DATA SUMMARY

LOCATION

Date and time	**Thursday, 22 October 2009; 10:50 UTC**
Site	**Runway 25R at the Barcelona Airport (Spain)**

AIRCRAFT

Registration	**PH-DXB**
Type and model	**DE HAVILLAND DHC-8-315**
Operator	**Air Nostrum (Operated by Denim Air)**

Engines

Type and model	**PRATT & WHITNEY (Canada), model PW-123E**
Number	**2**

CREW

	Pilot in command	First Officer
Age	**38 years old**	**34 years old**
Licence	**ATPL(A)**	**ATPL(A)**
Total flight hours	**6,300 h**	**2,060 h**
Flight hours on the type	**5,000 h**	**1,300 h**

INJURIES

	Fatal	Serious	Minor/None
Crew			**3**
Passengers			**32**
Third persons			

DAMAGE

Aircraft	**Minor**
Third parties	**None**

FLIGHT DATA

Operation	**Commercial air transport – Scheduled – Domestic – Passenger**
Phase of flight	**Landing**

REPORT

Date of approval	**19th December 2012**

1. FACTUAL INFORMATION

1.1. History of the flight

On 22 October 2009, a De Havilland DHC8-315, registration PH-DXB, was on a regular flight from the Barcelona Airport (LEBL) to the San Sebastian Airport (LESO). The flight was operated by Denim Air for Air Nostrum and its callsign was ANS-8852. Onboard were two pilots, one flight attendant (FA) and thirty-two passengers.

Weather conditions at the Barcelona Airport were somewhat adverse, given the presence of several storm cells in the vicinity, with occasionally heavy rain. The storms were also affecting the traffic situation, causing delays for both arriving and departing flights.

Flight ANS-8852 started the taxi phase ten minutes late, at 10:15 UTC[1]. It had enough fuel to fly to San Sebastian and back to Barcelona. The captain was the pilot flying (PF). The aircraft took off normally from runway 25L at 10:27, after which the crew raised the gear.

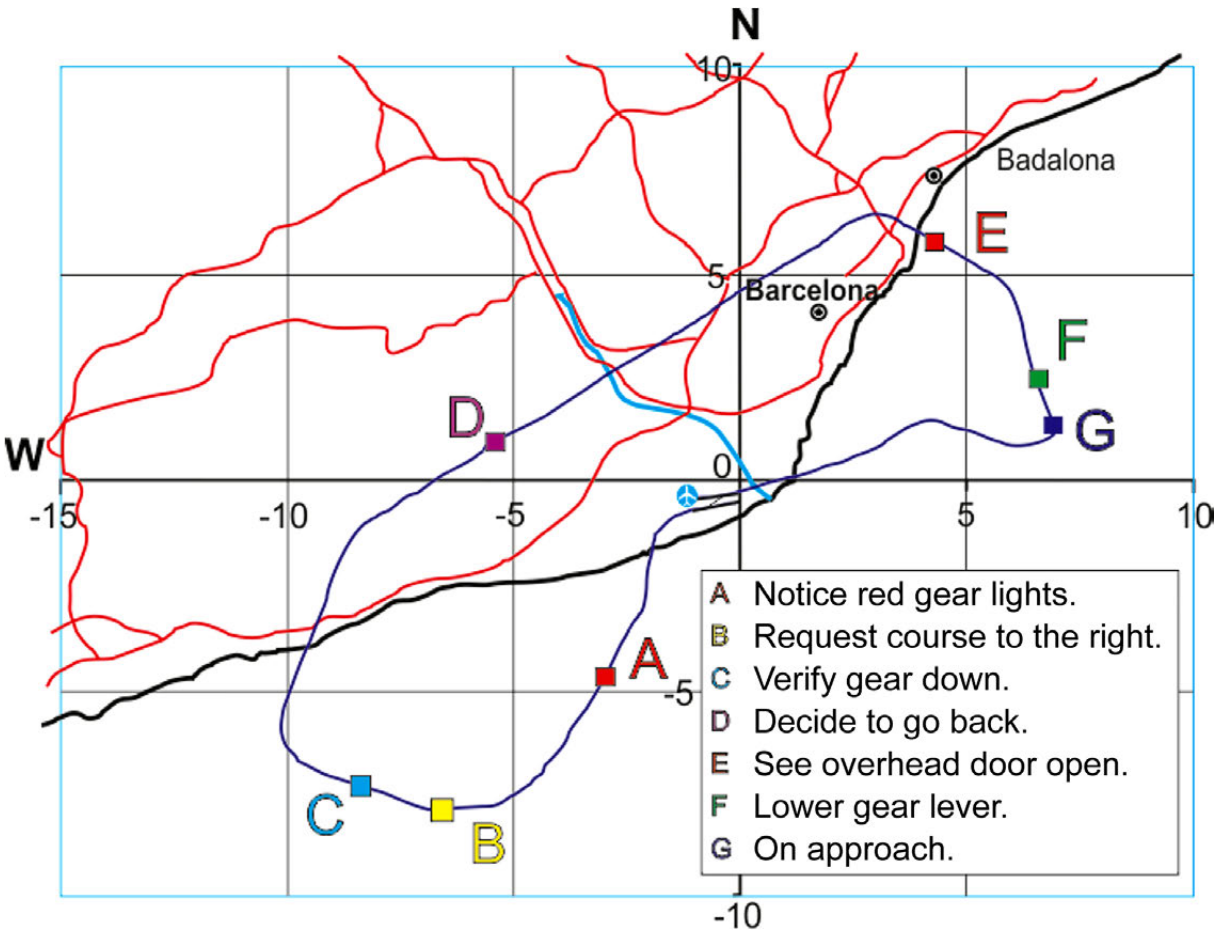

Figure 1. Flight path of the aircraft

[1] All times in this report are in UTC unless otherwise specified. To obtain local time, add two hours to UTC.

About three minutes later the crew noticed that the three gear not locked red lights were on. They asked the FA to visually confirm the position of the main landing gear legs. The FA reported that both the right and left legs were still down.

At that time the aircraft was still climbing and accelerating, having reached an altitude of 7500 ft. and an airspeed of 199 KIAS. The crew decided to return to Barcelona while they reviewed the procedures to ensure that the gear was properly configured for touchdown by lowering it using the alternate or emergency system.

ATC was informed that the airplane was returning to the departure airport with gear problems and accommodated its integration into the landing sequence, assigning it number two.

While using the alternate method to lower the gear, the crew noticed that the Landing Gear Alternate Release Door was open, its normal position being closed. They instinctively closed the release door, after which they heard "alarming and deafening" noises, in the crew's own words, so they opened it again. They continued with the alternate procedure for lowering the gear, placing the selector lever in the gear down position. Thirty seconds later the aircraft joined the circuit on short final, causing them once more to interrupt the procedure.

Before landing, the crew noticed that they had two green lights for the main gear, one red light for the nose gear and three amber lights for the open doors on the three legs. On short final, assuming that the nose gear leg had not deployed, the crew declared an emergency and requested the presence of firefighters. They also notified the FA, who in turn informed the passengers. The aircraft landed on runway 25R at 10:48 after a 21:26-minute flight. The main gear was down and locked, the nose gear was up and the flaps were deployed 15°. The gear down not locked horn was sounding continuously and several GPWS warnings were received. The doors on all three legs were open (see Figure 2).

During the landing on the wet runway, the nose contacted the asphalt for about 12 seconds until the aircraft came to a complete stop, damaging the two nose gear doors. The passengers evacuated the aircraft under crew instructions, with two difficulties: getting the passengers to leave the aircraft and go into the rain, and many passengers did not obey the crew repeated instruction to leave hand baggage behind. Evacuation was aided by the firefighting service, which was on the scene.

Approximately an hour after the airplane was evacuated, the front part of the aircraft was lifted with a crane so that it could be removed from the runway. Once the nose of the airplane was lifted, the alternate control in the cockpit for lowering the nose gear was actuated, and the gear lowered and locked correctly. The inhibit switch was found actuated in the cockpit and the overhead and floor doors were open. The PTU selector switch was in manual.

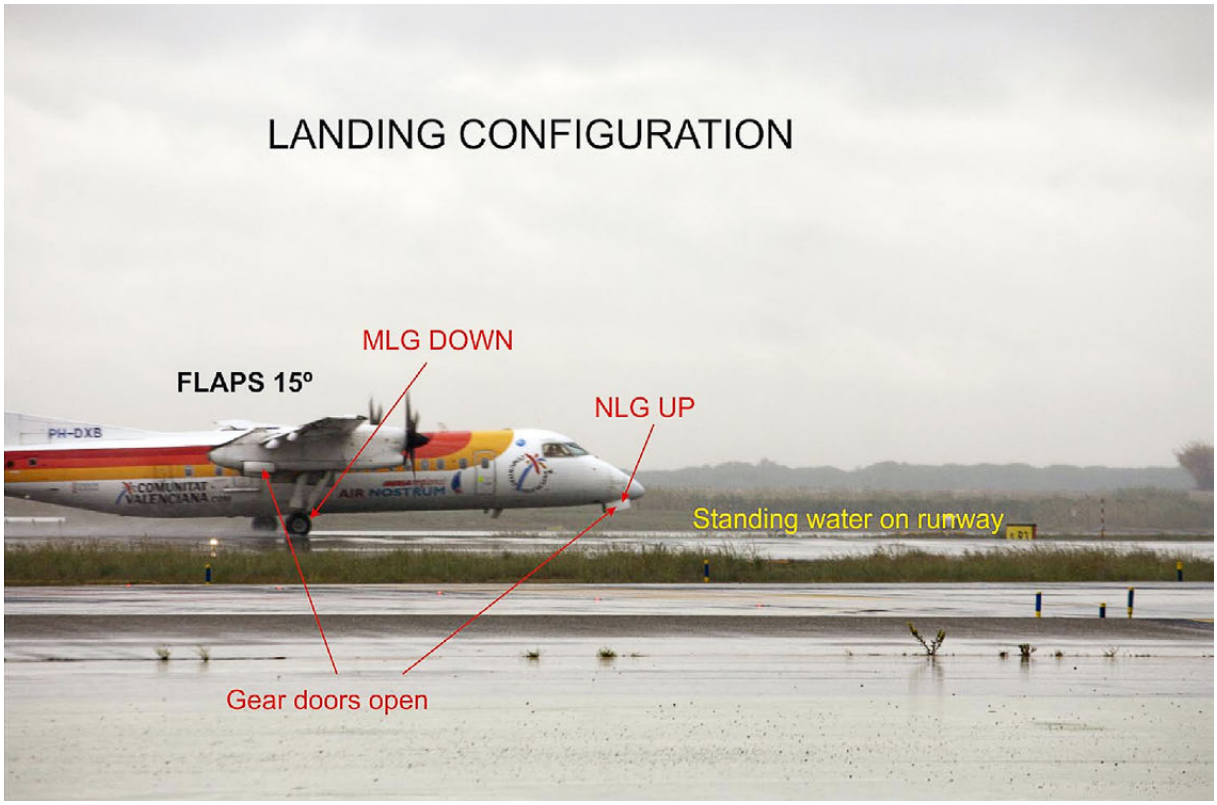

Figure 2. Photograph of the airplane during incident touchdown

Figure 1 shows the approximate flight path taken by the aircraft. This path was determined by integrating the TAS deduced from the IAS and using the magnetic data recorded on the DFDR. Also taken into account was a constant 18-kt wind from the SSW that was blowing on the morning of the incident, according to the meteorological information. The most significant points are labeled on the diagram.

1.2. Personnel information

The crew consisted of a captain, a first officer and a flight attendant.

1.2.1. *Pilot in command*

The captain, a 38-year old Spanish national, had an airline transport pilot license (ATPL(A)) issued on 9 March 2000 by the Dutch civil aviation authority. She also had a Class 1 medical certificate valid until 1 June 2010.

She had DHC-8 and IFR ratings, both valid until 1 April 2010. She had successfully passed the last proficiency check on 2 July 2009, the last line check on 18 April 2009 and had taken the last CRM refresher course on 1 December 2008.

The captain had a total of 6,300 flight hours, of which approximately 5,000 had been on the DHC-8. She had flown 16:20 h in the last 30 days and 6 hours in the last 24 hours. This was her first flight of the day, having gone on duty at 09:20, 45 minutes before the flight, which was scheduled for 10:05.

1.2.2. *First officer*

The first officer, a 34-year old Spanish national, had an airline transport pilot license (ATPL(A)) issued on 11 August 2009 by the Dutch civil aviation authority. He also had a Class 1 medical certificate valid until 7 March 2010.

He had DHC-8 and IFR ratings, valid since 1 August 2009, and had obtained a multi-engine aircraft rating on 7 June 2007. He had successfully passed the last proficiency check on 26 July 2009, the last line check on 15 May 2009 and had taken the last CRM refresher course on 7 October 2009.

The first officer had a total of 2,060 flight hours, of which some 1,300 had been on the DHC-8. He had flown 62:10 h in the last 30 days and 2:57 hours in the last 24 hours, of which 1:33 had been on a flight from San Sebastian to Barcelona that same morning and on the same aircraft. He had gone on duty at 04:45.

1.2.3. *Flight attendant*

There was a single crewmember in the passenger cabin, a licensed flight attendant (FA). She had gone on duty at 04:45 and had flown in on the San Sebastian-Barcelona flight. The stopover in Barcelona had lasted three hours.

1.3. Aircraft information

1.3.1. *General*

The De Havilland Canada DHC-8-315 DASH 8 is a high-wing aircraft designed for short-range regional air transportation. It was type certified in 1985. Nowadays the type certificate holder is Bombardier Inc.

The incident aircraft, with Dutch registration PH-DXB, has serial number 589. Its maximum takeoff weight (MTOW) is 19,495 kg and it is configured to carry 50 passengers. It has two Pratt & Whitney PW123E turboprop engines that generate 2,380 HP.

1.3.2. *Maintenance status*

The incident aircraft had the relevant airworthiness review certificate, which expired on 18 May 2010.

The maintenance data collected showed that the aircraft had accumulated 14,150 flight hours and 16,943 cycles.

All scheduled maintenance activities were up to date and its last overhaul had been in Valencia in July 2007, with 9,572 h and 11,562 cycles on the aircraft. The last maintenance tasks consisted of changing the number 2 tire on the left main landing gear and the 75-hour inspection. There were two deferred items, the replacement of the FMS (Flight Management System) unit and of the #1 audio panel.

1.3.3. *Weight and balance*

The balance sheet that was prepared at the Barcelona Airport prior to dispatch recorded the following weights:

• Total load:	2,798 kg		
• Dry operating weight:	12,592 kg		
• Actual zero fuel weight:	15,390 kg	Maximum:	17,917 kg
• Takeoff fuel:	2,450 kg		
• Actual takeoff weight:	17,840 kg	Maximum:	19,495 kg
• Trip fuel:	800 kg		
• Estimated landing weight:	17,040 kg	Maximum:	19,051 kg

— Takeoff balance: 26.98 %MAC; min. 20%; max. 40%
— Landing balance: 26.61 %MAC; min. 19.5%; max 40%

The calculation assumed 13 passengers in rows 1 to 7 and 19 passengers in rows 8 to 19, as per the load sheet.

Based on these load and balance conditions, it is estimated that moving half of the passengers from the forward rows to the aft rows would shift the center of gravity aft by 4% or 5% MAC. This shift could lower the load on the nose wheel by about 200 kg.

According to the operations manual, the approach speed with 15° flaps and these load conditions (Vref) was 105 kt.

1.3.4. *Information on the landing gear*

This type of airplane has a retractable tricycle gear with two wheels on each leg. The main legs, housed in the engine nacelles under the wings when retracted, deploy forward, into the wind. The nose wheel deploys by rotating aft.

Both the nose and main legs have two doors that open to allow the wheels through as they retract or deploy. The doors then close again once the wheels have moved up or down. There are an additional two doors on each leg that are operated by the motion of the leg itself. The nose wheels can be steered by the pedals or using a tiller located on the captain's side.

The IAS is limited to 173 kt with the gear deployed.

1.3.4.1. Normal lowering of the landing gear

The airplane has two independent hydraulic systems, each one powered from one of the two engines. The landing gear is powered by the No. 2 system, which is supplied from the hydraulic pump driven by the right engine. Each leg is equipped with a hydraulic cylinder or actuator. The main gear legs have a second auxiliary cylinder that is actuated by a manual hydraulic pump.

The gear up and down lever and a set of nine lights, arranged in three rows and three columns, are located on the landing gear panel in the cockpit. The gear selector lever has two positions (up and down) and electrically actuates a gear selector valve that directs hydraulic pressure from the #2 system to either raise or lower the gear, respectively.

The nine lights indicate the position of each of the legs and their doors (central column for the nose wheel and the side columns for the left and right legs). The lights on the first row are amber and when lit indicate that the associated door is open. The lights on the second and third rows are green and red, respectively. If a green light is lit, the associated leg is down and locked. A red light indicates that the associated leg is not locked or is not in a position consistent with that selected on the lever.

The lever used to operate the gear also has an amber light. If it turns on at the same time as the red lights, this indicates that the gear is in transit. If it remains on after the gear is retracted, this means that the door sequence has failed. If this light remains on, the gear must be lowered using only the alternate method.

The hydraulic flow is controlled using a 3-position (up, neutral and down) selector valve. The up and down positions correspond to the up and down positions of the gear lever, while the neutral position corresponds to the operation of the inhibit switch (discussed later), which is mainly used to isolate pressure in the system and to simulate a hydraulic failure.

The power transfer unit (PTU) allows for the pressurization of the #2 hydraulic system in the event of a failure of the right (#2) engine by transferring power from the #1

Figure 3. Gear lever and lights

system. When the oil pressure on the #2 engine is abnormally low and the gear is selected up, the PTU operates automatically to augment the #2 Standby Hydraulic Pump during a gear retraction. Additionally, AFM (Aircraft Flight manual) procedures allow for Manual selection of the PTU to aid the hydraulic system for gear extension.

The warning light panel in the cockpit has an amber light labeled "LDG GEAR INOP" that indicates a fault in the valve sequence required to operate the gear doors. When this light is on, the gear cannot be lowered using the normal method.

1.3.4.2. Alternate or emergency operation of the landing gear

Various controls housed in two locations are used to lower the gear using the alternate method:

- An overhead door labeled "Landing Gear Alternate Release" (Fig. 4), behind which is a "T" type handle to open the main landing gear doors and release the main gear. Opening this door actuates a bypass valve in the hydraulic system used for the normal operation of the gear. Alongside this door is the gear "Inhibit Switch".

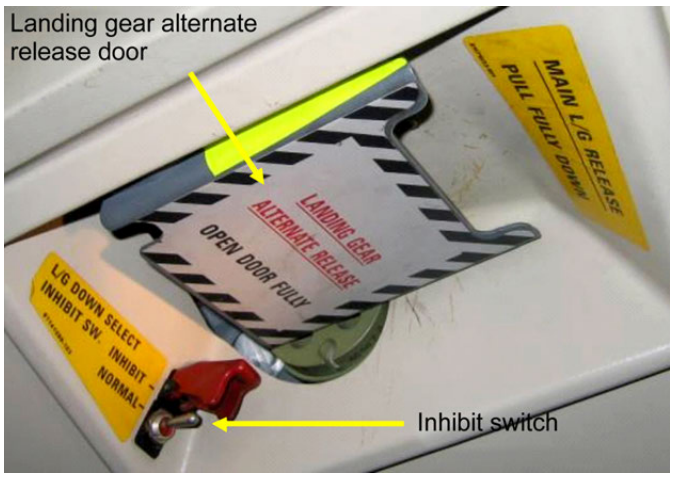

Figure 4. Gear inhibit switch

- A door on the floor labeled "Landing Gear Alternate Extension" (Fig. 6), behind which is a "T" type handle to open the nose landing gear doors and unlock the nose gear, an alternate gear indication system and a fitting for inserting a pump handle used to operate the manual pump that uses the auxiliary cylinder to assist in locking the main gear. Opening this door actuates a valve that redirects hydraulic fluid to lower the main gear using the alternate method.

The alternate method for (manually) lowering the gear is as follows:

1. Actuate the inhibit switch located in the copilot's overhead panel under a cover guard located beneath the door that houses the "T" handle for the manual extension of the main gear. When the inhibit switch is operated, the gear selector valve is electrically placed in the neutral position. This prevents the pressurization of the gear retraction/extension system by connecting the supply and return lines.
2. Place the landing gear selector handle in the "down" position. Doing this ensures that hydraulic pressure will not interfere with the operation to manually lower the gear.
3. Open the Landing Gear Alternate Release Door. Opening this door mechanically positions a bypass valve that isolates the gear system and keeps it from pressurizing by connecting the supply and return lines. This same connection is established electrically when the selector valve is placed in the neutral position.
4. Pull down on the main gear release "T" handle (Fig. 5) to initiate the lowering sequence. The "T" handle must be fully pulled. The pull sequence will initialy release the locks on the doors, which causes the doors to open under spring pressure and then release the locks on the landing gear. The two main legs fall forward. The doors, when opened by the alternate system, do not close again.
5. Open the Landing Gear Alternate Extension Door in the floor of the cockpit, to the left of the copilot. This closes a valve that allows for the pressurization of the auxiliary cylinder on each main gear leg.
6. Pull fully up on the "T" handle to release the locks keeping the nose gear in the up position. The doors are then opened and the locks are released. The nose gear leg will drop by gravity and be pushed by the dynamic pressure of the air flow.
7. Use the alternate indicating system to verify that the three legs are fully down and locked, as indicated by the three green lights.
8. If the main legs are pushed back by the wind and do not lock, complete the extension using the manual hydraulic pump.

Figure 5. Overhead door

Figure 6. Floor door

1.4. Meteorological information

When the aircraft took off at 10:15, the weather was stormy with heavy rain at times. The wind direction was variable at 4 kt. The cloud ceiling was at 3.500 ft.

When the aircraft landed at 10:50, the weather was still stormy with intermittent rain. Horizontal visibility was between 7,000 and 6,000 m and the cloud ceiling had fallen to 1,900 ft. The wind reported during the landing clearance was calm, though the 11:00 METAR indicated the wind was at 8 kt.

The wind above Barcelona at flight level FL75 was from the south-southwest at between 15 to 30 kt. The flight took place mainly below this level and encountered winds from the SSW at speeds of between 15 to 20 kt.

1.5. Communications

The aircraft was in contact with various approach control stations and with the Barcelona Airport tower. The transcript of these communications coincides with the recordings on the cockpit voice recorder (CVR). Radio communications were initially held in English, though once the flight plan changed and the aircraft headed back to Barcelona, the crew changed to Spanish.

In Section 1.7.1, Cockpit Voice Recorder (CVR), the radio communications were synchronized and sequenced with the cockpit communications so as to generate a timeline of the significant events that occurred during the flight.

1.6. Aerodrome information

The Barcelona-El Prat Airport is to the south of the city, near the sea, at an elevation of 14 ft. It has three runways designated 25R-07L, 20-02 and 25L-07R. The first two runways cross each other.

The runway where the incident flight landed, 25R, is 3,352 m long and 60 m wide. The elevation of the threshold is 10 ft. It has a PAPI visual glide slope aid and a CAT II/III ILS instrument aid. Both the visual and the ILS glide slopes have a 3° gradient.

1.7. Flight recorders

1.7.1. *Cockpit Voice Recorder (CVR)*

The aircraft had a solid-state cockpit voice recorder (CVR) with a maximum recording time of 120 minutes.

Laboratory processing of the recorder yielded four audio tracks associated with the captain's microphone, the copilot's microphone, the area microphone and a fourth channel that is a combination of the first three.

The crew spoke in Spanish to exchange information in the cockpit, though the checklists and terms specific to aircraft operations were in English, the main language of the operator, Denim Air.

The table below summarizes the conversations of most relevance to the incident as recorded on the track that is the combination of the other three channels. The reference time is the elapsed flight time from brake release. The text utilizes *italics* for literal internal communications between the crew, normal font for remarks, clarifications or a non-literal summary of a communication or of an action taken, and **bold** for literal radio communications.

Flight time	UTC time	Speaker	Contents
0	10:28:10	CPT	*¡Vámonos... take off!*
0:00:28	10:28:38	F/O	*Rotate.*
0:00:32	10:28:42	F/O	*Positive rate.*
0:00:33	10:28:43	CPT	*Gear up.*
0:03:11	10:31:21	F/O	Expresses surprise that the gear is not up.
0:03:16	10:31:26	CPT	Expression of displeasure.
0:03:18	10:31:28	F/O	*I hadn't noticed at all.*
0:03:20	10:31:30	CPT	*Forget it, back we go.*
0:03:26	10:31:36	F/O	Long exchange of opinion regarding significance...
0:03:42	10:31:52	CPT	... of the lights and how to proceed next.
0:03:46	10:31:56	CPT	*No! Let's see what it says here.* Asks for emergency QRH.
0:03:59	10:32:09	F/O	*I think there's one called unsafe.* Emergency checklist for landing gear unsafe.
0:04:16	10:32:26	CPT	*... landing gear unsafe, landing consideration, landing gear unsafe.*
0:04:35	10:32:45	F/O	*But we don't know the condition. I see it as unsafe, the doors are closed but the hook is what's not making contact.*
0:04:42	10:32:52	CPT	*Turn the lights on, let's see.* Initiate turn to 5,800 ft following standard instrument departure Graus 2W.
0:04:45	10:32:55	F/O	*... But in this case, is it below?* As a result of opening the landing gear alternate extension door and turning on the alternate gear indication switch.
0:04:50	10:33:00	F/O	*That's only a test.*
0:04:51	10:33:01	CPT	*Tell him we have to go back, that we have a faulty gear indication and have to go back.*

Flight time	UTC time	Speaker	Contents
0:05:31	10:33:41	F/O	**Air Nostrum 8852, we need a heading to the left, we have a gear indication, we have to go back, we need to go back.**
0:05:39	10:33:49	ATC	**Air Nostrum 8852, please contact 127.7, I'll inform them. Contact them right now.**
0:06:01	10:34:11	CPT	*Hello, can you see if the landing gear is up or down.* Conversation with the purser.
0:06:17	10:34:27	FA	*It's down.*
0:06:18:	10:34:28	CPT	*OK, we have to go back, the gear is down.*
0:06:23	10:34:33	F/O	**Confirm heading to the left 200°, 8852.**
0:06:26	10:34:36	ATC	**Air Nostrum 8852, what altitude do you require, please?**
0:06:31	10:34:41	F/O	**We're ok at 80.**
0:06:34	10:34:44	ATC	**Roger, maintain level 80, to the right heading 020.** The standard departure is interrupted to return to Barcelona using radar vectors.
0:06:40	10:34:50	F/O	**Maintaining 080, right 020, confirm 8852.**
0:06:45	10:34:55	ATC	**Confirm 020.**
0:06:47	10:34:57	CPT	*We're going back.* Firm decision made to return.
0:06:50	10:35:00	CPT/F/O	Exchange of opinions regarding condition of landing gear, of lowering in alternate mode and when to do it, and possible conditions of landing gear.
0:07:45	10:35:55	CPT	*Secure the cabin, give them instructions and tell them we might have to evacuate.* Intercom conversation with purser.
0:08:28	10:36:38	CPT	**Air Nostrum 8852, we need to turn right due to adverse weather.**
0:08:32	10:36:42	ATC	**8852 heading 060.** They are then transferred to 125.25 MHz.
0:08:39	10:36:49	F/O	Suggests to the captain that she fly while he handles the emergency.
0:09:29	10:37:39	F/O	Learns from the radio that they are number 2 and tells the CPT that they need more time.
0:09:32	10:37:42	CPT	*We have to slow, now that I think of it, we have the gear dangling out there.*
0:09:36	10:37:46	F/O	*... 173, but another thing, we tell him we need time, right?*
0:09:43	10:37:53	CPT	*No!*
0:09:45	10:37:55	F/O	*Ok, well, in any case, we'd do a go-around if we're on final and we don't get the indications, but you know this takes 7 minutes.*
0:09:54	10:38:04	CPT	*Yes!*
0:10:03	10:38:13	ATC	**8852, please descend to 5,000 ft, QNH 997.**
0:10:09	10:38:19	CPT	**Descending to 5,000 ft, 997, 8852.** The start descending to 5,000 ft and the approach checklist. They are then transferred to 118.1 MHz.
0:11:19	10:39:29	F/O	*Yes, well, if we want to do the alternate gear extension, we have to do condition levers.* The copilot starts sequence from alternate gear extension checklist.
0:11:24	10:39:34	CPT	*We can do that later, can't we?*

Flight time	UTC time	Speaker	Contents
0:11:27	10:39:37	F/O	*Ok! Maximum speed 140… it's because of the door, so we'd actually have to slow more.*
0:11:31	10:39:41	CPT	*Ok!*
0:11:43	10:39:53	ATC	**Air Nostrum 8852 hello, report position please.**
0:11:49	10:39:59	F/O	**Sorry, we hadn't called yet. We're on 060 descending through 6,000 to 5,000 on the 020 radial 8 miles out from Barcelona.** They are then transferred to 125.25 MHz, which they call and repeat the above information. They are then transferred once more to 118.1 MHz, which they call again and repeat the above information.
0:12:49	10:40:59	ATC	**8852 hello, radar contact, you can turn right to heading 130, descend 2,300 ft.**
0:13:02	10:41:12	CPT	*Ok! Speeds 4, 7, 23.*
0:13:04	10:41:14	ATC	**Air Nostrum 8852, do you have any technical problems turning, or any requirements?**
0:13:10	10:41:20	CPT	*No, only thing is we need to do an alternate gear extension.*
0:13:13	10:41:23	F/O	**Negative, for now all we have to do is lower the gear using the alternate procedure and as soon as we have three green lights, which we expect, we'll do a normal landing. If not I'll let you know.**
0:13.28	10:41:38	ATC	**Roger, well for now continue descending to 1,800 ft.** Descent to 1,800 ft, which they delay.
0:13:34	10:41:44	F/O	*Geez, xxx. So what do we do then? We have 140. Inhibit switch? Is that what it says?* They continue with the alternate gear extension checklist.
0:13:42	10:41:52	CPT	*Inhibit switch, where are you? No, that's not...*
0:13:45	10:41:55	F/O	*Sorry, the landing gear inhibit switch...*
0:13:48	10:41:58	CPT	*... up! Oh, that's why.* They find the landing gear alternate release door open.
0:13:50	10:42:00	F/O	*Is that why?*
0:13:52	10:42:02	CPT	*That's why.*
0:13:54	10:42:04	F/O	*I can't believe it... and, why was it like that?*
0:13:55	10:42:05	CPT	*Don't close it... no... doesn't matter now, leave it, leave it... leave it, leave it, open it, open it... we totally screwed it now, we screwed it now.* They close the door and a loud mechanical noise is heard.
0:14:05	10:42:15	F/O	*Why?*
0:14:07	10:42:17	CPT	*No, don't touch it.*
0:14:11	10:42:21	CPT	*We don't have the gear...*
0:14:15	10:42:25	ATC	**8852 you can turn right at your discretion to the localizer to complete ILS to 25 right.** Give vector to intercept runway 25R localizer.
0:14:21	10:42:31	CPT	*No, don't touch it.*

Flight time	UTC time	Speaker	Contents
0:14:23	10:42:33	F/O	*It's in... yes.*
0:14:24	10:42:34	CPT	*Oh, you'd already opened it.*
0:14:26	10:42:36	F/O	*Uhm, yes.*
0:14:27	10:42:37	ATC	**8852 I confirm you can turn right at your discretion to the localizer and complete ILS to 25 right.**
0:14:28	10:42:38	CPT	*We don't have the gear now.*
0:14:31	10:42:41	F/O	**Stand by, I'll call you back...**
0:14:32	10:42:42	CPT	*What's he saying?*
0:14:33	10:42:43	F/O	*That we can turn to intercept the localizer.*
0:14:38	10:42:48	CPT	*We're too high.*
0:14:40	10:42:50	F/O	**We need more miles, we're too high, 8852.**
0:14:44	10:42:54	F/O	*We haven't gone down to 1800!*
0:14:45	10:42:55	ATC	**Maintain current heading, you'll cross the localizer.**
0:14:48	10:42:58	F/O	**Maintain current heading, cross, 8852.**
0:14:51	10:43:01	CPT	*We're screwed, you shouldn't have touched that.*
0:15:03	10:43:13	CPT	*Ok!... hey, it's open. Pull!*
0:15:07	10:43:17	F/O	*Pulling.* The aircraft is at 5,300 ft and they are continuing with the alternate procedure to extend the gear.
0:15:16	10:43:26	CPT	*Continue the checklist please. What's it say?*
0:15:18	10:43:28	F/O	*Ok!*
0:15:19	10:43:29	F/O	*Condition lever... 1200... maximum airspeed 140.*
0:15:26	10:43:36	CPT	*Ok!*
0:15:27	10:43:37	F/O	*The inhibit switch, left gear, landing gear inhibit switch inhibit, what! Is it this one?*
0:15:31	10:43:41	CPT	*It's set, ok.*
0:15:32	10:43:42	F/O	*No, it's not set. It's up, but it's not set.*
0:15:34	10:43:44	F/O	*I'll set it.*
0:15:35	10:43:45	CPT	*Ok.*
0:15:37	10:43:47	F/O	*Now, inhibit.*
0:15:40	10:43:50	F/O	*Flaps 5... speed.* They extend flaps to 5°.
0:15:44	10:43:54	F/O	*Come on!*
0:15:46	10:43:56	CPT	*No landing gear down, so come on, hit that.*
0:15:54	10:44:04	CPT	*Gear released, ok?*

Flight time	UTC time	Speaker	Contents
0:16:01	10:44:11	F/O	*Tell him we have to turn.*
0:16:01	10:44:11	CPT	**Air Nostrum 8852 we should turn if possible.**
0:16:03	10:44:13	F/O	**Yes, you can turn right now.**
0:16:06	10:44:16	ATC	**Yes, you can turn right now.**
0:16:09	10:44:19	CPT	*Yes, turning.* They encounter turbulence, vertical acceleration increases to between 0.7 and 1.45 g's.
0:16:13	10:44:23	F/O	**8852, turning right to 250.**
0:16:16	10:44:26	ATC	**Heading 250, on your right.**
0:16:19	10:44:29	CPT	*We don't have the gear.*
0:16:25	10:44:35	F/O	*... I'm pumping...*
0:16:30	10:44:40		Alarm is heard for three seconds, then intermittent, then continuous (gear horn).
0:16:56	10:45:06	CPT	*Which one did we have to press for the inhibit?*
0:16:58	10:45:08	F/O	*Landing gear inhibit switch, this one, inhibit.*
0:17:13	10:45:23	F/O	*Speed!* Speed warning repeats four additional times. There is a drop in speed.
0:17:32	10:45:42	F/O	*Speed, ok, we're crossing... we have to go left... to... well, no...*
0:17:57	10:46:07	F/O	*So, what do you want to do?*
0:18:00	10:46:10	CPT	*Nothing, request the firefighters, we don't have nose gear.*
0:18:02	10:46:12	F/O	**Air Nostrum 8852, if we could have the firefighters, we don't have a nose gear down indication. The main gear is down but not the nose gear.**
0:18:11	10:46:21	ATC	**Roger, we'll call the firefighters. Call the tower on 18.1.**
0:18:20	10:46:30	F/O	*Speed! Speed!* The aircraft drops to 95 kts. The speed warning sounds several more times.
0:18:34	10:46:44	F/O	*Are we going around?*
0:18:37	10:46:47	CPT	*No! We're landing.*
0:18:41	10:46:51	F/O	**Barcelona Air Nostrum 8852, we're 4 miles out established on the localizer, a little high, but we don't have a nose gear down indication.**
0:18:51	10:47:01	ATC	**Air Nostrum 8852 roger, you are cleared to land runway 25 right, wind calm.**
0:18:57	10:47:07	F/O	**Cleared to land 25 right, wind calm, 8852.**
0:19:11	10:47:21	ATC	**8852, confirm declaring an emergency?**
0:19:14	10:47:24	CPT	*What's he saying?*
0:19:15	10:47:25	F/O	*Are we declaring an emergency?*

Flight time	UTC time	Speaker	Contents
0:19:16	10:47:26	CPT	*Mayday, mayday.*
0:19:17	10:47:27	F/O	**Mayday, mayday, mayday, 8852, declaring an emergency, the nose wheel is not down.**
0:19:23	10:47:33	ATC	**Roger.**
0:19:32	10:47:42	CPT	*Ok, runway in sight.*
0:19:38	10:47:48	F/O	*Landing check list.*
0:19:41	10:47:51	F/O	*What do we tell this lady?*
0:19:50	10:48:00	CPT	*Cabin crew sit down for... landing.* Calls the flight attendant.
0:19:55	10:48:05		*Ding Dong.* Indicator of intercom call.
0:19:57	10:48:07	CPT	*Yes?*
0:19:58	10:48:08	F/A	*Cabin ready.*
0:19:59	10:48:09	CPT	*We don't have the nose gear, ok?*
0:20:01	10:48:11	F/A	*Ok!*
0:20:19	10:48:29	F/O	*Do you want flaps 30? No, it doesn't matter right? 25 and set it down as late as possible.*
0:20:28	10:48:38	EGPWS	*Two hundred*
0:20:29	10:48:39	EGPWS	*TOO LOW GEAR, TOO LOW GEAR, TOO LOW GEAR, TOO LOW GEAR, TOO LOW GEAR, TOO LOW GEAR, TOO LOW GEAR.*
0:20:47	10:48:57	EGPWS	*TWENTY.*
0:20:48	10:48:58	EGPWS	*TEN.*
0:21:14	10:49:24		Sound of contact between runway surface and metal on nose of airplane.
0:21:21	10:49:31	EGPWS	*TOO LOW GEAR.*
0:21:27	10:49:37	F/O	*... Emergency*.
0:21:29	10:49:39	CPT	*... emergency,...*
0:21:31	10:49:41		Airplane stops.
0:21:41	10:49:51	CPT	**Air Nostrum 8852, we're evacuating on the runway.**
0:21:46	10:49:56	TWR	**Roger, thanks, the firefighters are behind you.**
0:21:49	10:49:59	CPT	**Thank you.**

1.7.2. *Digital Flight Data Recorder (DFDR)*

The aircraft was equipped with a digital flight data recorder. An analysis of the data recorded on it revealed that:

- Both engines were delivering power throughout the flight.
- There was no failure of either hydraulic system.
- When the approach was initiated, 30° bank turns were made. Vertical accelerations of between 0.63 and 1.47 g's were recorded.
- The landing took place with 15° flaps.
- The pitch angle during the landing was 6° nose up.

The graph in Figure 7 shows the IAS (blue) and altitude (magenta) over the course of the flight.

The maximum vertical acceleration at touchdown was 1.33 g's. The longitudinal deceleration during the landing run was between –0.25 to –0.54 g's.

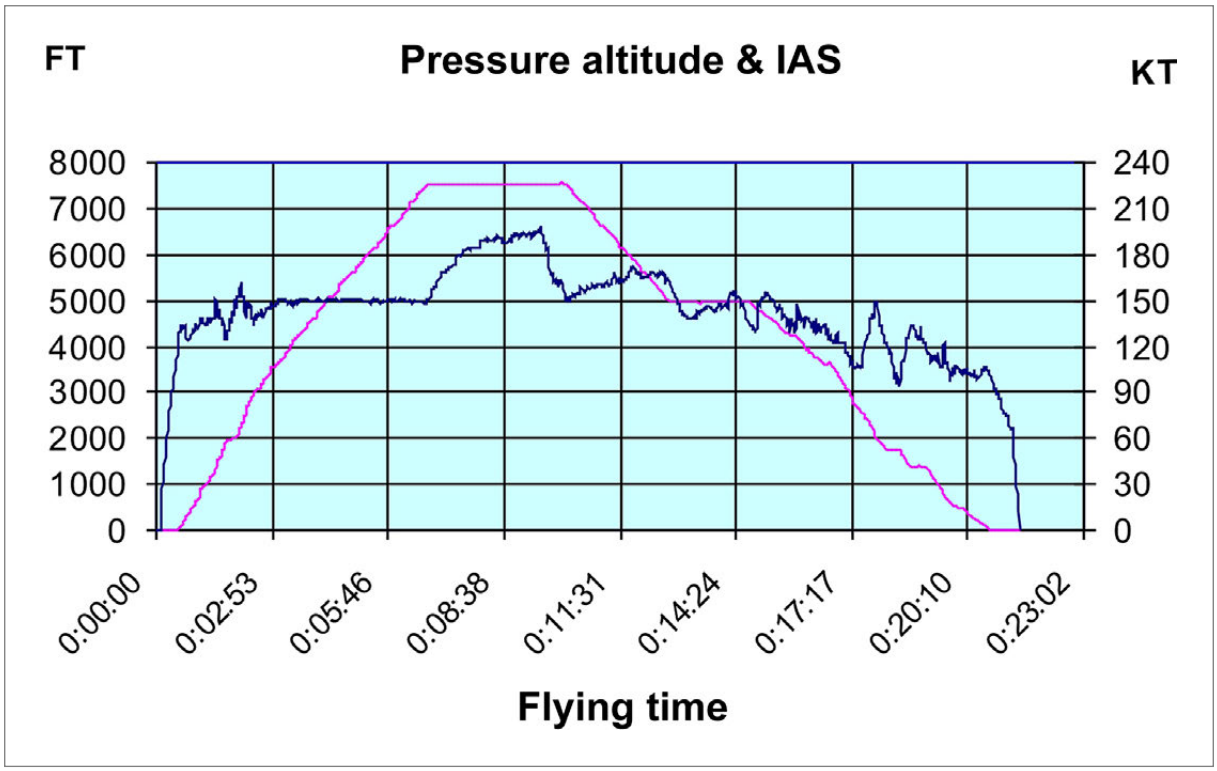

Figure 7. Graph of speed and altitude

1.8. Tests and research

The day following the incident, complete operational tests were conducted that included several extension and retraction cycles of the nose gear using both the normal and the emergency procedures with the airplane lifted on jacks. These tests were repeated a few days later after the aircraft was flown on a positioning flight to the maintenance base in Valencia. In the hangar in Valencia, the airplane was tested with the airplane up on

jacks, energized with electrical and hydraulic power from ground equipment and with the damaged doors on the nose gear removed.

The results were as follows:

1. The extension and retraction cycles of the nose and main gear were satisfactory.
2. The extensions using the alternate procedure were completed normally when the mechanical proportional valve for the nose gear doors was placed in its proper position. When this valve was not in its proper position, very long gear extension times of up to 225 seconds were recorded.
3. Repeating the gear retraction using the normal method, that is, raising the gear selector lever **but leaving the overhead door open and the floor door closed,** failed to raise the gear and left the three red gear unsafe lights energized.
4. With conditions as in point 3 above, closing the overhead door started the process of retracting the landing gear legs, with the door lights turning on momentarily before turning off when the legs were locked in the up position.
5. Repeating the retraction using the normal system, that is, raising the gear selector lever **and leaving both the overhead door and the floor door open,** failed to raise the gear and left the three red gear unsafe lights energized.
6. With conditions as in point 5 above, closing the overhead door started the process of retracting the nose gear lever with the main legs remaining extended. When the nose gear retracted and locked in the up position, its indicating light turned off. The red lights for the main gear legs remained on. On the alternate indicating system there were two green lights corresponding to the main gear legs down and locked.
7. In cases 4 and 6, the PTU motor pump turned on.

1.9. Organizational and management information

1.9.1. *Procedures involving the extension of the landing gear*

Denim Air had manuals with flight procedures in them containing normal and emergency checklists for use by its crews.

The preface to the emergency checklists contains guidelines to be followed when doing said lists:

- Crews must execute the procedures correctly, using the ECL (Emergency Checklist), the combined skills of both pilots and, most of all, sound judgment.
- The ECLs are to be read out loud by the PNF (unless otherwise specified) so that the PF can remain informed of the progress of the procedure.
- All actions, selections and switch manipulations that are not reversible shall be confirmed by both pilots prior to execution.

- When an emergency situation occurs, the nature of the fault must be clearly established by one pilot and confirmed by the other.
- The PF initiates the applicable procedure with the term "ACTION".
- Each ECL procedure shall be started with the PNF stating the name of the checklist in the applicable procedure.
- When the specific checklist is completed, the PNF must announce "CHECKLIST COMPLETE".

Part B of the Denim Air Operations Manual, Emergency Procedures, "Pilot Incapacitation", states that whenever the PM notifies the PF of a deviation from the desired flight profile, the PF shall reply "Checked correcting". If the PF does not reply, the PM will notify him one more time and if there is again no reply, the PM shall assume that the PF is incapacitated and take the controls of the airplane stating "My control".

1.9.1.1. Pre-flight

Line 4 of the normal PRE-FLIGHT checklist calls for a check of the position of the alternate landing gear controls:

Alternate landing gear controls ..... CHECKED

1.9.1.2. Failure of the #2 hydraulic system. ECL 18

In the event of a declared failure of the #2 hydraulic system, which supplies the normal system for extending and retracting the landing gear, the procedure first has the pilot check if the hydraulic fluid level is normal.

Pressure is then reestablished using the stand-by hydraulic pump and the PTU. If unsuccessful, the procedure refers to the one for the alternate gear extension.

A warning states that the procedure must be completed before the start of the approach, that the procedure could take up to seven minutes and that the nosewheel steering and parking brakes, among others, will be lost.

Some landing considerations are presented and a statement warns against using the PTU in manual during the approach.

1.9.1.3. Defective operation of the landing gear indicators. ECL 24A

If the landing gear indicating lights are suspected of working abnormally, the gear down and locked position is to be checked using the indicators installed beneath the floor

door. The procedure ends with the closing of the floor door before proceeding with a normal landing or with the alternate extension of the gear.

1.9.1.4. Gear light LDG INOP CAUTION LIGHT. ECL 24B

The procedure states that if this light is activated, the gear must be lowered using the alternate procedure and to land as soon as possible.

1.9.1.5. Alternate landing gear extension. ECL 25

The preliminary notes warn that the procedure can take up to seven minutes to execute and that it must be completed prior to the final approach. The PTU must not be selected to manual during the approach.

The procedure notes that releasing the locks on the retracted gear may require pulling on the handle with a force greater than that experienced during practice extensions.

The full procedure is included in Appendix A2. It starts with opening the overhead door and releasing the main gear and then checking the door and left and right leg gear indicators. The nose gear is then released, followed by a check of its doors and locks. Both the overhead and the floor doors must be left open.

1.9.1.6. Landing gear unsafe. ECL 26

If a landing is performed with the nose gear up and both main gear legs extended, it states to have the passengers' seats in the aft seats, to lower the nose before the effect of the elevator is lost and not to exceed a 5° up angle on the flare.

In preparation for the landing, the crew is instructed to open the E5 C/B (gear warning) and the B3/B9 C/B on the EGPWS and to warn of a possible evacuation. The entire procedure is included in Appendix A1.

1.10. Additional information

1.10.1. *Emergency checklists associated with the landing gear used by other operators and the manufacturer*

In page 11-2 of the QRH of Air Nostrum, operator of the flight and also an operator of the same DHC8-315 aircraft, there is a "Landing Gear Unsafe" procedure that refers to the condition of the active landing gear unsafe lights. It is attached as Appendix B1.

In this case, once the speed limitation is established, the list requires checking that the overhead door is closed and that the inhibit switch is in its normal position. If under these conditions the gear unsafe lights go out, the procedure allows for the normal continuation of the flight.

Checklists used by the operator Deim Air, normal and emergency checklists related with this event, and mentioned on precedent point 1.9.-Organizational and management information, were coherent with normal and emergency checklists approved and recommended by the manufacturer, according to data compiled and submitted by them.

2. ANALYSIS

2.1. Sequence of actions involving the landing gear system

It was the first flight of the day for the captain, but not for the rest of the crew, which had already flown the reverse of the route planned for this flight. On this leg the captain (CPT) was the pilot flying (PF) and the copilot (FO) was the pilot monitoring (PM). The FO conducted the walk-around check while the CPT did the pre-flight procedures in the cockpit (pre-flight checklists).

The "Landing Gear Alternate Release Door", located in the overhead in the cockpit, was probably partially open when the crew reported to the airplane, but if so, this was not detected either by the CPT during her check of the cockpit or subsequently by either pilot at any time prior to takeoff. The airplane thus took off with this condition uncorrected.

Under these circumstances, the bypass valve prevents the pressurization of the landing gear, meaning that it does not retract when the gear selector lever is placed in the up position.

When the gear lever was actuated after takeoff, the crew, which was probably focused on flying the airplane along the assigned instrument departure in difficult weather conditions with abundant clouds and storms nearby, did not detect anything abnormal.

Some three minutes after takeoff the crew saw the three red lights indicating a gear unsafe situation. The crew was unable to identify the condition of the gear, discussing it for several minutes along with which emergency checklist to use.

The CPT decided they had to return to Barcelona and informed ATC, which started supplying them with radar vectors to runway 25R along a wide circuit to the right, to the northwest of the airport.

They asked the flight attendant (FA) to visually verify that the main gear was down. They also opened the "Landing Gear Alternate Extension Door" and verified that the three green lights turned on when the associated switch was activated, but based on their own statements they could not determine whether the green lights indicated that the gear was down and locked or if it was only a test indication. The door was not closed after said lights were checked, as indicated in the corresponding procedure (ECL 24A). The bypass valve on the main gear alternate hydraulic system thus remained activated.

They finally concluded that all of the legs must be down and locked, but nonetheless decided to extend the gear using the alternate system.

On a parallel course to the runway, some 5 NM to the NW, it was probably then that they actuated the manual selection switch on the PTU, though they would not have noticed any consequences. Since the #2 hydraulic system was pressurized and there were no hydraulic loads, the pressures at either end of the PTU motor pump were balanced and thus the PTU would not have rotated.

The crew stayed on a NE heading on a long downwind leg while they combatted the emergency and decided to execute the alternate landing gear extension procedure. Near the base leg of the circuit (point E in Fig. 1), they started the alternate extension procedure by looking for the inhibit switch. It was then that they discovered the overhead door open.

After this, the flight crew temporarily closed the overhead door, which initiated a retraction of the entire landing gear apparently. The PTU, now loaded by the cylinders, started to rotate, making an "alarming and deafening" noise, according to the crew. Since the #2 engine was still rotating normally and supplying oil pressure, the only way to operate the PTU was to place it in manual. The nose gear doors would have opened to let the wheels through, turning on the corresponding amber light, and the nose leg would have fully retracted until it locked, turning off its amber indicating light.

The noise from the PTU made the crew open the overhead door again, which reactivated the bypass of the hydraulic system. The floor door very likely remained open and thus the bypass of the alternate, or standby, hydraulic system remained closed. Under these conditions, the auxiliary cylinder cannot move, and thus cannot provide a hydraulic lock for the main legs regardless of their position. The main legs, therefore, did not move from the down position, nor would they unlock from said position.

Had the crew not left the floor door open and had they not selected the PTU to manual, the landing gear would have fully retracted without making any abnormal noises. All of the gear lights would have gone out and they could have continued the flight.

Interrupting the alternate gear extension procedure for the reasons stated above, the crew resumed it later by selecting the gear down procedure and pulling on the lever to

release the main gear. As already indicated, the main legs were already down but the release of the locks resulted in the main gear doors opening. The photo in Figure 2 shows that the aircraft in fact had its main gear doors open. The CPT then noticed based on the cockpit indications that the nose gear was not extended and ordered the FO to pull on the corresponding handle.

Fig. 2 shows that the nose gear doors were open, which confirms that the copilot pulled on their release handle. As the procedure warns, the force applied may not have been sufficient, meaning that the gear would have remained locked in the up position. The alternate gear position system would have shown two green lights for the main gear down and locked and the light associated with the nose gear off, which informed the crew that they would have to land without the nose gear.

Later, when the aircraft was removed from the runway, the handle was pulled again, unlocking the nose gear, which extended without any problems.

Even though the main gear was correctly extended, the copilot actuated the stand-by hand pump, which is only necessary to fully extend the main gear if it is partially extended.

At that time the aircraft was on final approach and had joined the airport's traffic pattern. The crew was preparing for the imminent landing but without having prepared the aircraft in accordance with the emergency landing procedure with the nose gear up. The turns were performed at a bank angle of under 30° but the acceleration was between 0.63 and 1.47 g's, indicative of turbulence.

The main gear touched down a little after twenty minutes after the takeoff with a vertical acceleration of 1.33 g's. The airplane came to a full stop 43 s after touchdown. The nose was in contact with the ground for the last 12 of those seconds.

The water on the runway helped reduce the friction between the nose and the asphalt and eliminated any chance of sparking.

2.2. The overhead door in the procedures of manufacturer and Denim Air

None of manufacturer De Havilland and Denim Air's procedures considered that the position of the overhead "Landing Gear Alternate Release Door" could be the cause of the inability to retract the gear. In the event of an unsafe gear indication, the crew was instructed to perform other emergency procedures, including the alternate extension of the landing gear. Had a procedure been available to the crew that included a check of the position of this door, the crew could have quickly ascertained its abnormal position, corrected it and retracted the gear, allowing them to continue with the flight normally.

Such a procedure containing this check called *Landing gear unsafe*, and enclosed like appendix B1, has been identified in an operator with wide experience with this aircraft type. It thus seems reasonable to recommend to the manufacturer De Haviland-Bombardier and to Denim Air that they develop a similar procedure.

2.3. Execution of the procedures by the crew

The CVR recordings raise justified doubts regarding the way in which the procedures were followed. There were no clear oral references to the procedures in use at any given time, to each pilot's assessment of the situation, to the actions they were taking or to the completion of the procedures.

The procedures were constantly interrupted by operational considerations, by ATC communications and by the attention required by the weather situation. The crew's attention also drifted frequently due to emotional or secondary reasons, causing them to shift their focus away from the situation.

Starting with the flight preparation, the normal pre-flight CL (checklist) has the pilots check the alternate gear extension controls. A careful check of the cockpit upon reporting to the airplane would have eliminated the cause that triggered the incident, namely the partially or fully open position of the overhead door.

A greater focus on the flight conditions after taking off and selecting gear up would have alerted the crew to the fact that the gear had not retracted. As it was, it took the crew three minutes to notice the situation. The airplane continued to climb and accelerate to an IAS of 199 kt, in excess of the top speed allowed with the gear down.

The procedure for a failure of the #2 hydraulic system (ECL 18) should not have been performed since said failure did not occur; the #2 hydraulic system did not lose pressure. The activation of the PTU and the position of its switch in the cockpit, manual on, however, indicate that it had been manipulated. The switch was probably in the manual position for 13 minutes from the time of its initial actuation until after the landing, even though procedural warnings state that the PTU system must not be activated during the approach. The time limit for its operation is intended to prevent the heating of hydraulic fluid that can result from prolonged use of the PTU. However, since the main gear was immobilized and thus the PTU was not being used, it is reasonable to assume that no abnormal heating took place. The crew's reaction to the noise indicates a lack of knowledge of the system.

Procedure 24A on the alternate check of the gear's position emphasizes that regardless of the result of the check, the floor door must be closed before continuing on to other actions or procedures. It is thought that this door was left open as a logical reaction to the non-retraction of the main gear when the overhead door was closed. In support of

this conclusion, the results of the hangar tests confirmed that the gear does or does not go up depending on whether the door is closed or open.

The checklist for the alternate extension of the landing gear warns that the procedure can take up to seven minutes, which should be taken as a recommendation to execute it calmly. An analysis of the CVR recordings indicates that despite the FO does remind the CPT of this, it was too late and finally the crew did not take this recommendation into account.

The procedure notes that a considerable pulling effort may be required to unlock and release the gear before it can start to drop under the force of gravity. Based on the tests conducted and on the condition of the gear during the landing, it is believed that the effort made during the flight to release the nose gear was probably insufficient.

Despite having sufficient indications that the two main gear legs were down and locked, the crew insisted on using the stand-by pump, which has no effect on the nose gear. This also confirms a certain lack of knowledge of the system and the procedure.

The procedure also repeats the warning from ECL 18, Failure of the #2 hydraulic system, that the PTU must not be selected to manual during the approach.

As for the landing with the gear unsafe (ECL 26), the procedure was not explicitly followed, though some of its instructions may have been performed from memory. The precaution to relocate the passengers to the rear of the cabin was thus not taken. This could have reduced the weight on the nose gear by about 200 kg. The 5° nose-up limit was also exceeded, with a value of up to 6° being recorded during the flare and landing.

In preparation for an emergency landing, the procedure states to open the E5 and B3/B9 circuit breakers, which prevent the activation of the landing gear horn and the EGPWS warnings that will sound when landing with the gear not fully extended. Since the C/B were not opened, these acoustic warnings were received, increasing the stress level of the crew at a time of high tension during the emergency landing.

2.4. Human factors analysis

The airplane was verified to have no malfunctions that could have prevented the normal operation of the landing gear. Instead it was human actions and omissions that resulted in the landing gear alternate release door being left open improperly, in this condition not being detected during the preparation of the cockpit or at any other time prior to takeoff and, once airborne, in not resolving this abnormal situation properly. The actions of the pilots are determined by their technical and non-technical skills and abilities.

2.4.1. *Technical skills of the pilots*

Both pilots seemed to have insufficient knowledge of the alternate landing gear extension system, especially of the effect of the position of the "Landing Gear Alternate Release Door" and "Landing Gear Alternate Extension Door". Moreover, due to the way noted earlier in which they performed the emergency procedures, and due to the cockpit conversations recorded, it follows that neither pilot had an in-depth knowledge of or familiarity with the QRH. These conversations show this lack of knowledge when, for example, they seem to recall that there is a "unsafe" list, when they question the significance of the green lights they see under the "Landing Gear Alternate extension Door", when they look for a way to silence the gear horn or when they manually pressurize the system unaware that it would not affect the nose gear.

The CPT stated repeatedly that they were without the gear once the FO closed the "Landing Gear Alternate Release Door", evidencing a lack of knowledge of its function. Her resignation to land without the nose gear, believing it inevitable, shows a lack of overall knowledge of the landing gear system and of the alternate extension procedure.

Neither pilot seemed to know or remember the note in the procedures stressing the importance of pulling hard on the extension handles.

2.4.2. *Proficiency in non-technical skills, CRM*

An essential component of the CPT's responsibility is proper time management, both when acting with due diligence in some cases and when knowing how to find the time necessary to think in other cases to make plans, have a briefing, allocate the workload, execute the procedures without making mistakes, and so on. In this case the airplane had enough fuel for a round trip to San Sebastian, which gave the crew time to enter a holding pattern and properly resolve the situation, but the CPT insisted repeatedly that she wanted to land as soon as possible.

The basic roles of the crew were established on the ground, with the CPT acting as the pilot flying (PF) and the FO as the pilot monitoring (PM) and handling communications. This distribution of roles commonly assumes that in the event of an emergency, the PF will focus on flying the airplane while the PM handles the emergency using the corresponding checklist. However, from the time they discovered the problem, the CPT involved herself in reading the QRH, neglecting to a certain extent her duty to fly the airplane. The FO reminded her of this 8:39 minutes into the flight, but she seemed not to hear and continued to read the QRH.

The absence of an efficient task sharing in the cockpit contributed to the disorder and to the failure to execute items in the emergency procedures, as well as to poor oversight. This contributed to significant deviations from the required speed and flight path.

The CPT also made her decisions without considering the opinions of the FO. She did not act like part of a team whose decisions affect the other team members, most notably the flight attendant, whose efforts were vital to the safety of the passengers. There are no indications that there was any animosity between the two pilots; on the contrary, the long conversations recorded on the CVR prior to takeoff, many of a personal nature, show the good nature of their relationship and that they even shared common hobbies. It is logical, thus, to think that there was a climate of trust at all times that was conducive to communications. And yet the course of events and the CVR recording showed that the CPT made decisions without consulting her FO and ignoring his input.

The cause of the deficient teamwork was due in part to the fact that a briefing was not held in which the CPT highlighted the need to work as a team and encouraged participation and open communications, especially when the safety of the airplane was at stake.

Also notable was the hesitation of the FO to convey his opinions to the CPT with proper clarity and insistence and to ensure, at a minimum, that they were taken into account, especially when they affected safety. Not openly requesting a go-around when the CPT finally expressed her decision to land without the nose gear is highly indicative of a failure to use this CRM technique.

Defective team management and the ineffective tasks sharing resulted in the poor oversight of the flight and of the airplane's performance.

The airplane's speed exceeded the maximum allowed with the gear down (V_{le} of 173 kt) for two and a half minutes, reaching a maximum of 197 kt. During the execution of the alternate gear extension procedure, which states that the speed must be below 140 kt, the speed was maintained in excess of 150 kt during the almost four minutes it took to complete said procedure.

During the approach with the flaps at 15°, the IAS twice fell below the reference speed (105 kt), the second time dropping to 95 kt. Twice during the approach the PF forgot to descend after being cleared to do so. The PM also failed to notice this and on several occasions they forgot to change the radio frequency after having been transferred to another station.

2.4.3. *Possible subtle incapacitation of the CPT*

The difficulty of identifying the incapacitation of an on-duty pilot in time, especially a subtle incapacitation that is not accompanied by obvious signs such as a loss of consciousness, is well known. Such incapacitations, however, are more frequent and potentially more dangerous.

It is likely that the CPT was experiencing some kind of subtle incapacitation that could have affected her performance and that the FO did not detect it, despite having enough signs to warrant such suspicions. For example, the CPT's strange obsession with landing as soon as possible and her response to important inputs, such as when the FO informs her that they are number two for landing and he wants to request more time to complete the procedure and she replies, "I want to land now!" During the approach the airplane lost speed involuntarily twice. This was announced by the FO, who repeated the warning up to 18 times. On the first occasion in particular the CPT's reaction was minimal for several seconds, but the FO did not adhere to the protocol in the OM to detect the potential incapacitation and take control.

Checklists and call outs also serve to force the two pilots to interrelate, which enables them to check for behavior indicative of incapacitation. On this flight all of the normal lists were performed on the FO's initiative, even the "After takeoff", "Approach" and "Landing" checklists, which should have been initiated by the PF, the CPT in this case. The CPT is not heard acknowledging any items on these lists. There were also no call outs heard on the CVR involving the autopilot or FMS modes selected or any deviations in speed, except for those noted above. Thus, the lack of standardization in performing the lists and in using the call outs caused the copilot to miss an additional opportunity to detect the potential incapacitation of the CPT.

Two safety recommendations are issued to the operator in an effort to correct the deficiencies detected involving technical aspects and CRM.

3. CONCLUSION

3.1. Findings

- The aircraft had a valid airworthiness certificate and there were no defects or malfunctions noted in the landing gear system.
- The checklist procedures used by the operator were based and copied from those provided by the manufacturer.
- The flight in Barcelona started under stormy conditions.
- After takeoff, the gear did not retract when commanded.
- After operating various controls in the normal and alternate systems for extending the landing gear, the airplane's final configuration was one in which the gear doors were open, the two main landing gear legs were down and locked and the nose gear was up.
- The gear indicating lights on the alternate system showed that the main gear was down and locked and the nose gear was unsafe and not locked.
- The landing was soft, which helped to minimize the damage, which was limited to the nose gear doors and scrapes in the fuselage in the area of the nose.

- The 32 passengers and 3 crew evacuated the aircraft normally, aided by emergency services personnel.
- No faults or technical reasons were found that prevented the normal operation of the normal or alternate landing gear systems.

3.2. Causes

The cause of the incident was the improper operation of the landing gear system by the crew that, due to both a lack of knowledge of said system and to deficiencies in the use of the available procedures, was unable to identify or correct the abnormal configuration of the Landing Gear Alternate Release Door.

4. SAFETY RECOMMENDATIONS

REC 90/12. It is recommended that the operator, DENIM AIR, enhance its crew training on standard operating procedures (SOPs) in general and on the operation of the alternate gear extension system (including the manual pump, the doors and their effect on the bypass and stand-by valves) and on the PTU hydraulic power transfer system, including the limitations on their use.

REC 91/12. It is recommended that the operator, DENIM AIR, enhance its crew training on CRM, paying special attention to the importance that CRM skills have to the proper execution of procedures in general and to emergency situations in particular.

REC 92/12. It is recommended that the manufacturer Bombardier Inc. (former De Haviland) and the operator DENIM AIR define and implement an operating procedure on requiring crew actions in the event of an unsafe gear indication that checks the position of the Landing Gear Alternate Release Door and of the Inhibit Switch on the landing gear hydraulic system.

REC 93/12. It is recommended that DENIM AIR enhance its crew training on the application of pre-flight checklists and on verifying the condition of control instruments and components in the cockpit.

APPENDICES

APPENDIX A1
"Landing Gear Unsafe" Checklist used by Denim Air

Jenim Air	EMERGENCY CHECKLIST DASH 8	Q315

LANDING GEAR UNSAFE

- Prior to this procedure consider the 'ALTERNATE GEAR EXTENSION' checklist (tab 25A) or the 'LANDING GEAR INOPERATIVE' checklist (tab 24B) or the 'LANDING GEAR INDICATOR MALFUNCTION' checklist (tab 24A).

■ **Nose gear up and both main gears down:**

- Seat passengers aft.
- Lower the nose before the elevator effectiveness is lost.
- Use brakes for steering.

■ **One main gear up and nose gear up or down:**

- Seat passengers near emergency exits.
- Hold unsupported wing up as long as possible.
- Maintain directional control with rudder, brakes and nose wheel steering.

■ **Nose gear down and both main gear up:**

- Seat passengers near emergency exits.
- Touch down will be lower than usual, resist tendency to stall.

■ **Main and nose gear are up:**

- Seat passengers near emergency exits.
- Touch down will be lower than usual, resist tendency to stall.
-

Procedure continues on next page

Date: 21-10-2001	ISSUE: 7.	Page: 56

Jenim Air	EMERGENCY CHECKLIST DASH 8	Q315

LANDING GEAR UNSAFE (cont'd)

Landing considerations:

- Anticipate a possible 'ON GROUND EMERGENCY' procedure after landing.
- Maintain Vref and minimum rate of descent prior flare.
- Do NOT exceed 5° nose up during flare.
- Stop the aircraft on the runway, consider engine shutdown.
- Do NOT taxi to vacate the runway before the gear pins and nose gear lock are installed.

Preparation:

ATC..... INFORM
Cabin crew..... BRIEF
Seatbelt sign..... ON
Gear warning C/B (E5)..... PULL
(E)GPWS C/B (B3/B9)..... PULL

- If practicable burn fuel down to minimum, but NOT less than the final reserve fuel.
- Prepare cabin for 'on ground emergency'.

Landing:

Landing gear selector..... AS REQUIRED
Synchrophase..... OFF
Condition levers..... 1200 SET

- Use a flap setting which results in the lowest possible Vref.

Flaps..... ____ SET
Missed approach altitude..... ____ SET
Bleeds..... MIN and OFF
PA..... CALL

"CABIN CREW AND PASSENGERS EMERGENCY POSITIONS"

When aircraft has stopped:

- Stop the aircraft on the runway, consider engine shutdown.
- Do NOT taxi to vacate the runway before the gear pins and nose gear lock are installed.
- Anticipate a possible 'ON GROUND EMERGENCY' procedure after landing.

Date: 21-10-2001	ISSUE: 7.	Page: 57

APPENDIX A2
"Alternate Gear Extension" Checklist used by Denim Air

Jenim Air	EMERGENCY CHECKLIST DASH 8	Q315

ALTERNATE GEAR EXTENSION

Landing considerations:

- This ECL procedure shall be completed up to and including the alternate gear extension sequence, prior to commencing the final approach.
- Completion of this procedure may take up to 7 minutes.
- Landing gear can NOT be retracted after alternate extension.
- Nose wheel steering will be inoperative.
- Do NOT select MANUAL PTU on during approach.

Landing distance factor flap 15 ..... 1.21
Landing distance factor flap 35 ..... 1.21

After take off:

Landing gear position ..... CONFIRM
Flaps 0
Auto feather ..... OFF
Bleeds ..... ON and NORM
Climb power ..... _____SET
Synchrophase ..... ON
Tank aux pumps ..... OFF
Standby hydraulic pressure #1 and #2 ..... NORM
Altimeters ..... _____SET
Seatbelt sign ..... AS REQUIRED

Descent:

Pressurization ..... SET
Approach preparation ..... COMPLETED
Speed bugs ..... ___/___/___SET

Approach:

Nose wheel steering ..... ON
Exterior lights ..... SET
Seatbelt sign ..... ON
Altimeters ..... _____SET
Fuel transfer ..... OFF
Tank aux pumps ..... ON
Standby hydraulic pressure #1 and #2 ..... ON
Crew briefing ..... COMPLETED

Procedure continues on next page

Date: 21-10-2001	ISSUE: 7.	Page: 54

ALTERNATE GEAR EXTENSION (cont'd)

Alternate gear extension sequence:

Condition levers ..... 1200 SET
Maximum airspeed ..... 140 KIAS
L/G inhibit switch ..... INHIBIT
Landing gear selector ..... DOWN

- Gear release handle loads may exceed those experienced during practice extension
- If alternate gear extension is NOT successful consider the 'LANDING GEAR UNSAFE' checklist (tab 26A).
- If LEFT and/or RIGHT green gear locked advisory lights do NOT illuminate, insert hydraulic pump handle in socket and operate pump until LEFT and RIGHT green advisory lights illuminate.

Landing gear alternate release door ..... OPEN
Main gear release handle ..... PULL FULLY DOWN
Main gear green lights ..... ON
L and R DOOR amber lights ..... ON
Landing gear alternate extension door ..... OPEN
Nose gear release handle ..... PULL FULLY UP
Nose gear green light ..... ON
Gear-locked-down indicator ..... ON
Alternate doors ..... LEAVE OPEN
Anti-skid ..... TEST

Landing:

Cabin ..... READY and WARNED
Synchrophase ..... OFF
Landing gear ..... CONFIRM DOWN
Flaps ..... SET
Condition levers ..... CONFIRM 1200 SET
Missed approach altitude ..... SET
Bleeds ..... MIN and OFF

As soon as possible after engine shutdown:

Ground locks ..... INSTALL

APPENDIX B1

"Landing Gear Unsafe" Checklist used by Air Nostrum

LANDING GEAR UNSAFE
(RED LANDING GEAR UNSAFE ADVISORY LIGHT)

IF any RED landing gear UNSAFE advisory light remains ON:

1) MAX AIRSPEED..... V_{LO} (163 KIAS)
2) LANDING GEAR ALTERNATE RELEASE DOOR ..... CONFIRM CLOSED
3) LANDING GEAR INHIBIT switch..... CONFIRM NORMAL

IF RED landing gear UNSAFE advisory lights go OUT:

1) **Continue flight.**

- END -

IF any RED ldg gear UNSAFE advisory light remains ON:

Landing Gear was selected UP:

1) LANDING GEAR SELECTOR..... DOWN
2) **LAND AT NEAREST SUITABLE AIRPORT**

IF UNSAFE condition remains:

1) Complete *ALTERNATE LANDING GEAR EXTENSION PROCEDURE* (Page 11-5).

- END -

Landing Gear was selected DOWN:

1) RECYCLE ..... ONCE

IF UNSAFE condition remains:

1) Complete *ALTERNATE LANDING GEAR EXTENSION PROCEDURE* (Page 11-5).

----- END -----

APPENDIX C1
Dutch Safety Board Comments

DATE	YOUR REFERENCE	PAGE
July 18, 2012	E-mail 12 June 2012	1 from 2
CONTACT	OUR REFERENCE	ENCLOSURE(S)
K.E. Beumkes	OvV-12501459	0
TELEPHONE	PROJECT NUMBER	
+31 70 3337016	Report IN-027/2009	

THE DUTCH SAFETY BOARD

Comision de Investigacion de Accidentes e
Incidentes de Aviacion Civil
Ministerio de Fomento
Mr. F.J. Soto, secretary CIAIAC
C/ Fruela, 6
28011 MADRID
SPAIN

SUBJECT
Comments Draft Final Report

Dear Mr Soto,

Thank you for giving the Dutch Safety Board the opportunity to share its view regarding the draft final report of the incident with the DeHavilland Dash 8, registration PH-DXB, operated by Denim Air at Barcelona Airport on 22 October 2009. The Safety Board has read the report with care and believes that the CIAIAC has given a clear reproduction of the conditions that led to the incident. In general the Board agrees with CIAIAC's findings. It is the Board's opinion that CIAIAC's view on the performance of the crew is prudent.

The incident took place with a (wet lease) flight that was executed for the Spanish airline company Air Nostrum. It took place with a Dutch registered aircraft on the Air Operator's Certificate of the Dutch airline company Denim Air and piloted by Spanish pilots with Dutch pilot licenses.

The Safety Board's main concern regarding an incident like this in an international setting is the matter of oversight. Or, in other words, who is responsible for the operational aspects of this flight? And which civil aviation authority is responsible for the oversight and how did that authority act in respect to its responsibility? Probably this can be addressed in the report more extensively.

Under the same header some training issues could be addressed. Reading the report the Board became curious to know where the crew received training and by whom? What is the contents of captaincy training and what have been the training results in this case? Which authority approved training and kept oversight?

It could be that the CIAIAC considers these last questions not appropriate at this stage of the investigation. In that case it would contribute to flight safety if at least the CIAIAC address the matter of international oversight on operation and crew licensing and training.

ADDRESS
Anna van Saksenlaan 50 2593 HT The Hague The Netherlands
TELEPHONE +31 70 333 70 00 TELEFAX +31 70 333 70 77
INTERNET www.safetyboard.nl

P.O. Box 95404 2509 CK The Hague The Netherlands

OUR REFERENCE
OvV-12501459

THE DUTCH SAFETY BOARD

The Safety Board thinks that the matter of the so called "subtle incapacitation" of the captain is speculative and not substantiated. The Board agrees with the CIAIAC that the captain did not act as might expected but in the Board's opinion her behavior could also be related to stress. It would improve the report if the CIAIAC could clarify its assumption on the human aspects of the operation.

The matter of the instant return has been addressed in the report. But the Board thinks that this issue could get some more attention because this haste for return led to or at least contributed highly to the unsafe landing. This was not necessary as there was enough time (fuel) available.

In 2010 Denim Air has been declared bankrupt and the organization made a new start. The new organization disposed itself of the Dash 8 aircraft which was involved in this incident and operates with four Fokker 50 and one Fokker 100 aircraft only. This might be of concern since two of the four safety recommendation in the report refer to Denim Air Dash 8 operational procedures.

Finally the Safety Board has two technical remarks. In the third paragraph of page 21 of the report it is said that "under these circumstances, the bypass valve prevents the pressurization of the nose gear". But is it not that this is also true for the main gear and should be added?

Secondly, the incident makes it clear that the correct position of the "landing gear alternate release door" is important for the normal pressurization of the landing gear. This door is located on the overhead panel and a spring will hold the door in its place against gravity forces. It seems that the position of the door is critical and could be a weak link in the system. It would improve the report if the CIAIAC could clarify why the release door was not in the correct position prior to the flight and investigate whether this phenomenon has occurred with other Dash 8 operators too. If so, this may ultimately lead to a recommendation to the manufacturer to inform pilots in the aircraft manual in order to increase their awareness regarding the criticality of the position of the release door.

On behalf of Kas E. Beumkes, NL Accredited Representative,

H. van Duijn
Investigation manager