

Investigation Report

1X001-0/07
November 2008

Identification

Type of incident:	Accident
Date:	21 September 2007
Place:	Munich
Aircraft:	Transport aircraft
Manufacturer / type:	Bombardier Inc. / DHC 8-400
Injuries to persons:	No injured persons
Damage to property:	Aircraft seriously damaged
Other damage:	Airport installations
Source of information:	Investigation by BFU

Factual information

During the approach for landing on the Florence Airport it was impossible to extend the nose landing gear with the normal system. It was decided to return to Munich where an emergency landing was performed with extended main landing gear only.

History of the flight

The aircraft was on a scheduled flight from Munich to Florence. During the landing at the airport of destination the crew realised from the indicators that the nose landing gear was not extended. The extension process was repeated several times without success. According to the statement of the crew, the emergency process for extending the landing gear was not performed due to unusual mechanic noises; instead, the decision was taken to return to Munich.

In Munich, the attempts to extend the nose landing gear with the normal and also with the emergency procedures, failed. After the preparations for emergency

landing, the aircraft touched down at 7:52 p.m.¹ on runway 08R and came to a halt after approximately 465 m on the centre line of the runway. The passengers were able to leave the aircraft via the stairway at the front door.

Personnel information

Each of the pilots held his air traffic pilot license and medical certification. The captain had a flight experience of approximately 10,000 hours, of these 6,918 hours on this type. The co-pilot had a flight experience of 3,906 hours, of these 2,445 hours on this type.

Aircraft information

The aircraft DHC-8-400 (S/N 4028, year of construction 2000) is a high-wing aircraft with two engines. It has 72 passenger seats. The affected aircraft had valid certificates of registration issued by Germany. The maximum allowed take-off weight of the aircraft was 29,257 kg. The total operating time at the moment of the incident was 13,382 hours.

The DHC-8-400 has a retractable landing gear with nose wheel arrangement. The landing gear are extended or retracted by changing the position of the landing gear lever in the cockpit. This change triggers an electric signal in order to release the mechanical locks and to extend or retract the landing gears hydraulically. In case of a failure of the power supply or of the hydraulic system, the landing gear can be extended by means of a mechanic emergency system; however it cannot be retracted..

The emergency extension of the nose landing gear (NLG) is accomplished mechanically by pulling a "T"

¹ All times given are in local time unless indicated differently

handle located beneath a door on the cockpit floor. Initial activation of the Nose Gear Release Handle results in the opening of the nose landing gear doors.

As soon as the actuation mechanism of the nose landing gear doors is released by the release lever, a coil spring pulls open the doors. A continued pulling of the Nose Gear Release Handle results in the nose landing gear being released from its up lock, and then free falling to the down and locked position. Due to the missing hydraulic support, the nose landing gear doors remain open after an emergency actuation of the landing gear.

Meteorological information

At the time of the accident, the weather information for the airport Munich was the following: Wind from 80° with 5 knots, no clouds, no visibility restrictions (CAVOK), temperature 14 °C, dew point 9 °C, altimeter setting 1,022 hPa, no significant change to be expected (nosig).

Aerodrome information

The Munich airport is located to the northeast of the city; it has an elevation of 1,487 ft. It has two parallel concrete runways in east/west direction with a length of 4,000 m (08/26).

Flight data recording

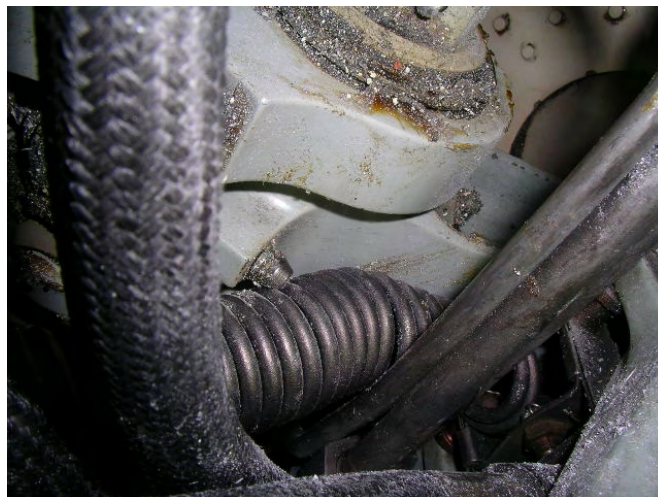
The flight data recorder and the cockpit voice recorder were available for data readout. A data readout was not performed.

Accident site and findings

Shortly behind the threshold of runway 08R, the aircraft touched down with the two main landing gear wheels. The slide mark of the nose began at taxiway B4, approximately 1,100 m behind the threshold. The aircraft came to rest on the centerline of the runway, at approximately 1,550 m near the taxiway B6. Both front nose landing gear doors were opened and pressed aside. For recovery purposes, the aircraft was positioned onto a special vehicle. It could be seen that the outer skin of the fuselage as well as the frame were scratched immediately behind the nose landing gear bay.

The further investigation of the aircraft resulted in the fact that no damage was present in the normal actuation system for the doors and the nose landing gear, nor in the emergency extension mechanism. An actuation distance of 11 cm was measured at the emergency extension pulling handle. At another aircraft of the same type, an actuation distance of approximately 30 cm was measured.

A coil spring was found jammed between the nose landing gear steering control hydraulic lines situated on the lower part of the NLG drag strut (Appendix 1). The spring was broken on one end. After removing the spring from the landing gear, the nose landing gear could be extended and retracted without any problems.



Jammed spring



Broken coil spring

The spring (spring PN: 47844-101) was a part of the actuation mechanism of the nose landing gear doors. It is loaded with the NLG doors in the closed position (Appendix 2) and is bent at both ends approximately 185° to facilitate its attachment to the NLG door and to the NLG door actuation mechanism, respectively. It was broken at one of the two hook ends. During the first visual investigation of the fracture surfaces, signs of a fatigue fracture were determined.

The German Federal Bureau of Aircraft Accidents Investigation ordered an expert from the Materials Science Institute of the Technical University of Braunschweig to determine the fracture type. The expert delivered the following comprehensive result:

1. *The scanning electronic microscope confirmed a fatigue fracture without any doubts.*
2. *The fatigue crack started on the inside of the hook end.*
3. *Within this already critical zone, the hook surface had been damaged additionally by fretting corrosion.*
4. *Due to the wear of the outer layer of the wire, the spring lost its protecting residual compressive stress, brought into it by shot peening in the surface area.*
5. *Due to the length of the crack and the striation width, a minimum of 3,000 crack-driving cycles must be assumed.*
6. *The damage results from the spring actuation during take-off and landing, not from the vibrations during flight.*
7. *The opposing hook, not broken so far, also showed noticeable traces of fretting corrosion. A crack having developed there, too, confirmed the principal conspicuity of the design.*
8. *The only way to avoid fretting corrosion is the constructive separation of the two fretting elements.*

Organizational and management information

The aircraft had been continuously serviced according to a program of the aircraft manufacturer in an own maintenance facility of the airline operator.

The last check of the landing gear system had been performed in the scope of an A check on 9 September 2007. At that moment, the aircraft had accomplished 13,379 flying hours and 13,475 landings.

Additional information

According to the information of the operator, the DHC8-300 initially also had lost such springs during flight. After the constructive change of the springs, such events didn't occur again.

Analysis

An emergency operation of the landing gear at the airport of destination would have led to a partially extended landing gear. In this configuration, a return to Munich would have been impossible. According to the results of the technical investigation, the crew had no chance to bring the jammed nose landing gear to the extended and locked position during the flight. Thus, the decision not to perform an emergency actuation of the landing gear in Florence, seems adequate and correct.

In spite of the jammed coil spring, the nose landing gear reached the mechanically unlocked position. This, however, resulted in an additional force, stressing the locking mechanism. The technical investigation revealed that neither the hydraulic system nor the traction cable of the emergency actuation system was able to deliver the force level necessary for releasing the locking system.

The investigation of the broken coil spring revealed that fretting corrosion on the inside of both hook ends had led to the development of fatigue cracks and thus to a decrease of the section. A load of this type occurs during take-off and landing in the mentioned areas and can be reduced by means of constructive measures.

However, the broken spring could only be jammed because the fragment with the spring body had unhinged from its attachment. The loss of such coil springs in other aircraft of the operator, identical in construction, shows that a fracture of the coil spring or a failure of the fixture does not necessarily lead to a jamming of the extension and retraction mechanism of the nose landing gear. However, in order to exclude this eventually in a reliable way, it must be constructively avoided that the coil springs unhinges from its attachment.

Conclusions

The immediate causes for the accident were the following:

- Due to a fatigue crack caused by fretting corrosion, a coil spring fractured in the actuation mechanism for the nose landing gear doors.
- The coil spring fragments fell into the closed landing gear bay near the strut and jammed in the drag strut during the retraction of the nose landing gear.
- The liberated coil spring jammed the NLG uplock mechanism and prevented the NLG from extending to its down and locked position
- Neither with the normal system nor with the emergency system was it possible to deliver the force necessary to release the locking mechanism.

Safety recommendations

Since the accident, the coil spring vendor and the aircraft manufacturer have introduced a modification to improve the Nose Landing Gear door linkage assembly. Modification 4-113552 introduces an improved NLG Door Spring Assembly attachment incorporating a retainer cap and insert to retain the spring in the event of breakage of a coil at either end.

Transport Canada, responsible for the type certification of the DHC-8-400, is in contact with the aircraft manufacturer regarding their considered implementation of a new designed tension spring.

Based on these actions of the aircraft manufacturer and Transport Canada, the BFU has abstained from a safety recommendation concerning this matter.

Investigator in charge K. Büttner

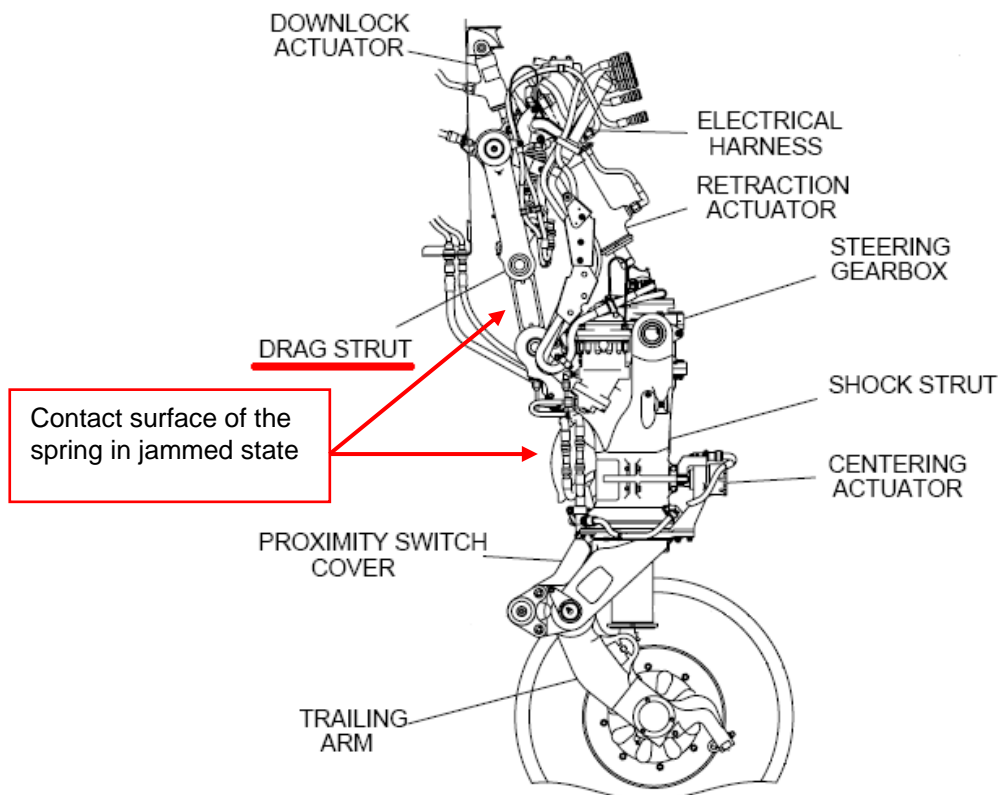
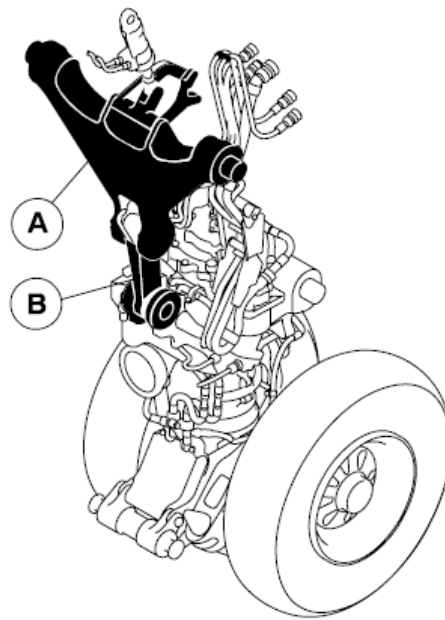
Co-operation

Investigation on site T. Karge, U. Berndt, K. Büttner

Appendices

Appendix 1

Figure of the nose landing gear



Appendix 2:

Position of the spring in the nose landing gear chamber

