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REPORT
ACCIDENT

Hard landing, bounces, failure of nose landing gear

Aircraft	Saab 2000 registered HB-IZG
Date and time	28 January 2014 at 07 h 31[1]
Operator	Darwin Airlines
Place	Paris Charles-de-Gaulle Airport (95)
Type of flight	Commercial air transport
Persons on board	Captain (PM)[2], copilot (PF)[3], 1 cabin crew, 16 passengers
Consequences and damage	Aeroplane severely damaged

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.

1 - HISTORY OF FLIGHT

At 07 h 05, at night, after a one-hour flight, the crew began the descent to Paris Charles-de-Gaulle airport. The captain asked the copilot to begin the approach briefing. This briefing did not raise any specific items.

At 07 h 13, the approach controller informed them that they would be radar vectored for the ILS 27R approach. Nine minutes later the crew was cleared for the ILS approach. The approach checklist was started one minute later at the request of the PF.

The PM told the PF that the rate of descent, which reached a maximum of about 1 750 ft/min, was too high. The PF reduced the rate of descent progressively. At an altitude of about 6,400 ft and 20 NM from the runway threshold, the localizer was intercepted.

The captain advised the copilot on managing an ILS approach and the vertical trajectory.

At 07 h 25, the ILS glide slope was intercepted. The controller cleared the crew to land on runway 27R and transmitted the wind from 200° at 12 kt. The captain gain advised the copilot by repeating to him the moment when he had to configure the aeroplane for the landing.

At 07 h 27, at an altitude of 3,400 ft, the crew started to configure the aeroplane. The captain asked the copilot to maintain a speed of 160 kt, which corresponded to what controllers expected as the minimum approach speed.

At an altitude of 2,300 ft (height of 1,900 ft above ground), the configuration chosen for the landing (flaps 20°) and the target approach speed (123 kt)[4] were selected. The PF called for the final check. The captain confirmed they were cleared to land and stated that the wind was coming from the left. At a height of 1,000 ft, the approach was stable and the runway was in sight. At a height of about 400 ft, the PF disengaged the autopilot and at 200 ft, the decision height, the crew decided to continue the approach.

[1] Except where otherwise stated, the times in this report are local.

[2] Pilot Monitoring.
[3] Pilot Flying.

[4] The approach speed chosen by the crew corresponded to the aeroplane's Vref for the selected configuration and to the aeroplane's landing weight without any increase.

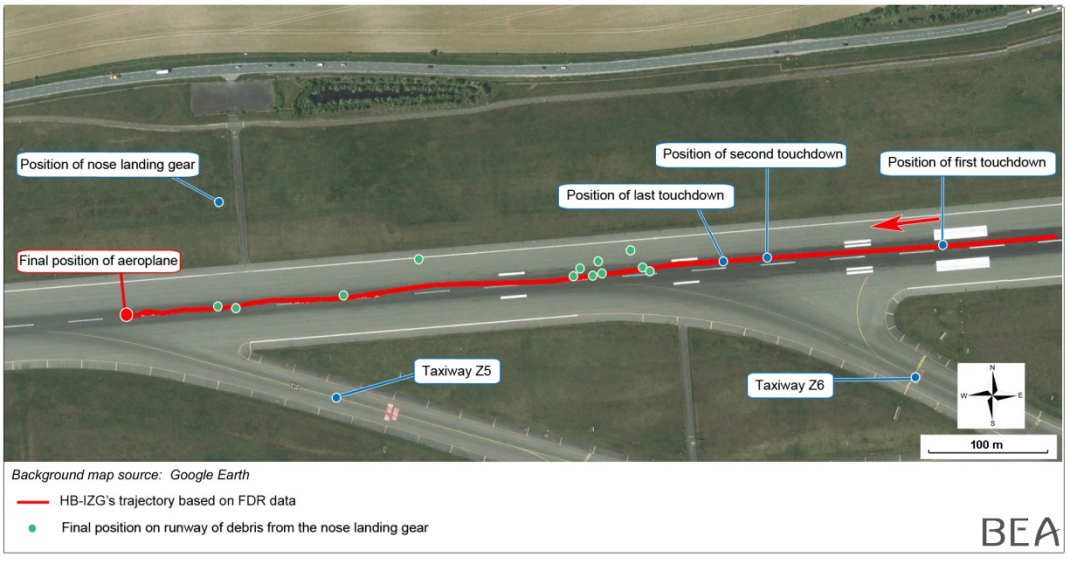
Descending through 50 ft, the PF moved the power levers progressively towards the flight idle position, decrabbed and flared; the pitch trim increased from 0° to 3°. Just before the main landing gear touchdown, control column movement was recorded at its maximum pitch-up value (11°) and the pitch trim then reached a value of 5°. The main landing gear wheels touched down hard on the ground, the aeroplane was then at an indicated speed of about 120 kt. The automatic flap retraction system (AFR) modified the flap deflection (from 20° to 15°). The aeroplane bounced on two occasions. During these bounces, the crew alternated between pitch-up and pitch-down inputs.

Analysis of the recorded parameters did not make it possible to determine precisely which crew member made inputs on the controls. However, the interviews with the crew allowed the following probable series of events to be established:

- « *the captain corrected the copilot's flare with a sudden significant nose-up input. After the first bounce the co-pilot, who still had his hands on the controls, probably surprised by the control column input, countered the captain's input. As the captain was no longer making any inputs, the control column was close to the pitch-down mechanical stop. This action led to another input by the captain to the pitch-up stop. On the second bounce, the copilot reacted to the input to the pitch-up stop and the control column was moved to the pitch-down mechanical stop. The captain increased the power, which was immediately reduced by the copilot* ».

The aeroplane's nose landing gear hit the ground with a high vertical speed and broke off during the last touchdown. The aeroplane came to a stop on the runway.

The PF told the controller there was « *an emergency on ground* », in response to which the latter asked him to continue the landing roll. Although the PF answered that he could not continue, the controller repeated his request. The PM then announced a distress situation using the correct terminology: « *mayday* ». The controller triggered the accident conditions one minute after the first message from the copilot on the emergency situation.



Aeroplane flight path and map of parts found on the runway

2 - ADDITIONAL INFORMATION

2.1 Examination of the aeroplane

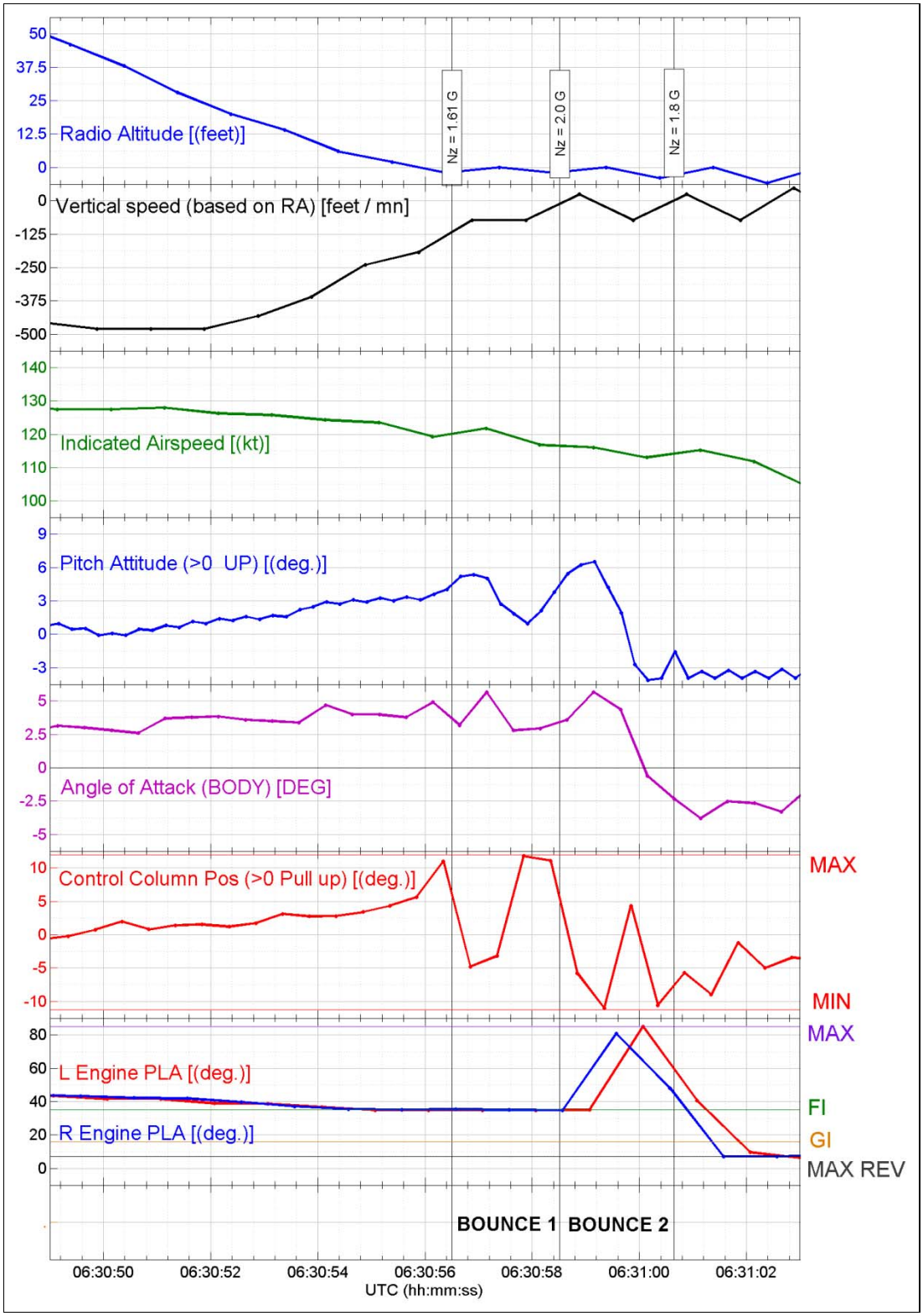
The examination of the aeroplane showed that all of the damage observed resulted from the brutal contact of the nose landing gear with the runway. The nose gear broke off due to overload. The examinations performed on the parts from the nose landing gear showed that it had been subject to a load greater than the ultimate loads defined by the certification criteria[5].

[5] The maximum vertical speed used for determining the ultimate loads is 10 ft/s.

2.2 Flight recorders

Analysis of the flight data made by the manufacturer based on the aeroplane model showed that the aeroplane touched the ground three times in the space of five seconds:

- 1st touchdown : only the two main landing gear units were in contact with the ground;
- 2nd touchdown : only the two main landing gear units were in contact with the ground;
- 3rd touchdown: only the nose landing gear was in contact with the ground. The failure occurred during this last touchdown. The vertical speed of the nose landing gear was estimated to be 11.5 ft/s.



Accident flight parameters during the landing

2.3 Personnel information

2.3.1 Captain

The captain was employed on 2 April 2013. Previously, he had been employed by the German airline OLT which operated Saab 2000s. It went bankrupt in 2013. It was not possible to obtain information on the captain's professional dossier before he started working for Darwin Airlines. The regulation does not require preserving these data in a case where an operator goes bankrupt.

He took the operator's conversion course between 2 April and 4 May 2013. During the line training flights, the captain was asked to pay attention to the flare during the night landing. The captain's leadership, his technical skills and his CRM competence were noted positively.

He held a commercial pilot's licence issued in April 2002. He had a total of 6,640 flying hours of which 2,260 on type and 1,720 as captain on SAAB 2000. He had made about 50 landings at Paris Charles-De-Gaulle, including four at night.

2.3.2 Copilot

The copilot was employed on 20 October 2013. He took the Saab 2000 training course provided by Braathens Training at Bromma in Sweden from 12 to 29 August 2013. He also undertook eight four-hour simulator sessions between 28 September 2013 and 8 October 2013 with instructors from Braathens. No remarks were made mentioning problems on landing during the simulator sessions. The practical examination to demonstrate competence on the aeroplane, the skill test was performed on 10 October 2013 by Darwin Airlines. The operator's conversion course began on 28 October and ended on 3 January 2014 with a line proficiency check.

The line training flights started on 14 November 2013 and ended on 31 December 2013. The line training was performed over 49 sectors (flights) with four different instructors.

He held a commercial pilot's licence issued on 15 December 2009. He had a total of 630 flying hours of which 80 on type. He was making his first landing at Paris Charles-de-Gaulle at the time of the accident flight. The copilot was considered «*inexperienced*»[6] by the airline.

[6] The operations manual states: "*A Flight Crewmember is defined inexperienced on type when the level of experience is less than the following: - 100 flying hours and 10 sectors within a consolidation period of 120 consecutive days; or - 150 flying hours and 20 sectors (no time limits).*"

2.4 Information on the operator

No landing techniques are described in the operator's documentation. The manufacturer recommends the following landing technique:

- *« A normal final approach should follow a 2.5-3 degrees glide path angle. With an aiming point approx. 1000 ft down the runway this will provide adequate height over threshold. Flare should be initiated when the main gear is a few feet above the runway; it is accomplished by raising the nose 5-6 degrees from approach attitude, i.e. for all normal cases the flare touchdown attitude should be 4-5 degrees nose up. When initiating the flare, gently reduce power to FI (Flight Idle) ».*

This technique was supposed to be covered during the pilots' recurrent training in 2013. The flight crew in this event had not followed this training.

The airline had not defined any procedure in case of bounces. Nevertheless, the manufacturer recommends:

- « *If the aircraft should bounce, hold or re-establish a normal landing attitude and add power as necessary to control the rate of descent. Power need not be added for a shallow bounce or skip. If a high, hard bounce occurs, initiate a go-around. Apply required power and use normal go-around procedures. A second touchdown may occur during the go-around. …* »

The operations manual specifies that the captain choses the pilot flying. There are no specific criteria in a case where the copilot is considered to be inexperienced.

2.5 Crew accounts

The crew's rotation had started on the day before the accident with a round-trip between Leipzig and Paris Charles-De-Gaulle, followed by another between Leipzig and Amsterdam. The copilot was PF on the second round-trip. The flight legs on the day of the accident were identical to those of the day before. The accident happened during the first flight of the day.

2.5.1 Captain's account

The captain encouraged the copilot to make the briefing approach as he considered that it should have been performed earlier. Apart from a crosswind component, the captain stated that the approach was in no way special.

He reckoned that the approach was normal and stable. From the decision height down, he felt more turbulence that the copilot was containing « *with difficulty* » through numerous small corrections on the controls. He thought that the copilot's corrections may have increased the turbulent impression on the trajectory. He noticed that the aeroplane had passed slightly below the ILS glide slope. He did not call it out to the copilot as he noticed that the trajectory was on the PAPI slope and that the copilot was looking outside.

On short final, the rhythm of the callouts made by the synthetic radio-altimeter voice seemed normal to him. He stated that he had kept his right hand near the thrust levers and his left hand ready to make an input on the thrust levers and his left hand ready to make an input on the control column. At about 20 ft, during the flare, the copilot had reduced the power to flight idle and was looking outside. The captain was not following the changes in the speed. He had the impression that the rate of descent was increasing. He then pulled on the control column as a reflex. He wanted to take over the controls but they were both making inputs on them. Ha stated that he did not call out «I have control» when he made the input on the control column. He considered that the aeroplane touched down hard on the runway, on the main landing gear, without this being unusual. The aeroplane then bounced, which made him to want to increase power. He thought that his input had no effect because the copilot was holding the thrust levers firmly in the flight idle position. The aeroplane touched down on the runway again. He stated that he only made pitch-up inputs during his inputs on the control column up until the last touchdown.

The captain explained that when he was PM and reckoned that a trajectory correction was necessary, he preferred to help the copilot by making direct inputs on the controls rather than taking over control formally. He was aware that this method carried the risk of dual inputs occurring.

He added that he had already experienced bounces during landing on Saab 2000 a short time after he joined the airline. He also said that it was possible to correct the aeroplane's trajectory either by increasing power and making a simultaneous pitch-up input on the control column, or by aborting the landing.

He considered that the night landings did not present any particular features.

During the landings performed the day before by the copilot, he considered that the copilot's skills were good. Nevertheless, he stated that he had asked him to pay attention to keeping on the centre line when landing with crosswind.

2.5.2 Copilot's account

The copilot explained that before the flight, he had told the captain of his lack of experience on the aeroplane type and at Paris Charles-De-Gaulle Airport. He added that he accepted that, consequently, the captain kept his hands on the flight controls during the landing. Finally, he stated that the flight took place normally and that the approach was stabilised, with a crosswind component from the left.

The copilot stated that at about 500 ft, he disengaged the autopilot then at about 200 ft he used the PAPI to continue the descent. He added that, under the crosswind, the final was turbulent and that this made corrective inputs difficult and resource-draining. He stated that he was concentrating his attention on maintaining speed and keeping to the runway centre line.

During the flare, at about 30 ft, he said that the rhythm of the callouts made by the synthetic radio-altimeter voice seemed normal to him. However, he had had the impression that the landing was hard. The aeroplane touched down on the runway the first time, then the captain pulled back on the control column as a reflex action. The copilot stated that this was done at the same time as his piloting inputs. It seemed to him that at the time of the second bounce, the captain had taken over the controls by calling out « *my control* ».

The copilot stated that the seat position recommended by the manufacturer was suitable for external vision but was less pleasant for reading the instruments and monitoring the parameters. Thus, he usually set his seat lower than the recommended position.

As to night landings, he had the impression that «everything happens more quickly». He had already experienced a bounce on landing during the first rotation. He stated that he had no knowledge of specific instructions in case of a bounce on landing.

2.6 Hard landings

The airline had established a flight analysis system and equipped its aircraft with maintenance recorders. This was not required by the regulations. The recorded parameters did not allow hard landings to be detected effectively. The detection of such landings depends on pilot perception and consequently on their feedback. The operator stated that it had few reports of hard landings before the accident. All hard landing reports in the log had to result in a check on the aeroplane by the maintenance teams. The airline did not, however, have these resources available at all of the airports served. A hard landing report can thus lead to the suspension of flights by the aeroplane in question.

The manufacturer does not provide specific criteria to determine if a landing can be classed as hard. Based on the manufacturer's experience, landings performed on Saab 2000 are regularly perceived as firm by flight crews because of the aeroplane's characteristics (low shock absorption due low ground clearance).

Darwin Airlines pilots reported that they regularly experienced firm landings and stated that it was not easy to detect when a landing was hard.

2.7 Meteorological information

The meteorological conditions were as follows:

- wind from 200° at 15 kt;
- visibility greater than 10 km;
- FEW at 1,000 ft.

3 - LESSONS LEARNED AND CONCLUSION

3.1 Designating a PF considered to be inexperienced

The operator defined the notion of « *inexperienced pilot* »; this meant a pilot having completed his line training but with low experience. The captain has to designate the PF for each flight by taking into account the copilot's experience. As of the date of the accident, the operator had not defined objective criteria to help the captain with this task. His decision thus depended on his knowledge of the copilot's experience and his feelings about designating him as PF.

The captain of the accident flight had evaluated this pilot's skills during the two legs undertaken on the day before the accident. He considered that they were adequate to be the PF during the accident flight. However the captain was vigilant and kept his hands near the controls to be able to intervene quickly in case of an error by the copilot. In addition, he gave him a lot of advice during the approach.

After the accident, the operator decided to define the following criteria to be applied so that a copilot with less than 300 flying hours could be designated PF:

Condition	F/O < 300 FH On type
Visibility (min)	1500m
Crosswind (max)	10kts
Night Landing	No
Contaminated	No
Cat B Airport	No
Cat C Airport	No

The copilot could not have performed the landing on the day of the accident with the above-listed criteria.

3.2 Management of the approach and the flare

The captain appears to have exceeded his prerogatives by giving a lot of instructions on the conduct of the approach. He abandoned his role as PM for what he considered to be that of an instructor. This situation may have upset crew teamwork by creating an inappropriate authority gradient.

Night time modifies pilots' usual perception of external visual clues and can affect the ability to estimate the height to perform the flare.

During the flare, the captain had the feeling that the aeroplane dropped prematurely and instinctively pulled back on the control column[7]. This action moved the control column to the pitch-up stop a short time before the wheels touched down. The captain's instinctive reaction was not accompanied by any callout on taking over control. The aeroplane was then being piloted by both the members of the flight crew.

[7] The flight data recording did not make it possible to determine who was making inputs on the controls.

As of the date of the accident flight, the airline had not defined any landing technique in its operations manual. After the accident, the operator decided to include that of the manufacturer in its documentation.

3.3 Dual inputs and managing a bounce

The two crew members likely had two different analyses of the situation. This led to dual inputs with no callout during the landing and the two bounces.

The method applied by the captain to correct the trajectory is not to take over control but to act « *in a transparent manner* ». In a dynamic phase like a bounce, this method can prove to be counter-productive. It is however difficult to take over the controls formally in a phase of flight which only lasts a few seconds.

The airline did not have any means of detecting hard landings and bounces. It did not take sufficient advantage of feedback from flight crews on these events. This absence of crew feedback could be explained by:

- the difficulty in detecting a hard landing on Saab 2000;
- reticence in blocking the aeroplane by reporting the event;
- an event-reporting culture that was in its infancy within the airline.

3.4 Captain's experience

The investigation was not able to determine the detailed professional experience of the flight crew. The airline did not have any information on the captain's competence other than that supplied by him. The captain's previous airline having gone bankrupt, it was not possible to recover the previous checks and evaluations relating to the captain.

This information is important for an airline so that it can know the professional level of all of its pilots.

The FAA created a framework for checking the professional experience of a pilot though the « *Pilot Records Improvement Act of 1996 (PRIA)*[8] » to follow up a number of failings detected during safety investigations. Europe does not currently have similar procedures.

[8] http://www.faa.gov/pilots/lic_cert/pria/

3.5 Conclusions

During the flare, the captain considered that the landing was going to be hard. Due to the urgency of the situation, he made quick pitch-up inputs on the control column without announcing his intentions to the copilot.

This absence of crew coordination led to dual input piloting and successive opposing inputs on the flight controls during management of the bounces.