

INTERIM STATEMENT No 2



ACCIDENT 67/18

STATE COMMISSION ON AIRCRAFT ACCIDENTS INVESTIGATION

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INTERIM STATEMENT No 2

ACCIDENT

OCCURRENCE No – 67/18

AIRCRAFT– BOMBARDIER DHC-8-402, SP-EQG

DATE AND PLACE OF OCCURRENCE – 10 JANUARY 2018, EPWA



Acting in accordance with Article 16.7 of Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC and following the standards provided in Annex 13 to the Convention on International Civil Aviation, the State Commission on Aircraft Accidents Investigation presents the following Interim Statement No 2.

The Interim Statement is a document detailing the progress of the investigation and any safety issues raised.

The Commission does not apportion blame or liability.

The Statement has been drawn up in the Polish language. Other language versions may be drawn up for information purposes only.

WARSAW 2020

Abbreviations and Acronyms

AMM	Aircraft Maintenance Manual
ATPL(A)	Airline Transport Pilot License (Airplane)
CA	Calendar Day
CMM	Component Maintenance Manual
DS / RWY	Runway
DSA	Drag Strut Assembly
EASA	European Aviation Safety Agency
EH	Engine Hours
EN	Event Notification
EPKK	John Paul II International Airport Kraków-Balice – ICAO code
EPWA	Warsaw Chopin Airport – ICAO code
FDR	Flight Data Recorder
FH	Flight Hours
FNC	Functional Check
ICAO	International Civil Aviation Organization
IIC	Investigator in Charge
LDS	Lower Drag Strut
LLL	Lower Lock Link
LMT	Local Mean Time
LUB	Lubrication

LW	Landing Weight
MLG	Main Landing Gear
MO	Month
NLG	Nose Landing Gear
PLL LOT S.A.	LOT Polish Airlines S.A.
PS	Proximity Sensor
QAR	Quick Access Recorder
SCAAI/PKBWL	State Commission on Aircraft Accident Investigation
TSB	Transportation Safety Board of Canada
ULC/CAA	Civil Aviation Authority
WOFW	Weight-off-Wheels
WOW	Weight-on-Wheels

General information

Occurrence reference number:	67/18			
Type of occurrence :	ACCIDENT			
Date of occurrence:	10 JANUARY 2018			
Place of occurrence	EPWA			
Type and model of aircraft:	BOMBARDIER DHC-8-402			
Aircraft registration marks:	SP-EQG			
Aircraft User/Operator:	Polskie Linie Lotnicze LOT S. A.			
Aircraft Commander:	ATPL(A)			
Number of victims/injuries:	Fatal	Serious	Minor	None
	0	0	0	63
Domestic and international authorities and organizations informed about the occurrence:	ICAO, EASA, ULC, TSB			
Investigator-in-Charge:	Andrzej Lewandowski			
Investigating Authority:	Państwowa Komisja Badania Wypadków Lotniczych			
Accredited Representatives and their advisers:	Accredited Representative: from TSB of Canada Advisers from: - Transport Canada - Pratt & Whitney - Bombardier's Air Safety Investigation Office			
Ad hoc safety recommendations:	Implemented			
Addressees of the recommendations:	Operator			
Type of document containing recommendations:	Final Report and separate document			
Date of the statement:	10 January 2020 – 2 nd Anniversary			

Synopsis

On 10 January 2018, at 18:07hrs LMT the Bombardier DHC-8-402 airplane, registration marks SP-EQG, took off from EPKK for a scheduled flight to EPWA (flight LO 3924). There were 59 passengers and 4 crew members on the board.

During the climb, after setting the landing gear control lever in the UP position, the NLG was not retracted and the relevant signal lights indicated that it remained in the transitional position and the nose door (N DOOR) remained open.

The Captain decided to continue the flight to the destination.

During the landing approach in EPWA the crew extended the landing gear with the alternate system. MLG was extended and locked, while NLG did not change its position.

On EPWA the crew performed an emergency landing on RWY11 with NLG in the unlocked position. NLG collapsed during the landing roll. When the airplane came to rest on RWY11 at 19:19 LMT the crew evacuated the passengers. None of the passengers or crew was injured during the evacuation. The airplane was damaged to the extent requiring repair.



Fig. 1. DHC-8-402 SP-EQG after emergency landing on EPWA RWY11.

1. NOTIFICATIONS AND REPORTS

On 11 January 2018 SCAAI sent Event Notification to: ICAO, EASA and TSB.

TSB appointed an Accredited Representative and his advisers from Transport Canada, Pratt & Whitney and Bombardier's Air Safety Investigation Office.

On 9 February 2018 SCAAI issued a Preliminary Report related to the accident.

2. RELEVANT INFORMATION

2.1. Direction of folding the strut

As part of the investigation, the Commission requested the Air Force Institute of Technology in Warsaw (ITWL) to carry out examination of the DSA kinematics and the damage to the DSA. As a result of the above examination, it was found that during retraction of the landing gear after take-off from EPKK, NLG DSA folded in aft direction, opposite to the intended by a designer (Figure 2-B).

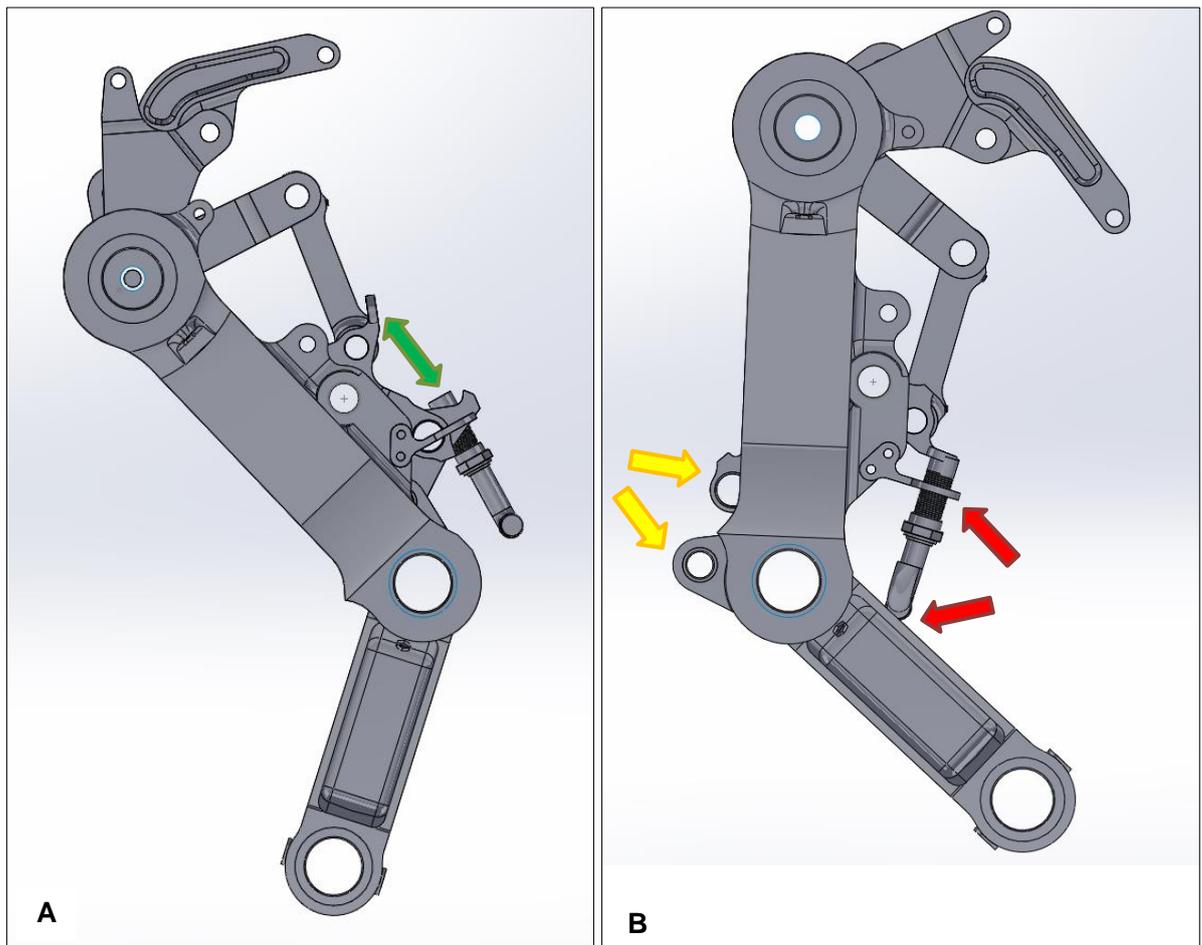


Fig. 2. NLG DSA in a transitional position during NLG retraction (side view): A - correct direction of the strut folding, B - reverse direction of the strut folding [source: ITWL expert opinion, figure modified by PKBWL].

In the figure above, the green arrows indicate NGLK2 PS face moving away from the target when DSA is folding in the right direction, the red arrows indicate collision areas

when DSA collapses in the opposite direction and the yellow arrows show disconnection of the link between the LLL and LDS (link which was damaged).

During retraction of the NLG the Drag Strut Assembly is folding in such a way that the articulated joint connecting the Lower Drag Strut (LDS) and Upper Drag Strut (UDS) is moving in the aft direction. Fig. 3 (A, B) below shows the correct location of LDS in relation to UDS after the investigated landing.

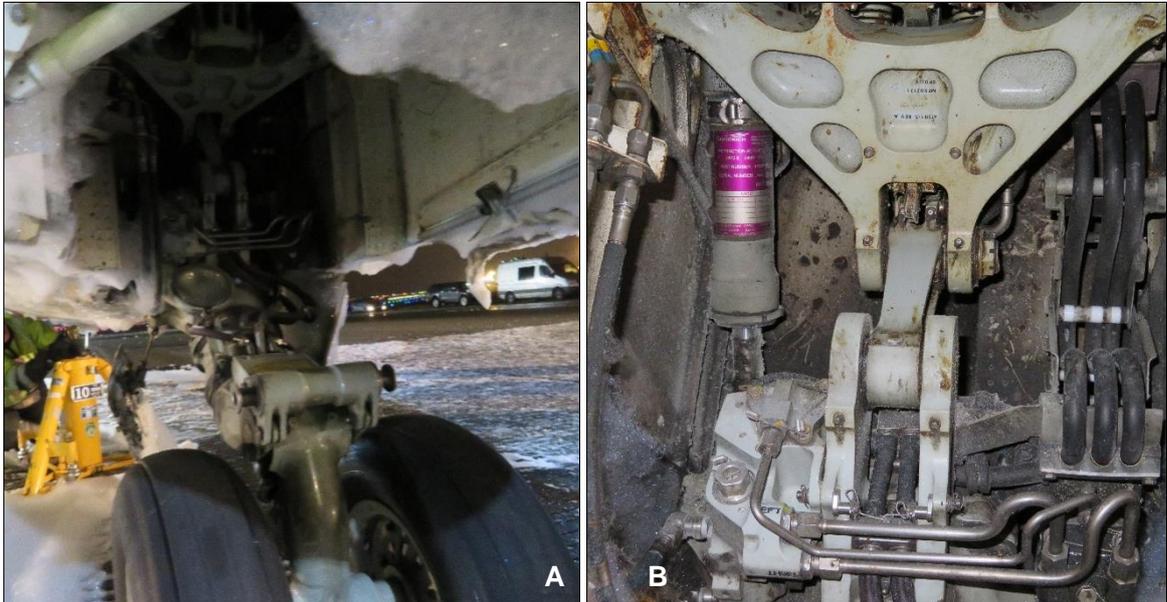


Fig. 3. Lifting the airplane – relative location of the Lower Drag Strut and Upper Drag Strut: A – general view, B – close-up [source: SCAA].

When lifting the airplane, it is not possible to move the above mentioned joint from the forward position to the aft position. Folding of the strut in the opposite direction is possible only when the Drag Strut Assembly is completely straight and free. If folding of the brace in a particular direction is initiated during landing, it is impossible to change this direction.

After disassembling the Drag Strut Assembly from the aircraft its detailed inspection was carried out, which showed that the Lower Drag Strut, Electrical Harness and NGLK2 Proximity Sensor face – its target, presented corresponding signs of mutual contact – Figures 4-6.

The collision of the above elements was possible only if the strut was folded in the wrong direction (forward) - therefore the damage did not occur during the landing

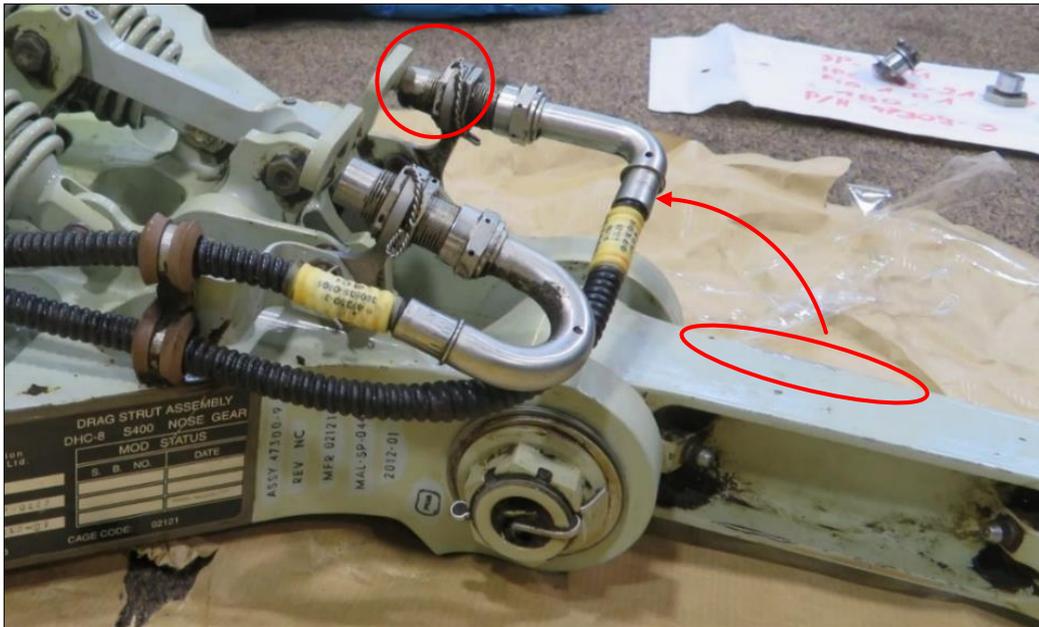


Fig. 4. Drag Strut Assembly - the red circle shows the place of the Proximity Sensor (NGLK2) collision with its target. The red ellipse shows the loss of the paint coating on the Lower Drag Strut and the arrow shows the direction of movement [source: SCAAI].

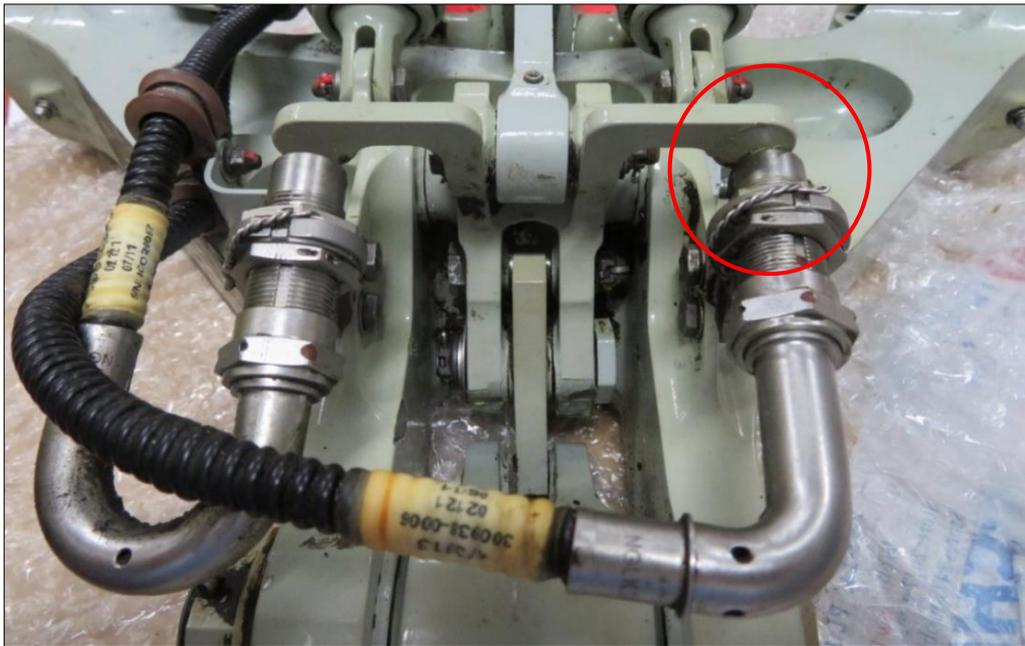


Fig. 5. Drag Strut Assembly – the red circle indicates the collision of the Proximity Sensor (NGLK2) with its target [source: SCAAI].



Fig. 6. Drag Strut Assembly – the red circle indicates the collision of the Proximity Sensor (NGLK2) with its target [source: SCAA].

2.2. NLG maintenance

The only maintenance procedure directly related to NLG DSA is *LUB of the Nose Landing Gear* - Q 32001-201-A-00, performed every 6 months (MO) or 500 flight hours (FH).

The above maintenance procedure does not allow to determine the wear status of individual elements of NLG DSA. One of the parameters that could indicate the wear of the assembly parts could be values of backlash measured in some selected places.

SCAAI asked the manufacturer/designer how to measure NLG backlashes, including NLG DSA. The answer was that the current AMM does not contain any data or requirements in this respect and during routine repair of DSA (every 60000 FH) all its parts are restored to the designed dimensions in accordance with CMM.

2.3. WOW and WOFW

The main landing gear and nose landing gear are equipped with Proximity Sensors WOW for MLG and WOFW for NLG, which inform about the weight or lack of weight on a corresponding strut. These data are recorded by FDR and QAR. The QAR records are periodically downloaded and analyzed for exceeding of operational parameters limits.

Analysis of the recorded data for SP-EQG showed that in addition to hard landings, there were also numerous cases of landings when the NLG sensor first responded, followed by the MLG sensor. The data from 1 January 2017 to the day of the accident were analyzed and they showed that there was 69 such cases (including one from the morning of the accident day), out of 2854 landings in the analyzed period. A common feature for the abovementioned 69 landings, apart from the order of the sensors loading, was a negative pitch angle.

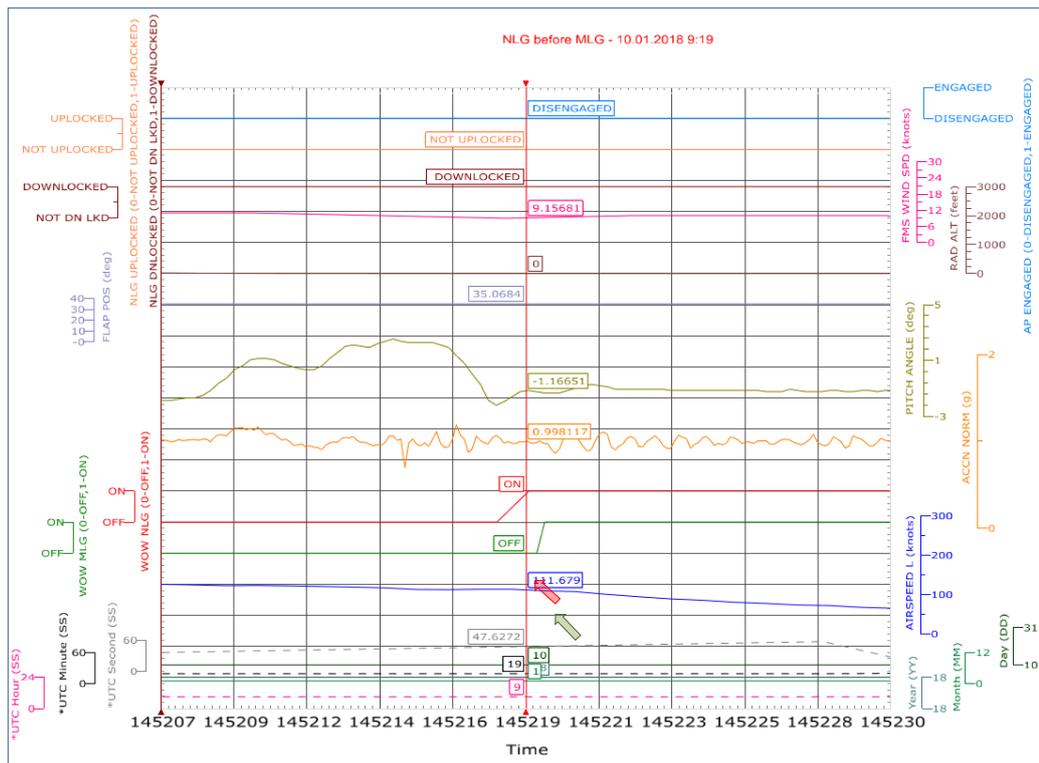


Fig. 2. Illustration of flight parameters during SP-EQG landing on 10 Jan 2018 at 9:19 hrs UTC. The red arrow shows the time when the weight was put on the NLG, and the green arrow shows the time when the weight was put on the MLG [source: SCAA with Insight 4.91].

2.4. Statistical analysis of FDR data

SCAAI asked the operator to select the data for the cases when the NLG load signal occurred prior to MLG load signal combined with an additional condition - a negative pitch angle at the time of touchdown.

Data from 1st Jan 2017 to 10th Jan 2018 were analyzed.

The analysis showed that there were 398 landings (on ten Q400) which had met the above conditions and that two aircraft significantly deviated from the average, including SP-EQG (see Fig. 8).

The data also showed that 32 landings occurred at the pitch angle (PA) greater than 1.2⁰ nose down.

The landing gear of the aircraft is designed in such a way that when the aircraft is stationary or taxiing without acceleration, its pitch angle is nose down. The pitch angle may also depend on the pressure in the NLG and MLG shock absorbers. For the accident aircraft the PA was in the range of 1.1 - 1.2⁰ nose down.

¹Insight 4.9 – Plane Sciences (Flightscape) software for flight parameters analysis, version 4.9.

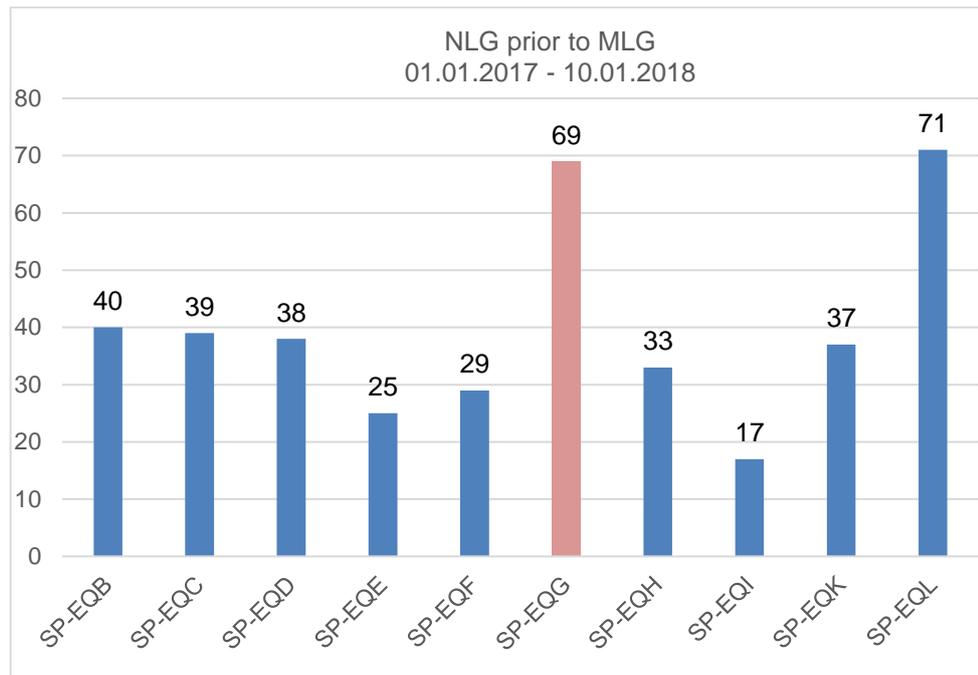


Fig. 8. Number of landings with weight on NLG signaled prior to weight on MLG – SP-EQG marked with claret color.

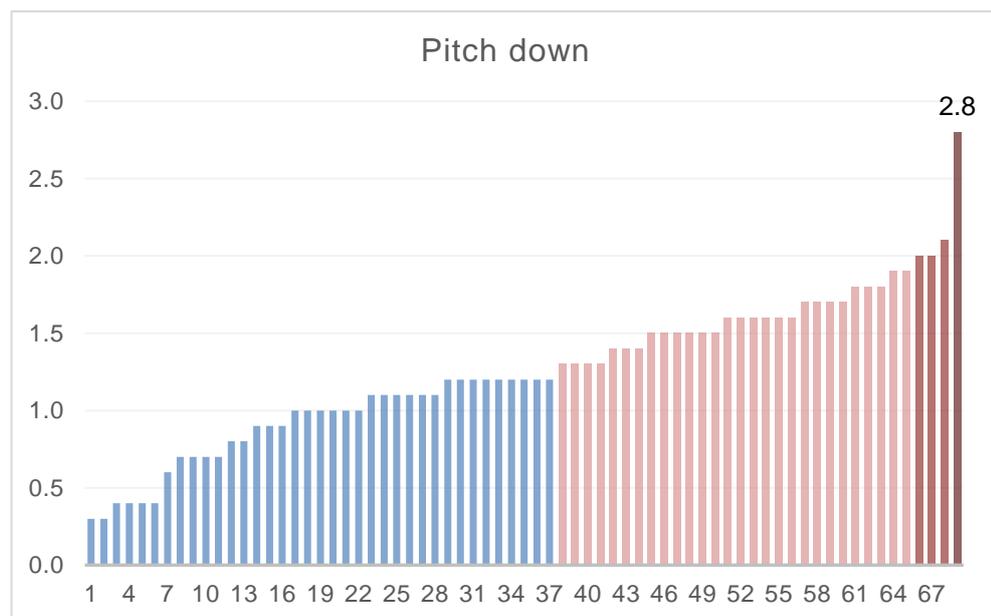


Fig. 9. Negative pitch angle during landings, when weight on NLG was signaled prior to weight on MLG - claret and brown colors show landings with “nose down” pitch angle of 1.3° and above.

2.5. LLL damage analysis

When LDS and UDS were folding in the wrong direction, the MR moment (FR force x R arm) was acting on LLL (through the pin connecting LLL and LDS) – Fig. 10, red arrows.

The moment (FR force) had a tearing effect on LLL at its smallest sectional area, which is confirmed by the nature of the damage shown in Fig. 10-C.

During proper retraction of the NLG, the acting force would have the opposite direction (green arrows), therefore it could not have caused any damage.

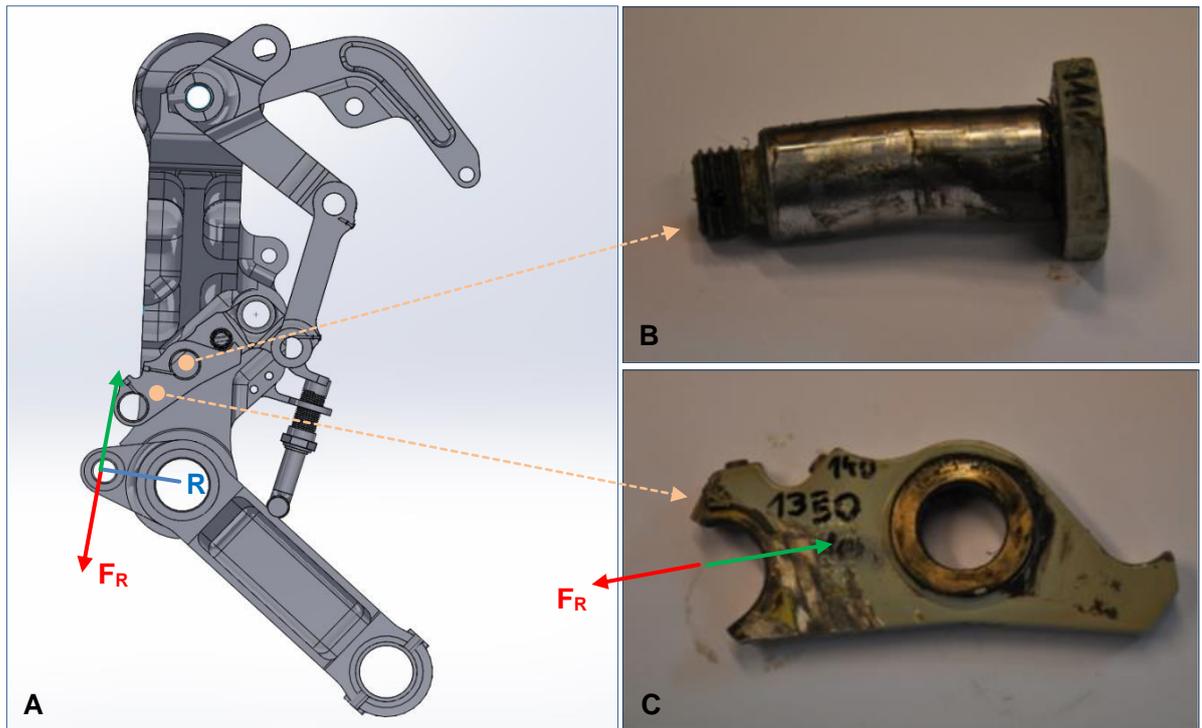


Fig. 10. Nature of damaging the NLG strut during incorrect retraction of the NLG - cross-section in the longitudinal plane: A - LDS collision with ELH, B - bent pin (axis of LLL rotation), C - damaged LLL.

Damage (bending) of the LLL pin (Fig. 10-B) indicates that the system was subjected to a great force while LLL movement was blocked, which occurs when LLL rests on the stop pin. Such conditions may occur when NLG is down and locked.

The LLL rests on the stop pin also when the NLG is completely retracted, but then the NLG system is not affected by any external force and in the investigated occurrence the NLG was not retracted.

3. STAGE OF INVESTIGATION

The investigation is at the stage of developing the Final Report.

THE END

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Signature on original

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