Launch the computation and crosscheck the results.*

**<u>FMGS DATA INSERTION</u>**

**GROSS WEIGHT INSERTION (INIT B PAGE)**

MCDU ZFWCG/ZFW ........................................................................INSERT | PF

*If the LOADSHEET (W & B) application is used:*
- *PF inserts the ZFWCG and ZFW as computed on his LPC.*

*If EDP is used:*
- *PF inserts ZFWCG 25 % and ZFW from OFP as default values.*

MCDU BLOCK FUEL........................................................................ INSERT | PF

*Insert the Block Fuel from the OFP calculation.*

**TAKEOFF DATA INSERTION (PERF TAKEOFF PAGE)**

MCDU TAKEOFF DATA....................................................................INSERT | PF

*The PF inserts the takeoff data as computed on his LPC in the PERF TAKEOFF page of the MCDU:*

- *V1, VR, V2, FLEX TO TEMP*
- *FLAPS and THS*

*May be delayed until final load figures received.*

*<u>Note:</u> The PF checks and updates if applicable, the takeoff shift, the THR reduction ALT and the EO acceleration ALT.*

TAKEOFF BRIEFING...............................................................PERFORM/CHECK | BOTH

*The PF performs the takeoff briefing using the MCDU flight plan. The PNF crosschecks the takeoff briefing using the ERM manual or appropriate paper charts.*

**Figure 11:** Detailed description of the LPC cockpit preparation in the CDM

1.17.1.3 Before engine start

The procedure *before pushback or start* in the QRH initially stipulates that the final results of the takeoff performance calculation should be entered into the MCDU and that this entry is to be checked.

| CM1 | CM2 |
|---|---|
| LOADSHEET.................................CHECK | |
| TAKE-OFF DATA.............................ENTER/REVISE (PF) | |
| TAKE-OFF DATA.............................CHECK (PNF) | |
| SEAT BELTS.................................ADJUST | SEAT BELTS.................................ADJUST |
| MCDU .........................................PERF T/O (PF) | |
| MCDU .........................................F-PLN (PNF) | |
| | EXT PWR ....................................CHECK OFF |
| | PUSHBACK/START CLEARANCE..........OBTAIN |
| NW/S DISC..................................CHECK AS RQRD | |
| WINDOW/DOORS..........................CHECK | WINDOW.......................................CHECK |
| RADIO DISABLED SHOWN ON EFB II ..........CHECK | RADIO DISABLED SHOWN ON EFB II ..........CHECK |
| BEACON.......................................ON | |
| SEAT BELTS..................................ON | |
| THR LEVERS.................................IDLE | |
| PARK BRK ACCU PRESS...................CHECK | |
| PARK BRK ....................................AS RQRD | |
| "BEFORE START C/L" | |

**Figure 12:** Before *pushback or start* procedure in the QRH

In this procedure, tasksharing generally takes place not as previously between the PF and the PNF, but between the commander (CM1) and the copilot (CM2). In deviation from this, however, inputting the takeoff data continues to be the task of the PF and checking this step continues to be that of the PNF.

The second and third points of the procedure, which relate to the takeoff performance calculation, are described in detail in the FCOM as follows:

TAKEOFF DATA........................................................................................................ENTER/REVISE

*The PF enters or revises the takeoff data in the INIT B and PERF pages of the MCDU.*

*Note: AB group: Standard flap setting customized (Refer to CDM/FCOM-PRO-NOR-SOP-AB GROUP MODIFICATIONS-BEFORE PUSHBACK OR START-TAKEOFF CONFIGURATION).*

TAKEOFF DATA........................................................................................................ CHECK

*The PNF checks the takeoff speeds and the flexible temperature, using the RTOW charts.*
*The PNF crosschecks the FMS entries of the PF.*
*The flight crew should pay particular attention in determining the takeoff configuration Refer to PER-THR-FLX DEFINITION.*
*Confirm any takeoff weight limitation.*

*Note: AB group: FOVE TASKSHARING customized (Refer to CDM/FCOM-PRO-NOR-SOP-AB GROUP MODIFICATIONS-BEFORE PUSHBACK OR START-FOVE TASKSHARING).*

**Figure 13:** Inputting and checking of the takeoff data in accordance with the FCOM

The final entry in this detailed representation in the FCOM reveals that deviating or supplementary operational procedures for the airberlin group with regard to FOVE tasksharing can be found in the CDM. FOVE (flight operations versatile environment) is the software used on the EFB. This leads to the following table in the CDM:

| airberlin | Belair | Niki |
|---|---|---|
| **FOVE data are calculated and checked according FCOM PRO-SUP-92:** | | |
| - M&B data : PF calculates and PNF cross checks M&B data and calculations. PNF inserts all required data in the consecutive AOC pages. PF confirms values. CM1 crosschecks and signs the loadsheets.<br>- T/O data : FOVE data entries and computations are done by PF and checked by PNF. Computations during taxi are done by CM2. | | - M&B data : CM2 calculates and CM1 cross checks M&B data and calculations. CM2 inserts all required data in the consecutive AOC pages. CM1 confirms values. CM1 crosschecks and signs the loadsheets.<br>- T/O data : FOVE data entries and computations are done by CM2 and checked by CM1. Computations during taxi are done by CM2. |

**Figure 14:** Inputting and checking of the takeoff data according to the CDM

This again stipulates that the takeoff performance calculation should be performed by the PF and cross-checked by the PNF on airberlin and Belair aircraft, but that any recalculations necessary during taxiing due to short-term amendments should be made by the copilot.

The introductory reference to *„FCOM PRO-SUP-92"* refers to the FCOM, which contains only the following instruction at the point referenced:

**INTRODUCTION**

Ident.: PRO-SUP-92-00013583.0001001 / 18 AUG 12
**Applicable to: ALL**

*Note: AB Group: Chapter LESS PAPER IN THE COCKPIT customized (Refer to CDM/FCOM-PRO-SUP-92 LESS PAPER IN THE COCKPIT).*

**Figure 15:** Note regarding operating procedures concerning the takeoff performance calculation which deviate from the FCOM

This note again refers to the CDM, in which the LPC *before pushback or start* procedure, which supplements the *before pushback or start* procedure in the QRH, appears as both a checklist and a detailed description.

| PF | PNF |
|---|---|
| LOADSHEETS........................ | CHECK and SIGN (CM 1) |
| MCDU ZFWCG/ZFW.......................INSERT | MCDU ZFWCG/ZFW..................... CROSSCHECK |
| TAKE OFF DATA.............. PREPARE and CHECK/REVISE | TAKE OFF DATA.......................CROSSCHECK |
| LPC / MCDU GREEN DOT......................COMPARE | LPC / MCDU GREEN DOT.....................COMPARE |

**Figure 16:** Excerpt from the LPC *before pushback or start* procedure in the CDM (as a checklist)

In accordance with this, the loadsheet is initially checked and signed by the commander. The PF then enters the loadsheet information on the mass and centre of gravity of the aircraft into an MCDU. This entry must be checked by the PNF.

If not already performed, the subsequent step involves the PF entering the loadsheet data into the EFB, carrying out the takeoff performance calculation using the EFB, reading the results from the EFB screen, and entering these results into the FMGS using an MCDU keyboard. The CDM describes this procedure as follows: *„If the final conditions have not changed, verify and confirm the preliminary takeoff data are still valid. If the takeoff conditions have changed the PF recomputes the takeoff data, using the TAKEOFF application on his LPC."*

This step must also be checked by the PNF in accordance with the following instruction in the CDM: *„The PNF crosschecks the takeoff data entered by the PF on the MCDU INIT B and PERF TAKEOFF pages with the data on the LPC."*

In the last step, the flight crew compares the green dot speed, which is dependent on the aircraft mass and is calculated from the on-board FMGS, with the value determined by the EFB. If the values are different, this would indicate that the calculations in these two systems had been performed with different aircraft masses.

The comparison of the green dot speeds is the final step in the LPC *before pushback or start* procedure in the CDM. Before starting the engines, however, it is necessary to take into account the *before pushback or start* procedure in the QRH respectively FCOM, which is supplemented by this (see Figure 12). The last item in this procedure includes the commander's command *„BEFORE START C/L"*, which prompts the copilot to work through this checklist. This checklist can be found both on the back cover of the QRH as well as on the pilot's sliding tables and in unmodified form in the CDM:

| BEFORE START | |
|---|---|
| Applicable to: ALL | |
| GEAR PINS and COVERS.................... | REMOVED |
| SIGNS.................... | ON/AUTO |
| FUEL QUANTITY.................... | _____ KG (BOTH) |
| ALTIMETERS.................... | QNH____/_____FEET (BOTH) |
| T/O DATA.................... | INSERTED, V1_____V2_____ (BOTH) |
| BEACON.................... | ON |
| PARKING BRAKE.................... | AS RQRD |

**Figure 17:** *Before start* checklist in the CDM

The *before start* checklist includes the item *"T/O DATA"*, the explicit purpose of which is to prompt both flight crew members to cross-check the input of the take-off data into the FMGS again.

Chapter 8.3.19.1.2 of the Belair OM A also makes the following reference to the necessary cross-checking by the other flight crew member of entries with a bearing on safety made on the FMGS: *„For flight safety reasons critical flight crew actions require a cross check. Critical flight crew actions in this respect are for example* […] *performance calculations, including AFS/FMS entries.”*

1.17.1.4 After engine start

The *engine start* and *after start* procedures, which according to the QRH respectively FCOM should follow the cockpit preparation do not include any steps which affect the takeoff data.

The last step in the *after start* procedure is to read through the *after start* checklist on the back of the QRH. This checklist does not make any reference to checking takeoff data either.

1.17.1.5 During taxi to the takeoff runway

According to Belair's procedures, the commander (CM1) should always control the aircraft while taxiing, regardless of whether he is PF or PNF for the entire flight. The taxi procedure, which is to be performed while taxiing to takeoff, stipulates that the copilot should check whether the programming of the FMGS is still in accordance with the current clearance issued by air traffic control. The QRH describes this check as follows:

| CM1 | CM2 |
|---|---|
| BRAKES........CHECK | |
| **• ATC clearance obtained:** | |
| | ATC CLEARANCE........CONFIRM |
| | TO DATA........REVISE IF RQRD |
| | FMGS F-PLAN/SPD........CHECK |
| | FCU ALT/HDG........SET |
| | BOTH FD........CHECK ON |
| FLT INST&FMA........CHECK | FLT INST&FMA........CHECK |

**Figure 18:** Excerpt from the taxi procedure in the QRH

This includes checking the takeoff data *„if required”*. In the detailed description of the procedure in the FCOM, this condition is stipulated as follows: *„if takeoff data has changed,* or *in case of a runway change”:*

Ident.: PRO-NOR-SOP-10-A-00010248.0001001 / 18 AUG 10
**Applicable to: ALL**

**TAKEOFF DATA/CONDITIONS**

If takeoff data has changed, or in case of a runway change, prepare updated takeoff data, as appropriate:

F-PLN (Runway)........REVISE
FLAPS lever........AS APPROPRIATE

*Select takeoff position.*

V1, VR, V2........REINSERT
FLX TO temperature........REINSERT

**Figure 19:** Excerpt from the taxi procedure in the FCOM

As a supplement to the QRH, the FCOM includes the following instruction to review the takeoff briefing together with a reference to the CDM:

Ident.: PRO-NOR-SOP-10-A-00010267.0001001 / 20 AUG 12
**Applicable to: ALL**

TAKEOFF BRIEFING.......................................................................CONFIRM

L3 Note: *AB group: Content of Briefing customized (Refer to CDM/FCOM-PRO-NOR-SOP-AB GROUP MODIFICATIONS-TAXI-TAKE OFF BRIEFING).*

**Figure 20:** FCOM instruction to review the takeoff briefing while taxiing

Although the FCOM does not include detailed instructions on how to review the takeoff briefing, the referenced point in the CDM stipulates that any amendment to the intended takeoff runway requires the takeoff briefing to be adjusted.

**TAKEOFF BRIEFING**

| airberlin | Belair | Niki |
|---|---|---|
| Changes to the previous briefing are to be confirmed before T/O. Examples:<br>- RWY<br>- SID<br>- RWY condition | | |

**Figure 21:** CDM instruction to check the takeoff briefing while taxiing

According to Belair, the procedures to be performed while taxiing (including checking the takeoff briefing) should be performed by the two pilots in silence; this is based on the principle of sterile cockpit procedure described in chapter 8.3.19.1.1 of the OM A:

*„Sterile Flight Deck procedures dictate that only essential flight deck work be performed during all ground operations involving taxi, takeoff and landing (...) thus allowing the flight deck crew to concentrate on traffic and flying the aeroplane."*

1.17.1.6 During line up

According to the QRH, the procedure to be applied while lining up includes that both pilots are checking whether they have lined up on the correct runway.

| CM1 | CM2 |
|---|---|
| TAKEOFF RUNWAY.......CONFIRM | |
| SLIDING TABLE.......STOW | SLIDING TABLE.......STOW |
| "PACKS OFF" (if required).......ANNOUNCE | PACKS 1+2.......OFF |
| "TAKE-OFF CHECK".......ANNOUNCE | NO SMOKING SIGN.......CYCLE OFF/AUTO |
| | "TAKE-OFF ALL GREEN".......ANNOUNCE |
| | "PACKS OFF" (if required).......ANNOUNCE |
| "TAKE-OFF ALL GREEN".......ANNOUNCE | |
| "PACKS OFF" (if required).......ANNOUNCE | |

**Figure 22:** Excerpt from the *before takeoff* procedure in the QRH

The FCOM describes this check in detail as follows:

Ident.: PRO-NOR-SOP-11-A-00010393.0001001 / 16 MAR 11

TAKEOFF RUNWAY....................................................................................................CONFIRM

*Confirm that the line up is performed on the intended runway. Useful aids are:*
- *The runway markings,*
- *The runway lights,*
  *Be careful that in low visibility, edge lights could be mixed up with the center line lights.*
- *The ILS signal,*
  *If the runway is ILS equipped, the flight crew can press the ILS pb (or LS pb): The LOC deviation should be centered after line up.*
- *The runway symbol on the ND,*
- *The Runway Awareness and Advisory System .*

**Figure 23:** Excerpt from the *before takeoff* procedure in the FCOM

## 1.18 Additional information

### 1.18.1 Information regarding takeoff distance calculation

The following table presents the results of the takeoff performance calculations as performed by the flight crew for a full-length takeoff and an intersection take-off. The calculation is based on a takeoff mass of 63.0 tons.

In the case of a full-length takeoff, the takeoff power of the engines is set at the minimum possible which allows a sufficient angle of climb in the event of engine failure at decision speed and a continued takeoff. The 2nd segment gradient, which should be a minimum of 2.4%, is the limiting factor here.

In the case of an intersection takeoff, the takeoff power of the engines is set at the minimum possible in order to allow the aircraft to come to a standstill before the runway end in the event of engine failure at decision speed and a rejected takeoff. The stop margin is the limiting factor here.

| | *Full length takeoff* | *Intersection takeoff* |
|---|---|---|
| *accelerate stop distance* (ASD) | 2394 m | 1875 m |
| *stop margin* | 1057 m | 1 m |
| *takeoff run* (TOR) | 2076 m | 1618 m |
| *takeoff distance* (TOD) | 2463 m | 1841 m |
| *2nd segment gradient* | 2.80 % | 4.47 % |
| *flex temperature* | 62 °C | 49 °C |

Reducing the takeoff power of the engines below the maximum possible value is designed to minimise the temperature in the engine turbines and consequently engine wear. It is achieved by specifying an increased outside air temperature (flex temperature) for the FGMS in order to calculate the engine power.

Calculating the ASD, TOR and TOD distances with the help of the EFB is based on the assumption that the outside air temperature corresponds to the specified flex temperature. Because the effective outside air temperature is lower, this distance information contains a hidden safety margin. It is not possible for either the crew or the operator to quantify this safety margin. Such a quantification is not the subject of the present investigation.

### 1.19 Useful or effective investigation techniques

Not affected.

# 2 Analysis

## 2.1 Technical aspects

There are no indications of any pre-existing technical defects which might have caused or influenced the serious incident.

## 2.2 Human and operational aspects

### 2.2.1 Flight crew

The commander performed the cockpit preparation preliminary performance determination according to the corresponding operating procedures (see Figure 11). However, it was no longer possible to determine how the commander came to the figure of 66.8 tons as the estimate of the takeoff mass required for this determination. A mass that was clearly above the value of 63.3 tons noted in the operational flight plan (OFP). Since the maximum power would have been used for an intersection takeoff the flight crew planned a full-length takeoff in order to protect the engines.

The procedures to be applied during cockpit preparation are designed to ensure that the takeoff data calculated on the EFB is consistent with both the takeoff data programmed on the FMGS and the intentions of both pilots. This was the case until the takeoff briefing for a full-length takeoff, during which the commander announced to the copilot the prospect of a change of his intention provided that the takeoff mass of 62.8 tons according to the load sheet would allow to do an intersection takeoff.

In accordance with his declaration of intent, the commander calculated the necessary takeoff data for an intersection takeoff. The calculation confirmed that an intersection takeoff was possible with reduced engine power. After the commander and the copilot had agreed on an intersection takeoff and the copilot had checked the recalculation of the takeoff data, the copilot remained convinced until takeoff that the new calculated takeoff data were correctly inserted in the FMGS by the commander.

The commander, however, remained certain that the reprogramming of the takeoff data was still pending when he was distracted by the handling agent because of a missing passenger. He therefore wrote the recalculated takeoff data on a piece of paper. The decision to interrupt his work and leave the cockpit at this stage was not appropriate to the situation and facilitated the occurrence of the present serious incident.

By recording the intersection takeoff data on a piece of paper the commander broke his habit of programming the conservative case (in this case the intersection takeoff data) and recording the full-length takeoff data on a piece of paper. This made it possible after the distraction for the commander to regard the piece of paper as confirmation that the takeoff data for an intersection takeoff had been programmed in accordance with his usual habit.

The *before pushback or start* procedure stipulates that the final takeoff data is first entered by the commander. The copilot must then check these entries, whereby the procedure explicitly requires that the programmed takeoff data is checked (see Figure 13 and 16). Because neither the entry nor the check were performed in accordance with this provision, it was not possible by the flight crew to discover that the takeoff data were incorrectly programmed.

The last step in this same *before pushback or start* procedure is to work through the *before start* checklist, which includes both pilots cross-checking the takeoff data again (see Figure 17). Even using this checklist, the two pilots failed to notice that the programmed takeoff data did not correspond to the calculated takeoff data on the commander's EFB.

The following factors may have contributed to the incomplete application of the *before pushback or start* procedure:

- the commander's inappropriate and unusual use of a piece of paper to record the calculated takeoff data;
- the copilot's biased assumption that the takeoff data which the commander had recently calculated were correctly programmed in the FMGS;
- the one-off careless execution of a check, probably due to the frequency of the checks prescribed in the entire process;
- the time pressure caused by the delay;
- process-related factors (see chapter 2.2.2).

The taxi procedure stipulates that the copilot should check the takeoff data while taxiing to the takeoff runway (see Figure 18). As this check is stipulated only as *„if required"* and the copilot was convinced that the takeoff data had been correctly programmed, it is logical that the copilot did not notice the error. The takeoff briefing must also be checked while taxiing (see Figure 20). The error did not become apparent during this check either, since neither pilot regarded the imminent intersection takeoff as reason to change their intention anymore and therefore an adjustment of their takeoff briefing seemed not to be necessary. The stipulation that checks should be performed silently while taxiing may have contributed to this.

While lining up, the flight crew must, as part of the *before takeoff* procedure, check whether the aircraft is *„on the intended runway"* (see Figure 23). Although this procedure could have served as a reminder of the delayed programming of the correct takeoff data, there is no check stipulated to ensure the correct intersection or the available runway length.

### 2.2.2 Operator

The procedures to be taken into account by flight crews can be found in several different manuals, allowing for a comprehensive system of cross referencing. The operator's adjustments to the generally applicable manufacturer's guidelines are also divided among different sources. The relevant procedures are therefore not user-friendly presented.

Cockpit preparation must basically be in accordance with the QRH. It was done by the crew according to the procedures and completed with regard to a full length takeoff. Only afterwards the decision was made for an intersection takeoff and therefore uncomplete execution of the steps required by the cockpit preparation procedure remained undetected.

The *before pushback or start* procedure again includes entering and checking the takeoff data, as well as working through a written checklist for the first time in the entire procedure. This checklist includes only seven points, one of which is checking the takeoff data (see Figure 17). In addition to the human factors mentioned in chapter 2.2.1, the following procedural factors may have contributed to the fact that even the use of this checklist did not lead to the discovery that the programmed takeoff data were incorrect:

- The formulations *„TAKEOFF DATA...ENTER / REVISE"* in the operating procedures and *„TAKEOFF DATA...INSERTED"* in the checklist do not explicitly include checking data which has already been entered. Obviousy only checks were made whether the takeoff data has been programmed and not which takeoff data has been programmed.

- The fact that entering and checking the takeoff data was subject to tasksharing between the PF and PNF and therefore varied from flight to flight.

The taxi procedure includes the steps to be taken in the event that the takeoff data or the intended takeoff runway is changed (see Figure 19). As the copilot believed that the intersection takeoff data had already been programmed and the condition *„if required"* was therefore not fulfilled, he did not conduct these steps. The commander had no influence on this, because the copilot must complete the taxi procedure alone and in silence.

The stipulation that the takeoff data check and takeoff briefing check should be performed in silence while taxiing is an inappropriately narrow interpretation of the sterile cockpit procedure. A „closed loop" between the pilots, which allows an incorrect assumption by one pilot to be identified and corrected by the other, is silent not possible. Furthermore, it remains unclear whether the check has taken place or has been forgotten.

# 3 Conclusions

## 3.1 Findings

### 3.1.1 Technical aspects

- The aircraft was licensed for VFR and IFR transport.
- Both the mass and centre of gravity of the aircraft were within the permitted limits according to the AFM at the time of the serious incident.
- The investigation produced no indications of any pre-existing technical faults which might have caused or influenced the serious incident.

### 3.1.2 Crew

- The pilots were in possession of the necessary licences for the flight.
- There are no indications of the pilots suffering from health problems during the flight involved in the serious incident.

### 3.1.3 History of the serious incident

- At 15:15 UTC the commander calculated the necessary engine power for takeoff based on his takeoff mass estimate of 66.8 tons.
- The calculation indicated that a takeoff from the intersection Foxtrot was only possible with maximum engine power. The commander therefore decided to use the entire runway length of 3400 m for the takeoff (full-length takeoff).
- After receiving the loadsheet, which indicated a takeoff mass of 62.8 tons, at 15:20 UTC the commander recalculated the necessary engine power for a full-length takeoff and programmed the flight management and guidance system (FMGS) accordingly.
- The crew then conducted the takeoff briefing for a full-length takeoff.
- When it emerged that the takeoff mass was lower than initially estimated, the commander considered an intersection takeoff from the intersection Foxtrot. A runway length of 1900 m was available from this intersection.
- At 15:25 UTC the commander calculated the necessary engine power for an intersection takeoff. The copilot checked the calculation and the commander recorded the results on a piece of paper.
- The copilot assumed that the commander had entered the recently calculated data into the FMGS.
- However, the commander had postponed the reprogramming of the FMGS for an intersection takeoff until later as he left the cockpit because of a missing passenger.
- The commander returned to the flight deck approximately 10 minutes later. Shortly thereafter, the crew received clearance to push back the aircraft and start the engines. The task of reprogramming the FMGS, which had previously been postponed, was no longer performed.
- At 15:36 UTC the aircraft pushback began.
- While taxiing to the takeoff runway, the flight crew requested from air traffic control clearance to takeoff from the intersection Foxtrot.

- The crew answered air traffic control's question as to whether the flight crew was prepared for an immediate takeoff from the intersection Foxtrot in the affirmative.
- At 15:43 UTC the flight crew initiated a takeoff roll from the intersection Foxtrot with an engine power which had been calculated for a takeoff from the beginning of the runway (full-length takeoff).
- During the takeoff roll, both pilots made the observation that the remaining length of the runway was unusually short.
- No use was made of the possibility to use the throttles to increase the engine power to the maximum level during takeoff roll.
- The plane took off 350 m before the end of the runway. The aircraft passed the end of the runway at a height of 104 ft.

3.1.4 General conditions

- The relevant procedures for calculating, programming and checking the takeoff data are divided among various publications.
- The before start checklist includes checking the input of the takeoff data in the form of the instruction *„takeoff data...inserted”*. This instruction does not explicitly include checking which takeoff data has been entered.
- The procedures stipulate that the copilot cross-check the takeoff data while taxiing only *„if required”.*
- The copilot should perform the checks, including the *„takeoff briefing...confirm”* check, silently during taxiing.
- Flight preparations took place under time pressure and were interrupted by external circumstances.
- The weather conditions had no influence on the serious incident.

## 3.2 Causes

The serious incident is attributable to the fact that the aircraft did not reach the necessary flight performance on takeoff, because the flight crew performed the takeoff from a runway intersection with an engine power which had been calculated for the entire length of the runway.

The following factors contributed to the serious incident:

- the fact that the commander was distracted by external circumstances during takeoff preparations;
- the uncomplete examination of the takeoff data within the frame of the "before start” checklist;
- procedures which stipulated individual checks only *„if required”*;
- the fact that essential checks were performed in silence.

# 4 Safety recommendations, safey advices and measures taken since the serious incident

## 4.1 Safety recommendations

None

## 4.2 Safety advices

None

## 4.3 Measures taken since the serious incident

On 24 October 2013 the operator amended the procedures to stipulate that the PNF must perform an additional and independent takeoff performance calculation. The operator had already decided on this amendment at the time of the serious incident, but had not yet published it. The corresponding instruction to the pilots was as follows:

*"Effective immediately the takeoff performance calculation procedure has changed: Final takeoff performance calculations performed by the PF must be crosschecked by the PNF with an independent calculation of the performance figures on the PNF's EFB before being entered into the PERF page of the MCDU. This procedure is in line with Airbus SOP* [standard operating procedures] *and reduces the risk of a takeoff based on wrong performance figures."*

Furthermore, the operator reported that the company data manual (CDM) had been abolished as it had been possible to integrate the relevant information into the flight crew operating manual (FCOM) after the introduction of new software.

The operator also stated the *before takeoff* procedure (see Figure 22) had been adjusted. With their call *„takeoff all green"* both pilots now confirm they have examined silently additional points from memory. This points appear as a final remark in the procedure description as follows:

*„CAUTION: With the response 'TAKEOFF ALL GREEN' the crew member confirms that:*

1. *Packs switching according to takeoff calculation.*
2. *Altitude in the FCU window.*
3. *Flex setting on upper ECAM DU.*
4. *T/O memo 'ALL GREEN'.*
5. *Flaps indication on lower ECAM corresponds to the calculated T/O flaps setting, entered on the MCDU PERF page.*
6. *RWY entered in the MCDU."*

Payerne, 21 August 2015 Investigation Bureau STSB

*This final report was approved by the Board of the Swiss Transportation Safety Investigation Board STSB (Art. 10 lit. h of the Ordinance on the Safety Investigation of Transportation Incidents of 17 December 2014).*

*Berne, 13. August 2015*

## List of abbreviations

| | |
|---|---|
| AB | Air Berlin |
| AFM | Aircraft Flight Manual |
| AFS | Auto Flight System |
| ASD | Accelerate Stop Distance |
| ASDA | Accelerate Stop Distance Available |
| ATPL | Airline Transport Pilot Licence |
| C/L | Checklist |
| CDM | Company Data Manual |
| CEST | Central European Summer Time |
| CM1 | Crew member 1 (left seat) |
| CM2 | Crew member 2 (right seat) |
| DU | Display Unit |
| EASA | European Aviation Safety Agency |
| ECAM | Electronic Centralised Aircraft Monitoring |
| EFB | Electronic Flight Bag |
| FCOM | Flight Crew Operating Manual |
| FCTM | Flight Crew Training Manual |
| FCU | Flight Control Unit |
| FMGC | Flight Management and Guidance Computer |
| FMGS | Flight Management and Guidance System |
| FMS | Flight Management System |
| FOVE | Flight Operations Versatile Environment |
| IFR | Instrument Flight Rules |
| LDA | Landing Distance Available |
| LPC | Less Paper Concept |
| LT | Local Time |
| MCDU | Multipurpose Control and Display Unit |
| OFP | Operational Flight Plan |
| OM | Operations Manual |
| PERF | Performance |
| PF | Pilot Flying |
| PNF | Pilot not Flying |
| QRH | Quick Reference Handbook |
| RWY | Runway |
| SOP | Standard Operating Procedures |
| T/O | Takeoff |
| TOD | Takeoff Distance |
| TODA | Takeoff Distance Available |
| TOR | Takeoff Run |
| TORA | Takeoff Run Available |
| UTC | Universal Coordinated Time |
| V1 | Decision Speed |
| V2 | Takeoff Safety Speed |
| VFR | Visual Flight Rules |
| VR | Rotation Speed |
| WGS 84 | World Geodetic System 1984 |
| ZFW | Zero Fuel Weight |
| ZFWCG | Zero Fuel Weight Centre of Gravity |