BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

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SAFETY INVESTIGATION REPORT

Incident to the ATR72-212A registered F-HBCM operated by Chalair Aviation on Saturday 21 September 2024 on Caen-Carpiquet airport

Time	Around 08:20[1]
Type of flight	Passenger commercial air transport
Persons on board	Captain (PF[2]), co-pilot (PM); two cabin crew, thirteen passengers
Consequences and damage	None
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.	

Take-off with an erroneous centre of gravity

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on statements.

While preparing the passenger commercial air transport flight between Caen airport and Kerry airport (Ireland), there were discussions between the station agents and the crew concerning the final update to the aeroplane's weight and balance sheet. The Caen airport traffic agents started passenger boarding and then carried out various updates to the preparation software. These modifications led to a passenger seat allocation proposed by the software that was different to the actual on-board situation. This new passenger seat allocation leading to a centre of gravity that was too far aft based on the information entered in the software, led to two passengers being moved from row 8 to row 3.

The crew took off at around 08:20 on runway 31. The captain felt that the flight controls were heavy during the rotation and observed after trimming the aeroplane, that the trim indicated 2.2 UP instead of the 1.2 UP calculated when preparing the flight and recorded on his weight and balance sheet. He then contacted the nominated ground operations manager at Chalair Aviation and asked him to check. The latter, in coordination with the Operations Control Centre (OCC), understood that an error had been made with respect to the dry operating index. The OCC transmitted the corrective action to the crew via the air control services of the destination airport: this action, carried out during the approach, consisted of moving six passengers sat in the forward area to the rear area of the cabin. The aeroplane landed without further difficulty.

[1] Except where otherwise indicated, the times in this report are in local time.
[2] The glossary of abbreviations and acronyms frequently used by the BEA can be found on its web site.

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2 ADDITIONAL INFORMATION

2.1 Personnel information

2.1.1 Flight crew

	Captain	Co-pilot
	Male, aged 52	Male, aged 22
Licence	Valid ATPL (A) obtained on 24 November 2011, along with a valid class 1 medical fitness certificate	Valid CPL (A) obtained on 11 May 2022, along with a valid class 1 medical fitness certificate
Ratings	IR ME ATR42/72, IR/PBN	IR ME ATR42/72, IR/PBN
Total experience (h)	12,690	910
Experience on type (h)	8,710 on the ATR	667 on the ATR

	Purser	Cabin crew
	Female, aged 32	Female, aged 27
Licence	CCA obtained on 9 December 2020	CCA obtained on 12 September 2023
Ratings	ATR42/72	ATR42/72
Initial training (date)	May 2023 Qualified for ATR42:7 June 2023 Qualified for ATR72:9 June 2023 Qualified as purser: 7 June 2023	October 2023 Qualified for ATR42: 10 January 2024 Qualified for ATR72: 1 Feb 2024
Total experience (h)	1,151	300
Experience on type (h)	388	85

2.1.2 Station personnel

The initial theoretical training of a traffic agent consists of the acquisition of knowledge and operational skills in order to plan the loading, check documents and coordinate activities when handling an aircraft on stopover, in accordance with the IATA “Load control AHM 590” procedure.

	Supervisor (Aeroplane zone manager)	Traffic agent
	Male, aged 39	Female, aged 28
Recruited by Caen airport (date)	1 September 2007	1 October 2019
Initial theoretical training (date) as traffic agent	10 March 2016	27 March 2023
Theoretical training, recurrent training (date) as traffic agent	15 May 2023	----------

The traffic agent started her shift at 06:00 in the morning of the incident (wake-up 04:45). It was the fifth and last day of an early-rise cycle. She specified that she had not felt particularly tired the morning of the incident.

The supervisor wanted to optimize the handling of the aeroplane so that it would leave on time despite its late arrival. To do this, he anticipated passenger boarding, went back and forth between the operations room and the aeroplane and simultaneously dealt with the catering.

2.2 Organisational and management information

2.2.1 Chalair Aviation procedures

The Load and Trim Sheet (LTS) can be generated by computer or manually. The computer-generated LTS is privileged by the operator. The LTS can be drawn up by the crew, the OCC or the station handling service. The Chalair Aviation OCC fills in the information for one line, for the season, by allocating an aeroplane by default in the software. According to the planned division of tasks, the station handling service can access it via an internet link in order to make modifications with respect to the day's flight. The completed document (containing useful information for the operational flight plan) is then handed to the captain who can ask the OCC or the station handling service to take into account corrections in order to obtain the definitive LTS.

Corrections to the Dry Operating Weight (DOW) and Dry Operating Index (DOI)[3] can be made manually by the captain on the document sent by the station. These corrections are then updated in the preparation software by the station agent. The finalized LTS is handed to the captain who is responsible for accepting it.

Chalair Aviation operates the ATR42-500, the ATR72-500 and the B1900 D. The ATR DOIs are all negative whereas the DOI for the B1900D is positive and around 20.

2.2.2 Caen-Carpiquet airport - Air operations

The Chalair Aviation OCC calculates the weight and balance for the aircraft in its fleet at the majority of its stations. In June 2024, Chalair Aviation delegated this task for the Caen-Kerry and Caen-Southampton lines to the station handling service at Caen-Carpiquet airport.

Chalair Aviation, which uses the software iPort DCS, proposed this software to the station handling service at Caen-Carpiquet airport and trained the supervisor. The supervisor indicated that he was in charge of the training of the traffic agents and that all the agents had followed the training. However, they had not had a lot of practical experience given that there is only one flight a week and the summer period in which the agents were on holiday. The agents explained that they had been given heterogeneous, non-standardized training on the use and specificities of the software. The knowledge acquired was not checked at the end of the training.

2.2.3 iPort DCS detailed information

The software, iPort DCS (*Departure Control System*) is an operations management software used in the aviation industry. It is a means of having centralized and automatic management of several handling of passengers and flight preparation aspects, notably, check-in of passengers and baggage, assignment of seats according to the configuration of the aeroplane, optimization of the loading, calculation of the weight and balance as well as the generation of flight documents including the LTS.

[3] Dry Operating Index: this index corresponds to the aeroplane equipped with the fixed elements required to carry out the given flight, including the crew and their baggage. It is used to determine the centre of gravity of the aeroplane with the help of a weight and balance chart.

2.3 Aircraft information

2.3.1 History of operations on the day of the incident

The flight file for this route was set up for the season by the Chalair Aviation OCC by assigning the ATR 72-500 registered F-HAPL by default. On the day of the incident, the operator was using the ATR 72-500 registered F-HBCM for this flight.

The Caen station traffic agent accessed iPort and entered the load information. She printed the document and then handed it over to the purser to give it to the captain. Passenger check-in started at 06:30.

The captain corrected the dry operating weight and index on the document in order to take into account an additional piece of crew baggage and then returned it to the station handling service so that it could produce the definitive version of the LTS.

The supervisor orally transmitted the corrected index value to the traffic agent who positioned the cursor on the DOI field and wrote over the data that was present by entering 15.5 instead of -15.5[4]. The traffic agent cannot remember if she heard the “minus” sign during their exchange.

The supervisor anticipated boarding due to the small number of passengers and went to the gate between 07:00 and 07:30.

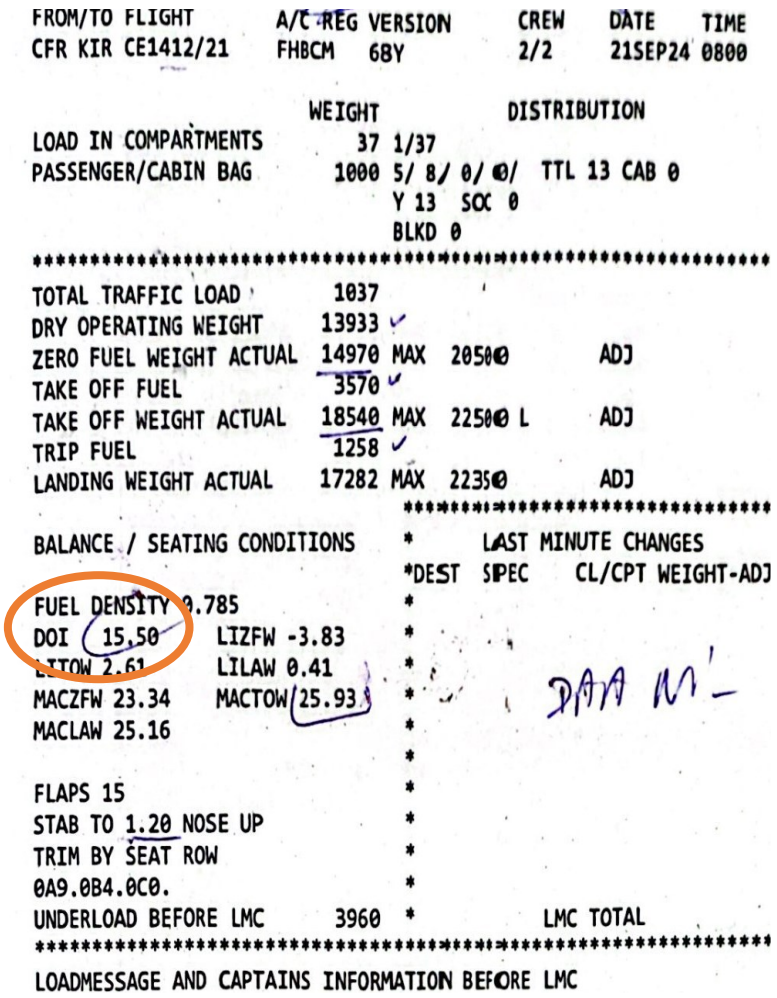
On validating the LTS, the traffic agent noticed that the registration of the aeroplane was not available in the saved list and added it. This correction imposed the re-organization of the passenger seating plan. During this action, the seats randomly assigned by iPort were no longer consistent with the actual situation. The supervisor returned on board the aeroplane to determine the exact position of the passengers and transmitted the information to the traffic agent. This seat allocation, manually entered in iPort, with an erroneous DOI value, led to a centre of gravity that was too far aft. For this reason, two passengers were moved from the rear to the front of the cabin.

The supervisor handed over the definitive LTS to the captain who did not notice the sign error. He validated it and handed back a copy to the supervisor.

The purser indicated that the supervisor asked her to move the passengers after boarding. Two passengers were moved to the front of the cabin.

The cabin crew member who had counted the passengers found that the passenger seat allocation was unusual given the small number of passengers on board. They were mainly sat in the centre and front of the cabin. She called the purser’s attention to this. The purser replied that this seat allocation had been validated by the pilots and she thus stopped questioning it.

[4] In this occurrence, the dry operating index indicated by the captain was -15.5 but the “minus” sign was omitted when the handling agent entered the data.



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FROM/TO FLIGHT      A/C REG VERSION     CREW    DATE    TIME
CFR KIR CE1412/21   FHBCM   68Y         2/2     21SEP24 0800

                    WEIGHT          DISTRIBUTION
LOAD IN COMPARTMENTS      37 1/37
PASSENGER/CABIN BAG     1000 5/ 8/ 0/ 0/  TTL 13 CAB 0
                             Y 13  SOC 0
                             BLKD 0
**********************************************************************
TOTAL TRAFFIC LOAD        1037
DRY OPERATING WEIGHT     13933 ✓
ZERO FUEL WEIGHT ACTUAL  14970 MAX  20500        ADJ
TAKE OFF FUEL             3570 ✓
TAKE OFF WEIGHT ACTUAL   18540 MAX  22500 L      ADJ
TRIP FUEL                 1258 ✓
LANDING WEIGHT ACTUAL    17282 MAX  22350        ADJ
                               ********************************
BALANCE / SEATING CONDITIONS   *      LAST MINUTE CHANGES
                               *DEST  SPEC    CL/CPT WEIGHT-ADJ
FUEL DENSITY 0.785             *
DOI  15.50      LIZFW -3.83    *
LITOW 2.61      LILAW 0.41     *
MACZFW 23.34    MACTOW 25.93   *
MACLAW 25.16                   *
                               *
FLAPS 15                       *
STAB TO 1.20 NOSE UP           *
TRIM BY SEAT ROW               *
0A9.0B4.0C0.                   *
UNDERLOAD BEFORE LMC      3960 *          LMC TOTAL
**********************************************************************
LOADMESSAGE AND CAPTAINS INFORMATION BEFORE LMC
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Figure 1: load and trim sheet (source: Chalair)

The captain indicated that he took off from runway 31 with a weight of 18,540 kg, with a calculated decision and rotation speed (V1/Vr) of 104 kt. The action on the control column required an abnormally high force. The simultaneous action on the trim resulted in the value of 2.2 UP instead of the 1.2 UP calculated on the load and trim sheet. He added that he immediately contacted the nominated ground operations manager to find out the reason for this. He suspected an error in entering the DOI in the weight and balance calculation software.

The nominated ground operations manager indicated that he received an SMS message from the captain, after taking off, informing him of the sensation of a “heavy nose” when taking off and asked him to check with the OCC where this error could have come from.

After checking the weight and balance sheet issued by the assistant via the iPort DCS, he replied by SMS that he was to move six passengers from the front to the rear of the cabin. As he was no longer in contact with the captain, he sent the information via Shannon approach and Kerry control.

2.3.2 Simulations

Chalair estimated that the centre of gravity value was 15.9 % MAC on taking off from Caen - Carpiquet airport during the incident flight. This value was outside the operational limits (see Figure 2 and Figure 3) but was within the certified weight and balance envelope for take-off and landing.

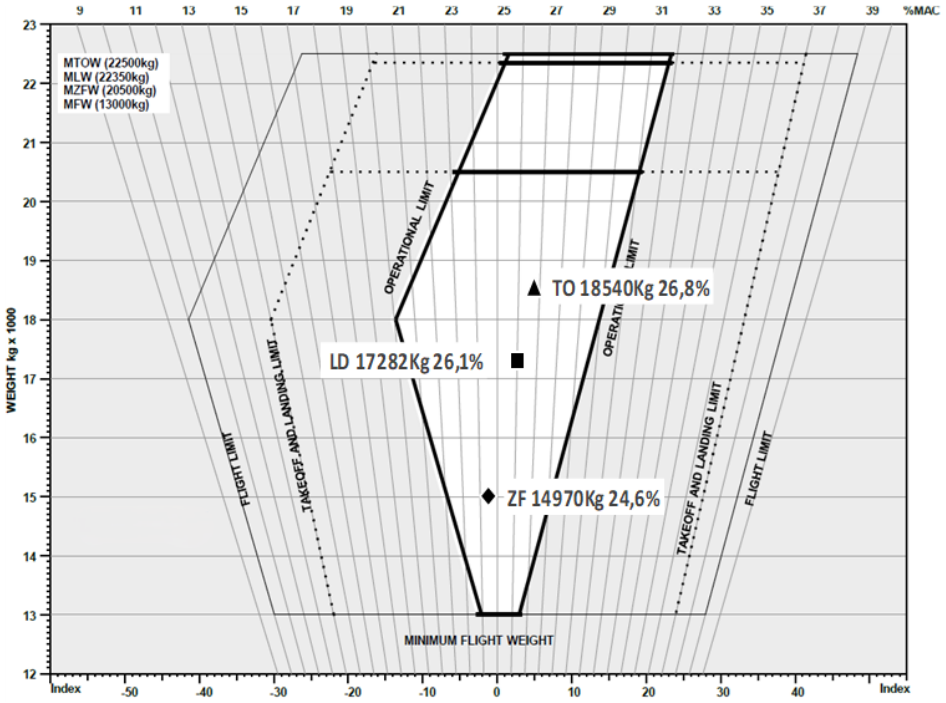

Figure 2: weight and balance chart with a DOI of 15.5, as entered by the station agent for the incident flight, implying a certain passenger seat allocation in the cabin (source: Chalair)

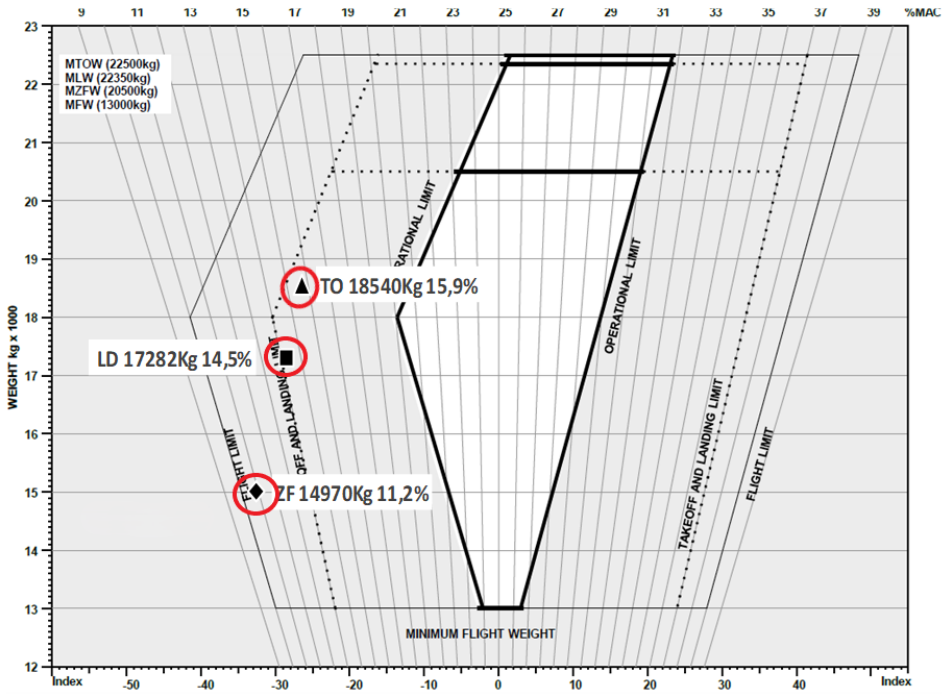

Figure 3: weight and balance chart with a DOI of -15.5 with an identical passenger seat allocation in the cabin (source: Chalair)

Two simulations were carried out for a take-off weight of 18,540 kg corresponding to the estimated weight in the incident.

- The first simulation showed that an additional difference of 1.1% MAC with respect to the centre of gravity for the incident flight would have meant that the aeroplane was outside the weight and balance envelope for take-off and landing. This limit would have been exceeded on transferring a weight of 50 kg from zone C to zone A, 110 kg from zone C to zone B or 90 kg from zone B to zone A. On taking a standard passenger weight of 88 kg, this corresponds to moving **one** passenger from zone C to zone A, **two** passengers from zone C to zone B or **two** passengers from zone B to zone A.
- The aim of the second simulation was to quantify the variation in force for the same pitch rate (taking a nose-up attitude) between an aeroplane with a centre of gravity of 26% MAC (middle of weight and balance chart) and an aeroplane with a centre of gravity of 14.8% MAC (limit[5] of certified weight and balance envelope for take-off and landing). For the same pitch rate, a variation in the centre of gravity of 11% towards the forward limit requires an additional force of 12 daN.

These simulations show that, based on a sign error in the DOI, it was not improbable for the crew to find themselves in a situation where they were outside the centre of gravity envelope and outside the certified take-off and landing envelope which could lead to difficulties in controlling the flight path. Moving a small number of passengers can lead to this unwanted situation.

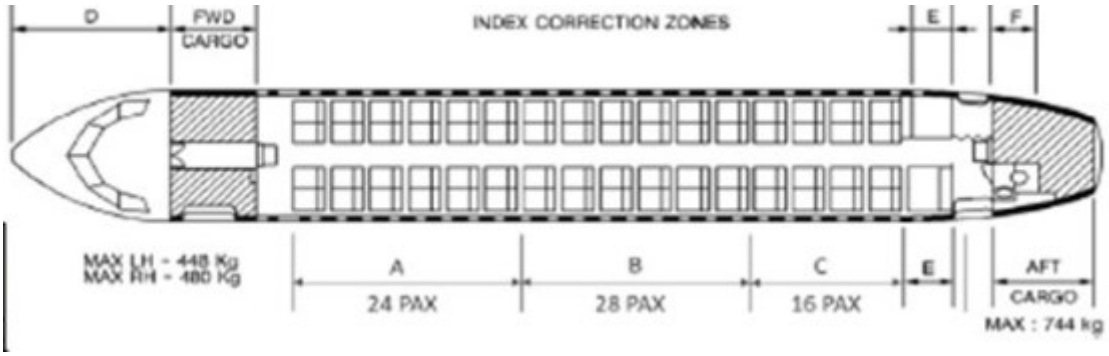

Figure 4: diagram of F-HBCM cabin (source: Chalair)

[5] The calculations carried out outside the certified envelope are by definition uncertain.

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation.

Scenario

On finalizing the weight and balance sheet, the traffic agent entered an erroneous index (sign error) in the calculation software. Subsequently, still in the software, the traffic agent's modification of the registration resulted in a new passenger seat allocation based on the erroneous index. The captain checked the sheet without seeing the entry error. Several passengers were moved to new seats to take into account this new seat allocation.

The unusual passenger seat allocation in the cabin was detected by the cabin crew member who mentioned this to the purser. This information was not shared with the captain as he had just validated the weight and balance sheet.

During the take-off, the captain detected that the flight controls were heavy. After take-off, he observed a trim setting that was inconsistent with the calculated value. He contacted the nominated ground operations manager in order to check the LTS data. After verification and detection of the error, the OCC had a new passenger seat allocation sent to the crew via the ATC in order to correct the centre of gravity for landing. The aeroplane landed without any anomaly.

Contributing factors

The following factors may have contributed to the data entry error:

- the traffic agent having followed short training and her lack of regular practical experience;
- a perfectible software configuration where the dry operating index pre-filled by the OCC can be modified or overwritten;
- the underlying tiredness of the traffic agent combined with the supervisor's extra workload generated by time pressure.

Safety measures taken by the operator, Chalair Aviation

The operator perceived the possibility of modifying an aeroplane's Dry Operating Index (DOI) in the iPort DCS software as a breach in the safety of its flights. Chalair Aviation therefore suspended Caen station's use of the iPort DCS software for producing weight and balance sheets and specified that these sheets would now be produced by the OCC until internal procedures or the software have been modified. A directive was published, restricting the modification of the DOI to qualified personnel.

The station traffic agent had had to modify the weight and balance sheet in order to take into account the captain's correction of the DOW/DOI. During the validation, she added the registration F-HBCM which was not shown in the list of aeroplanes proposed. On doing this, the passenger seat allocation in the cabin was re-organized and led to passengers being moved to the front of the cabin (due to the erroneous dry operating index). The operator has issued an information note addressed to its personnel explaining the importance of fully completing the weight and balance sheet.

Safety measures taken by Caen airport

In coordination with Chalair Aviation, Caen airport notably plans to set up a training plan for the traffic agents in the use of the iPort DCS software. A proficiency check is to be included.

It also plans to study the fatigue cycles of the agents in order to optimize their rotations.

The BEA investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liabilities.