State Commission on
Aircraft Accident Investigation

Warsaw, 31 October, 2012

Interim Statement of the State Commission on Aircraft Accident Investigation on investigation into air accident No 1400/2011

Acting under Article 16 par. 7 of the **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** (EU Journal of Laws L. 2010.295.25) and in compliance with the principles set out in Annex 13 to the Convention on International Civil Aviation, the State Commission on Aircraft Accident Investigation releases Interim Statement on the accident to B-767 airplane, registration marks SP-LPC, which occurred on 1 November 2011 (Occurrence No 1400/2011).

The investigation into the occurrence is being conducted by the SCAAI Investigating Team in the following composition:

MSc (Eng.) pilot Waldemar Targalski	- Investigator-in-Charge
D (Eng.) Stanisław Żurkowski	- member of the Team
MSc (Eng.) Bogdan Fydrych	- member of the Team
MSc (Eng.) Piotr Lipiec	- member of the Team
Eng. Tomasz Makowski	- member of the Team
MSc (Eng.) Stanisław Kaczmarczyk	- SCAAI expert
MA Elżbieta Stolarek	- SCAAI expert

On 3 November 2011, SCAAI forwarded Event Notification to the following recipients: European Aviation Safety Agency (EASA), the European Union (EU), the International Civil Aviation Organization (ICAO) and the National Transportation Safety Board (NTSB).

According to ICAO Annex 13 NTSB designated its Accredited Representative and his technical advisers from the Federal Aviation Administration (FAA) and Boeing Company. In the course of the investigation the SCAAI Investigating Team is in constant contact with the Accredited Representative and his advisers. SCAAI is all the time supported by the NTSB in the consulting and technical expertise, as well as other issues related to the investigation conducted.

SCAAI also cooperated with BFU (Bundesstelle für Flugunfalluntersuchung) in the field of the cockpit voice recorder read out.

In connection with the investigation a number of tests/studies and researches were conducted, which can be divided into the following groups related to:

- Technical and operational documentation of the airplane;
- Technical issues;
- Crew;
- Evacuation of the passengers after landing;
- Rescue and fire fighting operation;
- Operational issues in PLL LOT SA;
- Operational issues in the Air Traffic Service (ATS).

As part of the studies and expertise SCAAI asked NTSB to perform or supervise the following tests and analysis:

- Analysis of the hydraulic hose failure;
- Testing and analysis of the performance of C829 BAT BUS DISTR and C4248 LANDING GEAR – ALT EXT MOTOR circuit breakers;
- Testing and analysis of the performance of the electric motor of the alternate landing gear extension system.

Actions of the SCAAI Investigating Team related to the technical and operational documentation of the airplane:

- SP-LPC airplane service documentation from the period prior to the accident was protected and is in the course of analysis;
- Periodical technical inspections and maintenance of the aircraft were examined against the manufacturer recommendations;
- Analysis of the aircraft maintenance program was carried out for the tasks related to the zone in which the damaged hydraulic hose was located. This zone is inspected at least every 6000 hours (interval 1C). The last inspection, in accordance with the applicable procedure was carried out in March 2011. No faults in the hydraulic system were found;

- The applicable technical documentation of the individual systems and installations of B767 aircraft was analyzed, particular emphasis was placed on the analysis of the hydraulic and electrical system of the landing gear. Conclusions from the analysis enabled to develop the functional test programs of the landing gear and the electrical installation of the alternate landing gear extension system;

- The aircraft electrical system documentation was analyzed for the function of C829 BAT BUS DISTR circuit breaker;

- Technical modifications of P6-1 circuit breaker panel introduced by the aircraft manufacturer were checked;

- BPCU (Bus Power Control Unit) internal memory recordings were analyzed;

- Documentation of the electric motor of the alternate landing gear extension system was analyzed.

In the scope of the technical issues:

- Photographic documentation of the airplane and the occurrence site was made;

- Initial inspection of the aircraft cockpit and cabin was carried out immediately after the accident. It was found that C829 BAT BUS DISTR circuit breaker on P6-1 panel (located on the right side behind the Co-pilot seat) at A1 position was in the „Off" setting (pulled out);

- On-board recorders (CVR - Cockpit Voice Recorder, SSFDR – Solid State Flight Data Recorder) and QAR - Quick Access Recorder memory were protected;

- Readouts of all available data from the on-board recorders were completed;

- After lifting the aircraft from the runway a test of the landing gear extension with the alternate landing gear extension system was carried out. After connecting the Ground Power Unit, setting C829 BAT BUS DISTR circuit breaker on the position „On" and activation of the alternate landing gear extension system, the landing gear was extended and locked;

- Functional tests of the alternate landing gear extension system were carried out on another BOEING B767-300 airplane (SP-LPB). The tested airplane was identical to SP-LPC. The tests showed that:

- when C829 BAT BUS DISTR circuit breaker was in „On" setting (pushed) – moving ALT GEAR EXTEND switch into „DN" setting caused extension of the landing gear;
- when C829 BAT BUS DISTR circuit breaker was in „Off" setting (pulled out) – moving ALT GEAR EXTEND switch into „DN" setting did not cause extension of the landing gear;
- observation of C829 BAT BUS DISTR circuit breaker from F/O seat was very difficult;
- accidental „Off" setting of the circuit breaker was very difficult but it was possible. Commission did not excluded such a situation.

- Visual inspection of individual elements of the alternate landing gear extension system of SP-LPC was made. Load limiters indicators of this system (NLG/MLG LOAD limiters) did not show overload;

- Electric motor of the alternate landing gear extension system was disassembled and sent to NTSB for functional testing. The tests did not show any faults in the functioning of the device. Additional and the fundamental proof that the unit remained operational all the time was the successful extension of the landing gear after lifting the aircraft from the runway on 2 November, 2011. The following is a part of an expert opinion prepared under supervision of NTSB:

"Boeing SCD S257T400 requirements indicate that the actuator is operating as designed in the extend direction with regard to deploying the landing gear. The 23VDC clockwise stall torque value of 755 in-lbs exceeds the retract opposing load of 400 in-lbs as specified in Boeing SCD S257T400 Section 3.2.3.2. The bonding resistance value of .007 ohm compared with the ATP requirement of .005 ohm is not considered significant for purposes of this evaluation";

- Damaged flexible hydraulic hose (according to AIPC 32-32-54-05, item 152: AS4624J-0300SS), connecting the brake system on the right leg with the „C" (central) hydraulic system was disassembled. Visual inspection carried out in Poland revealed a fracture in the area of the metal band around the tip of the hose, which initiated the occurrence. The following is a part of an expert opinion prepared in NTSB laboratory:

"To determine the facture mechanism, the fracture surfaces of the crack were examined using a scanning electron microscopy (SEM). The nature of the crack indicates that there was possible stress relaxation of the hose material resulting in material creep. This was a result of possibly kinking at the nipple and socket. According to the hose manufacturer, kinking at this location is common because the hose does not swivel and often gets kinked during installation. The inner Kevlar lining of the pressure sleeving had signs of abrasion. This is indicative of repeated hose flexing due to pressure changes during the operation of the landing gear. According to the manufacturer, this may also indicate that the hose was not installed complete straight";

- The results of the tests of the hydraulic fluid samples collected from SP-LPC hydraulic systems in 2005, 2007 and 2010 were verified. The verification was carried out by PLL LOT S.A. - Chemical Testing Section acc. to B737/767 29-15-00/29-00-00. The parameters of the fluid samples met the requirements;

- In order to determine the role of C829 BAT BUS DISTR circuit breaker, functional tests were carried out on airworthy airplanes of the same model (SP-LPB and SP-LPA);

Functional tests of the entire electrical installation of the alternate landing gear extension system were carried out. In this case the Commission took into account recommendations of the airplane manufacturer:

  - it was found that when C829 circuit breaker was in „Off" setting and the power supply to the STBY POWER buses was disconnected in the standard way (switch on the "overhead panel") the light STBY POWER BUS OFF did not illuminate;

  - it was confirmed that the „Off" setting of C829 BAT BUS DISTR circuit breaker was not indicated in the cockpit by EICAS (Engine Indications and Crew Alerting System) and not recorded by SSFDR;

  - it was confirmed that setting C829 BAT BUS DISTR circuit breaker in the „Off" position may be noticed only if there is a need for activation of the systems protected by this circuit breaker;

- electric current in the circuits of C829 BAT BUS DISTR and C4248 LANDING GEAR – ALT EXT MOTOR was measured during the process of the landing gear extending. No faults were found;

- after removal of C829 BAT BUS DISTR and C4248 LANDING GEAR – ALT EXT MOTOR circuit breakers the interior and wiring of P6-1 panel was visually checked, in particular cables W1040-009, -010, -044 and -047. No faults were found;

- C749 (B7), C804 (B1), C805 (B2), C806 (B3), C807 (B5), C808 (B6), C809 (B4), C828 (A5), C879 (A6), C906 (A7), C1100 (C2), C4097 (A4), C4248 (F6) and C829 BAT BUS DISTR circuit breakers were set in the „Off" position and after that the insulation resistance between the output of the C829 BAT BUS DISTR circuit breaker and the airplane construction was measured. The results in accordance with the aircraft manufacturer documentation;

- insulation resistance (after removal of the circuit breaker and the motor of the alternate landing gear extension system) of the C4228-M1104 motor supply circuit was measured (ALTN switch in DN position). The result in accordance with the aircraft manufacturer documentation.

- C829 BAT BUS DISTR and C4248 LANDING GEAR – ALT EXT MOTOR circuit breakers were removed and tested in a certified maintenance organization - LOT Aircraft Maintenance Services (LOT AMS) according to Boeing Part Specification BPS-C-144 rev. B and Boeing Part Standard BACC18X rev. U. Their current-time and mechanical characteristics were in accordance with the manufacturer specifications.

- LOT AMS carried out X-ray scanning of the C829 BAT BUS DISTR and C4248 LANDING GEAR – ALT EXT MOTOR circuit breakers from SP-LPC aircraft and the new circuit breakers of the same type. X-rays were carried out in the „On" and „Off" settings. No faults were found in configuration of the internal mechanisms parts of the two circuit breakers removed from SP-LPC.

- C829 BAT BUS DISTR and C4248 LANDING GEAR – ALT EXT MOTOR circuit breakers were sent to NTSB for testing. No faults were found. Below is the conclusion of the tests:

  "Both the battery bus distribution and the alternate extend motor circuit breakers were electrically and mechanically tested per the requirements in their respective specification. No faults were noted for either breaker. Both breakers were subject to a CT examination which found all internal components in place and intact. The circuit breakers were disassembled. An

examination of the electrical contacts for both breakers found them in unremarkable condition and consistent with normal functional operation (verified by the electrical testing). The actuation button on both breakers was examined for condition. Aside from the damage caused by the push/pull test fixture, no significant damage was present on either plastic button head/shaft".

Commission members participated in the detailed visual inspection and preparation of an inventory of damage to the aircraft carried out by the manufacturer specialists.

In the scope of the human factor:

- Statements from all members of the flight crew and the cabin crew were received;
- Statements from the relevant personnel of the Operations Center were received;
- Statement from the mechanic performing pre-flight check at the take off aerodrome (Newark) was obtained;
- Operator records related to the aircraft crew were analyzed. The crew had all necessary qualifications to perform the flight;
- Detailed psychological analysis of the critical situation during the flight and its effect on the crew actions was carried out;
- Analysis of the checklists contained in the QRH (Quick Reference Handbook) D632T001-35LOT related to the loss of pressure in the central hydraulic system was carried out - logical errors were found.

Based on the current analysis of the records related to the actions of the crew and the aerodrome services, State Commission on Aircraft Accident Investigations determined the following facts **(the investigation has not been completed yet)**:

- The checklist contained in the D632T001-35LOT QRH (Quick Reference Handbook) related to the loss of pressure in the central hydraulic system (page 13.4) did not lead the crew to the successful extending of the landing gear by using the alternate system. The crew reached the point:

ALTN GEAR EXTEND switch.....DN

Due to the fact, that after this action the „gear down" lights did not illuminate, the crew could not proceed with the next step prescribed in the checklist, i.e.:

LANDING GEAR LEVER .....DN.

- ***HYDRAULIC SYSTEM PRESSURE (C only)*** checklist (QRH, page 13.4) did not take into account malfunction of the alternate landing gear extension system - no matter what caused its malfunction. The checklist did not contain any instructions on further actions in case of malfunction of the alternate landing gear extension system. Lack of such instructions relates also to the ***HYDRAULIC SYSTEM PRESSURE (L and C)*** and ***HYDRAULIC SYSTEM PRESSURE (R and C).***

- The above mentioned checklists did not refer also to the Chapter ***Non-Normal Checklists, Landing Gear, Section 14.***

- ***GEAR DISAGREE*** checklist contained in the same Section (page 14.12) also did not include a possibility of malfunction of the alternate landing gear extension system. It included the possibility of partial extension of the landing gear (any leg of the landing gear not extended). However, it did not include the possibility that all three legs are not extended, thus does not contain any instructions for the crew how to perform a landing with the landing gear fully retracted.

- QRH for B-767 D632T001-35LOT applicable at the occurrence time, developed by the manufacturer, did not contain any guidance for the crews concerning procedures in case of malfunction of both landing gear extension systems (primary and alternate). There was lack of appropriate checklist e.g. **ALL GEAR UP LANDING**;

- Based on the current technical researches SCAAI may conclude that the most likely cause of malfunction of the alternate landing gear extension system was the „OFF" position of C829 BUT BUS DISTR circuit breaker (on P6-panel) during the attempt of landing gear extension by using the alternate system. A separate issue is an explanation of what was/could have been the reason that at that time the circuit breaker was in the „OFF" position.

- After evacuation of the passengers from the aircraft there was lack of the right organization and coordination of their speedy and smooth movement to designated area or means of transportation.

Therefore, at this stage of the accident investigation, first of all having regard to the safety of the flight operations and acting under **Article 17 par. 1 of the Regulation (EU) No 996/2010 of the European Parliament and of the Council and Chapter 6 par. 6.8 of Annex 13 to the Convention on International Civil Aviation**, in June this year the State Commission on Aircraft Accident Investigation forwarded to the appropriate authorities the proposed interim safety recommendations related to the accident investigation:

B-767 airplane manufacturer:

1. Verify and modify the above mentioned checklists taking into account the conclusions of the Commission.

2. Modify the appropriate checklist by adding a subsection that in case of failure in the alternate landing gear extension the flight crew should check C4248 LANDING GEAR - ALT EXT MOTOR and C829 BUT BUS DISTR circuit breakers.

3. Develop a checklist specifying the flight crew actions in case of the total failure in the landing gear extension.

4. Introduce an appropriate Bulletin providing for a physical protection of the circuit breakers located in the areas of direct contact with shoes, cleaning equipment, hand luggage etc. (i.e. places in which the breakers may be damaged or accidentally set in wrong positions). This applies to all B-767 operators which did not construct such a protection on the operated aircraft below production line No 863.

LOT Polish Airlines in consultation with B-767 manufacturer:

1. Verify and modify the above mentioned checklists taking into account the conclusions of the Commission.

2. Modify the appropriate checklist by adding a subsection that in case of failure in the alternate landing gear extension the flight crew should check C4248 LANDING GEAR - ALT EXT MOTOR and C829 BUT BUS DISTR circuit breakers.

3. Develop a checklist specifying the flight crew actions in case of the total failure in the landing gear extension.

4. Construct a physical protection of the circuit breakers located in the areas of direct contact with shoes, cleaning equipment, luggage etc. (i.e. places in which the breakers may be damaged or accidentally set in wrong positions). This applies to all B-767 airplanes used by the operator, which do not have such a protection.

Management of Warsaw Chopin Airport

Develop procedures for arrangement of fast and smooth movement of passengers evacuated from an aircraft to designated area or means of transportation.

According to **Article 17 par. 3 of the Regulation (EU) No 996/2010 of the European Parliament and of the Council** a safety recommendations shall in no case create a presumption of blame or liability for an accident, serious incident or incident.

The SCAAI Investigating Team is working in order to determine the causes and circumstances of the accident occurrence. Details will be included in the Final Report on investigation into the accident.

Investigator-in-Charge
MSc (Eng.) pilot Waldemar Targalski