FINAL REPORT

ACCIDENT

Occurrence No.: 1400/11

Aircraft: B767-300ER, SP-LPC

November 1, 2011
Warsaw Chopin Airport (EPWA), RWY 33

This Report is a document presenting the position of the State Commission on Aircraft Accidents Investigation concerning circumstances of the air occurrence, its causes and safety recommendations. The Report was drawn up on the basis of information available on the date of its completion.

The investigation process can not be considered as finally closed. The investigation may be reopened if new information becomes available or new investigation techniques are applied, which may affect the wording related to the causes, circumstances and safety recommendations contained in the Report.

Investigations into air occurrences are carried out in accordance with the applicable international, European Union and domestic legal provisions for prevention purposes only.

The investigation was carried out without the need of application of the legal evidential procedures, applicable for proceedings of other authorities required to take action in connection with an air occurrence.

The Commission does not apportion blame or liability.

In accordance with Article 5 paragraph 5 of the Regulation (EU) No 996/2010 of the European Parliament and of the Council on the investigation and prevention of accidents and incidents in civil aviation […] and Article 134 of the Act – Aviation Law, the wording used in this Report may not be considered as an indication of the guilty or responsible for the occurrence.

For the above reasons, any use of this Report for any purpose other than air accidents and incidents prevention, can lead to wrong conclusions and interpretations.

This Report was drawn up in the Polish language. Other language versions may be drawn up for information purposes only.

WARSAW 2017

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ABBREVIATIONS AND ACRONYMS

3D	3-Dimensional
ABP (AP)	Able Bodied Passenger (Assistant Passenger)
AC	Alternating Current
ACARS	Aircraft Communication Addressing and Reporting System
ACC	Area Control Centre
AFB/LSP	Airport Fire Brigade
AFM	Airplane Flight Manual
AIP	Aeronautical Information Publication
AIPC	Aircraft Illustrated Parts Catalogue
ALT FLAPS	Alternate Flaps
ALTN	Alternate
APP	Approach Control Service
APU	Auxiliary Power Unit
ARC	Airworthiness Review Certificate
ARM	Airplane Recovery Manual
ASPH	Asphalt
ATC	Air Traffic Control
ATPL(A)	Airline Transport Pilot Licence - Aeroplane
ATS	Air Traffic Service
AUTO	Automatic
BFU	(Bundesstelle für Flugunfalluntersuchung
BPCU	Bus Power Control Unit
BPS	Boeing Part Specification
CAA/ULC	Civil Aviation Authority
CAT	Category
CC	Cabin Crew
CC1	Cabin Crew#1
CCTV	Closed circuit television
COFA	Certificate of Airworthiness
CONC	Concrete
CPT	Captain
CSN	Cycles Since New
CVR	Cockpit Voice Recorder
CZK	Emergency Management Centre
DC	Direct Current
DK/TWY	Taxiway
DN	Down
DOP	Airport Duty Officer
DS	Runway
EAP	Emergency Action Plan
EASA	European Aviation Safety Agency
EICAS	Engine Indications and Crew Alerting System
EPWA (ICAO) WAW (IATA)	Warsaw Chopin Airport
ETOPS	Extended Range Operations with Two-Engine Airplanes
EU	European Union
EVAC	Evacuation

FAA	Federal Aviation Administration
FIR	Flight Information Region
FL	Flight Level
FMS	Flight Management System
FO	First Officer
GCU	Generator Control Unit
GSPEED	Ground Speed
GW	Gross Weight
HMG	Hydro Motor-Generator
HYD	Hydraulic
HYDPRC	Hydraulic Pressure C
HYDQTC	Hydraulic Quantity C
ICAO	International Civil Aviation Organization
IDG	Integrated Drive Generator
ILS	Instrument Landing System
INOP	Inoperative
IR	Instrument Rating
Izn	Rated Current
KDR	Rescue Operations Manager
KEWR (ICAO) EWR (IATA)	Newark Liberty International Airport
KGP	National Police Headquarters
KOSZ	Health Service Coordinator
KPPL	Airport Police Station
KSP	Capital Police Headquarters
kt	Knot
KZ-DOP	Shift Manager of Airport Duty Officers
LC	Line Check
LMT	Local Mean Time
LPR	Air Medical Rescue
LSP	Airport Fire Brigade
MCC	Maintenance Coordination Centre
METAR	Meteorological Aerodrome Report
MLG	Main Landing Gear
MLW	Maximum Landing Weight
MTOW	Maximum Take off Weight
MZFW	Maximum Zero Fuel Weight
N1ACTL	N1 Actual Left
N1ACTR	N1 Actual Right
NLG	Nose Landing Gear
NNC	Non-Normal Checklists
NTSB	National Transportation Safety Board
OFF	Disconnected
ON	Connected
OPC	Operator Proficiency Check
OSG	Border Guard Unit
P/N	Part Number
PA LSP	Alarm Point of the Airport Fire Brigade
PA System	Passenger Address System
PANSA/PAŻP	Polish Air Navigation Services Agency

PCN	Pavement Classification Number
PDC	Pre-Departure Check
PDT	Aircraft Technical Log
PF	Pilot Flying
PKBWL/SCAAI	State Commission on Aircraft Accidents Investigation
PLL LOT	LOT Polish Airlines
PM	Pilot Monitoring
PP PL	“Polish Airports” State Enterprise
PRALT	Pressure Altitude
PRESS	Pressure
PSG	Border Guard Sation
PSP	State Fire Service
QAR	Quick Access Recorder
QRH	Quick Reference Handbook
QTY	Quantity
RALT	Radio Altitude
RAT	Ram Air Turbine
RCB	Government Centre for Security
RF	Refill
RK	Concentration Area
RWY	Runway
S/N	Serial Number
SD COP	Command Post of the Air Operations Centre
SEM	Scanning Electron Microscopy
SRL	Air Traffic Service
SSFDR	Solid State Flight Data Recorder
SWY	Stopway
SYS	System
TR	Type Rating
TRU	Transformer Rectifier Unit
TSN	Time Since New
TWR	Tower
UP	Up
UTC	Coordinated Universal Time
VACC	Vertical Acceleration
VHF	Very High Frequency
VIP	Very Important Person
WCZK	Crisis Management Provincial Centre
WSKR PSP	State Fire Service Provincial Post of Rescue Coordination
WSPR	Provincial Station of Ambulance Service
ZMR LC	Chopin Airport Medical Rescue Team
ZRM	Medical Rescue Team

GENERAL INFORMATION

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<tr><td>Place of occurrence</td><td colspan="4">Warsaw Chopin Airport (EPWA)</td></tr>
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<tr><td>Aircraft registration marks:</td><td colspan="4">SP-LPC</td></tr>
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<tr><td>-</td><td>-</td><td>-</td><td>231</td></tr>
<tr><td>Investigator-in-Charge:</td><td colspan="4">Waldemar Targalski – until Apr 30, 2013
Piotr Lipiec - from Apr 30, 2013 until Nov 10, 2016
Bogusław Trela – from Feb 27, 2017[1]</td></tr>
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<tr><td>Composition of the Investigation Team:</td><td colspan="4">As below</td></tr>
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<tr><td>Date of completion of the investigation:</td><td colspan="4">May 5, 2017</td></tr>
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[1] Due to organizational changes in SCAAI since February 27, 2017 drafting of the Final Report has been overtaken by SCAAI Expert/Member Bogusław Trela.

SYNOPSIS

On November 1, 2011 at 04:19 hrs UTC[2] B767-300ER aircraft, registration marks SP-LPC departed from Newark Liberty Airport (KEWR) for flight LO 16 to Warsaw (EPWA). Its crew consisted of two pilots and eight persons of the cabin crew. There were 221 passengers on the board.

After the take-off, during retraction of the landing gear and flaps the center hydraulic system failed. That failure prevented extension of the landing gear with the normal system (hydraulic). After consultation with the Operator's MCC the flight crew decided to continue the flight to Warsaw.

During the landing approach in Warsaw the extension of the landing gear with the alternate system was unsuccessful. Due to this fact the crew performed an emergency landing on RWY33 with the landing gear retracted. The airplane landed at 13:39 hrs. After landing the crew carried out evacuation of the passengers. Nobody suffered any injuries.

Investigation into the occurrence was conducted by the SCAAI Investigation Team in the following composition:

Waldemar Targalski, MSc (Eng.), pilot	- Investigator-in-Charge until Apr 30, 2013;
Piotr Lipiec, MSc (Eng.)	- Investigator-in-Charge until Nov 10, 2016;
Bogusław Trela, MSc (Eng.)	- Investigator-in-Charge since Feb 27, 2017;
Stanisław Żurkowski, D. (Eng.)	- Member of the Team;
Bogdan Fydrych, MSc (Eng.)	- Member of the Team until Nov 10, 2016;
Tomasz Makowski, Eng.	- Member of the Team;
Stanisław Kaczmarczyk, MSc (Eng.)	- SCAAI expert;
Elżbieta Stolarek, MA	- SCAAI expert.

In the course of the investigation State Commission on Aircraft Accidents Investigation determined that the causes of the accident were:

1. Failure of the hydraulic hose connecting the hydraulic system on the right leg of the main landing gear with the center hydraulic system, which initiated the occurrence.
2. Open C829 BAT BUS DISTR circuit breaker in the power supply circuit of the alternate landing gear extension system in the situation when the center hydraulic system was inoperative.

[2] Unless otherwise indicated, all times in the Report are expressed in LMT (LMT=UTC+1hour).

3. The crew's failure to detect the open C829 circuit breaker during approach to landing, after detecting that the landing gear could not be extended with the alternate system.

Factors contributing to the occurrence were as follow:

1. Lack of guards protecting the circuit breakers on P6-1 panel against inadvertent mechanical opening; from 863 production line the guards have been mounted in the manufacturing process (SP-LPC was 659 production line).
2. C829 location on panel P6-1 (extremely low position), impeding observation of its setting and favoring its inadvertent mechanical opening.
3. Lack of effective procedures at the Operator's Operations Centre, which impeded specialist support for the crew.
4. Operator's failure to incorporate Service Bulletin 767-32-0162.

During the investigation SCAAI has formulated 9 proposals of interim safety recommendations. At the end of the investigation SCAAI did not formulate additional safety recommendations.

1. FACTUAL INFORMATION

1.1. History of the flight

On November 1, 2011 a passenger LO 16 flight of B767-300ER airplane, registration marks SP-LPC, was scheduled from KEWR to EPWA.

The Pre-Departure Check of the airplane was carried out by a ground engineer from a contracted service organization in accordance with Operator’s requirements. The ground engineer was responsible for conducting PRE-DEPARTURE CHECK and ETOPS CHECK. The above procedures did not include cockpit check. The ground engineer did not find any failures or irregularities and did not notice anything unusual.

The flight crew arrived at Newark Liberty Airport at a time specified by Operator and in accordance with its operating procedures. When commencing the flight duty period the crew members were rested, refreshed, in a good psychophysical condition. They did not report overload by air operations.

Upon arrival at the aircraft stand each flight crew member performed his duties as provided for in the operating procedures of the airline. CPT conducted Exterior Walk-Around while FO conducted cockpit check. FO checked on-board equipment and the cockpit preparation for the flight. According to the flight crew statement no failures or irregularities were found. The crew deemed the airplane fully operational for the flight to Warsaw.

The ground engineer from the contracted maintenance organization was not present in the cockpit during the flight crew preparation.

During the flight CPT was PF and FO was PM.

At 03:58:11 hrs the crew started the engines. The take-off took place at 04:19:08 hrs. After the take-off, during the retraction of landing gear and flaps the hydraulic fluid from the center hydraulic system (C system) flew out, which consequently led to pressure drop in this system. The pressure drop in the C system was signaled on the hydraulic panel – SYS PRESS and on EICAS - C HYD SYS PRESS and recorded by on-board flight data recorders.

After completion HYDRAULIC SYSTEM PRESSURE (C only) procedure contained in QRH and consultation with the Operator's MCC, the flight crew decided to continue the flight to Warsaw. The flight proceeded without significant distortions.

Landing in Warsaw was to be carried out with the alternate landing gear extension system. This situation was well known to pilots due to numerous exercises carried out in a flight simulator.

Taking advantage of the available time, the CPT and FO developed a plan for landing in accordance with the procedure contained in QRH and discussed an anticipated sequence of events.

At 12:17 hrs, during approach to landing on EPWA aerodrome the flight crew performed the procedure of the lading gear extension using the alternate landing gear extension system. However, after the anticipated time the landing gear was not extended. The crew checked the correctness of execution of the procedure against QRH and again attempted to extend the landing gear. After failure of the second attempt to extend the landing gear with the alternate system the approach to landing was abandoned. At 12:22 hrs the crew reported to ATC inability to extend the landing gear and requested the Operator's MCC assistance.

Around 12:25 hrs the flight crew declared EMERGENCY. The airplane was directed to a holding zone. The Operator's Operations Centre enabled the crew to communicate with experts. FO executed expert recommendations and checked the alternate landing gear extension switch and circuit breakers on P-11 and P6-1 panels. After that FO reported to Operations Centre and to CPT that the circuit breakers had been checked. FO also cycled (pulled and reset) the ALT EXT MOTOR circuit breaker as indicated by an expert. However, the landing gear was not extended.

In the meantime pilots of two F-16s of the Polish Air Force inspected SP-LPC from the air and informed the crew that the landing gear was still in the retracted position but the tail skid was extended. After that information the crew attempted to extend the landing gear in a gravitational way, but it also ended in failure.

After a series of unsuccessful attempts to extend the landing gear and due to low fuel quantity, the crew decided to carry out an emergency gear up landing. CC1 was instructed by Captain to prepare the cabin and passengers for emergency landing. During the preparation the passengers were calm, they carried out the crew instructions, there was no panic.

Prior to the landing firefighters distributed foam over RWY 33 at a distance of about 3000 m. External services arrived at the airport (PSP and emergency ambulances).

The plane touched down on RWY 33 of EPWA aerodrome (Figure 7) at 13:39 hrs. At the time of touchdown about 1600 kg of fuel (1939 liters at a density of 0.825 kg/l) was in its tanks, the engines were running and their recorded speeds were N1ACTL = 57%, N1ACTR = 38%. The plane was moving on RWY 33 along its centre line and stopped 42 m after the intersection with RWY 29. When the aircraft was moving, sparks were coming out of the right engine, and they were suppressed by the applied foam; then the engine caught fire.

When the airplane came to rest, the crew evacuated the passengers and LSP extinguished the fire. During the evacuation none of the passengers or crew suffered any injuries. During the landing the aircraft sustained substantial damage, which caused its withdrawal from service.

1.2. Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
None	10	221	-
TOTAL	10	221	

1.3. Damage to aircraft

As a result of the gear up landing the following parts of the aircraft were damaged:

- both engines;
- airframe (mainly lower aft part of the fuselage);
- nacelles of both engines;
- components of on-board systems in the affected areas.

1.3.1. Damage to engines

Due to substantial damage both engines were qualified for a special survey to decide about their further use.

1.3.2. Damage to airframe

- Fuselage - local deformation preventing opening of the right aft cargo hold, damage to skin and elements of frames and stringers in the area of section 46, damage to the water tank service door, drain mast destroyed (Figure 1).
- Left wing - flap bracket fairing tip broken, cracked edges of the landing gear shock absorber hatch door, damaged brackets of the hatch door, damaged inboard flap skin in the area of the trailing edge.
- Right wing - flap bracket fairing tip broken, support points covers were cut out.
- Left main landing gear - strut of the main landing gear hatch door damaged (damaged joints of elements - Figure 2).
- Right main landing gear - strut of the main landing gear hatch door damaged (Figure 2).

Figure 1. Damage to the lower part of the fuselage in the area of section 46 – front view and close up.
(Source: Boeing)

Figure 2. Damaged struts of the main landing gear hatch door (left and right).
(Source: Boeing)

1.3.3. Damage to engines nacelles

- Left nacelle – fan casing deformed and damaged inside due to contact with the rotating fan blades and abraded outside due to contact with the ground. Thrust reverser damaged (elements partially abraded, partially detached, fixings of same elements bent), some elements fell off from the airplane (Figure 3).
- Right nacelle – fan casing deformed and damaged inside due to contact with the rotating fan blades and abraded outside due to contact with the ground. Thrust reverser damaged (elements partially abraded, partially detached, fixings of some elements bent - Figure 4).

Figure 3. Damage to the left engine nacelle – from the left: fan inlet inside, bottom part, thrust reverser. (Source: Boeing)

Figure 4. Damage to the right engine nacelle – from the left: fan inlet inside, bottom part, thrust reverser. (Source: Boeing)

1.3.4. Damage to on-board systems

- Electrical system - wiring insulation on the right main landing gear was damaged.
- Antennas - the lower VHF antenna was destroyed.
- Hydraulic system - in the area of the most severe airframe damage some components and elements of hoses fittings were damaged and detached.

The above damage description is based on the document: *"AIRCRAFT SURVEY REPORT, LOT POLISH AIRLINES WARSAW, POLAND, 767-300EREM, SP-LPC, VN293/V2316/V8126/LN659, February 17, 2012, Rev. B"* developed by the Boeing Company on LOT POLISH AIRLINES order.

As a result of the above described damage, the Operator decided to withdraw the airplane from further service.

1.4. Other damage

Five lights of the RWY 33 centre line lighting were damaged as a result of the emergency landing.

1.5. Personnel information (crew data)

Captain (CPT)

Male, aged 57, holder of ATPL(A) issued by the President of the Civil Aviation Authority, valid until February 12, 2013.

Ratings:

- TR B-757/767 – valid until June 30, 2012;
- radiotelephony communication from aircraft in Polish and English languages;
- CAT II/IIIA approaches - issued on April 9, 2010.

CPT was a holder of:

- Operator Proficiency Check (OPC), valid until May 31, 2012;
- Line Check (LC) valid until May 31, 2012;
- Class 1 Aero-Medical Certificate valid until January 27, 2012.

Total flight time:……………………………………15 980 hrs 36 min;

Flight time as Pilot-in-Command: ………………14 007 hrs 36 min;

Flight time on B-767: ……………………………13 307 hrs 08 min;

Flight time as Pilot-in-Command on B-767:……..12 432 hrs 51 min;

Flight time over the last 90 days:…………………213 hrs 48 min;

Flight time over the last 28 days: ………………..78 hrs 31 min;

Flight time over the last 24 hours:………………..9 hrs 46 min.

The last flight prior to the occurrence - October 30, 2011.

FO

Male, aged 51, holder of ATPL(A) issued by the President of the Civil Aviation Authority, valid until April 21, 2014.

Ratings:

- TR B-757/767 – valid until November 30, 2011;
- radiotelephony communication from aircraft in Polish and English languages;
- CAT II approaches - issued on March 4, 2009

FO was a holder of:

- Operator Proficiency Check (OPC) valid until November 30, 2011;
- Line Check (LC) valid until November 30, 2011;
- Class 1 Aero-Medical Certificate valid until April 20, 2012.

Total flight time……………………………………….9431 hrs 16 min;

Flight time as Pilot-in-Command: ………..………..835 hrs 45 min;

Flight time on B-767: …………………..……..1981 hrs 09 min;

Flight time as Pilot-in-Command on B-767:……... none;

Flight time over the last 90 days: ....……….224 hrs 7 min;

Flight time over the last 28 days: ....……….42 hrs 15 min;

Flight time over the last 24 hours:………………….9 hrs 46 min.

The last flight prior to the occurrence - October 30, 2011.

Cabin crew (CC)

The cabin crew data are shown in the Table below.

Function	M/F	Age	Qualifications	Experience
CC1	M	61	Senior steward /Instructor	39 years
CC2	F	53	Senior stewardess	30 years
CC3	F	49	Senior stewardess	22 years
CC4	M	46	Steward	18 years
CC5	M	49	Steward	20 years
CC6	F	26	Stewardess	3 years
CC7	F	33	Stewardess	10 years
CC8	F	37	Stewardess	16 years

All members of the cabin crew held valid Aero-Medical Certificates and valid ratings to perform their duties on B-767-300 airplane.

1.6. Aircraft information
1.6.1. General information

Airframe:

Year of Manufacture	Manufacturer	Airframe Serial No	Registration Marks	CAA Register Number	CAA Register Date
1997	Boeing Commercial Aircraft, USA	28656	SP-LPC	3352	May 15, 1997

Engines: General Electric CF6-80CB6, maximum thrust 270,5 kN.

Engine	Year of manufacture	Serial No	Time Since New	Cycles Since New
Left	1995	695665	67 265	8239
Right	1995	695344	65 997	8436

Airplane weights:

- Maximum Zero Fuel Weight (MZFW): 86 315 kg;
- Fuel weight for flight LO 16: 47 320 kg;
- Weight of the airplane ready for the flight (according to FMS): 163 729 kg;
- Payload weight: 30 094 kg;
- Maximum Take-off Weight (MTOW): 185 065 kg;
- Actual Take-off Weight (according to FMS): 163 085 kg;
- Maximum Landing Weight (MLW): 145 149 kg;
- Actual weight prior to the landing (the last FMS record): 118 152 kg.

Certificate of Airworthiness - valid until May 15, 2012;
Airworthiness Review Certificate - valid until May 15, 2012;
Airframe Total Flight Time Since New - 85 429 hrs 36 min;
Airframe Total Cycles Since New - 8002;
Date of the last “A” inspection - September 27, 2011.

1.6.2. Airplane hydraulic systems – operation and signaling

General

B-767-300ER airplane has three independent hydraulic systems: left, right and center. The hydraulic systems power the following systems:

- flight controls;
- leading edge slats;
- trailing edge flaps;
- **landing gear extension and retraction;**
- wheel brakes;
- nose wheel steering;
- autopilot servos;
- tailskid.

The center hydraulic system is described below because an element of this system failed during the investigated occurrence.

Center Hydraulic System

The system consists of a reservoir, two electric motor-driven pumps which run continuously in flight, an air-driven demand pump, which is powered by engine bleed air and can run continuously (in ON mode) or temporarily (in AUTO mode) when system demand exceeds the output of the two electric motor-driven pumps. The system has also a ram air turbine (RAT) pump which operates only when deployed in emergency flight conditions. The RAT pump deploys automatically when both engines are inoperative.

Fluid Supply

Hydraulic fluid is supplied to each hydraulic pump from a reservoir. A quantity measuring system provides information to the EICAS status display.

RF displays on the EICAS status page when a reservoir requires refilling prior to dispatch.

The QTY light illuminates and the EICAS advisory message C HYD QTY displays when the reservoir quantity is low.

System Pressure Indications

The SYS PRESS light illuminates and the EICAS caution message C HYD SYS PRESS displays when the hydraulic system pressure is low.

Hydraulic system pressure displays on the EICAS status page.

Only flight control system is powered independently from any hydraulic system; it ensures its operation even when two hydraulic systems fail.

The landing gear extension and retraction system is powered only from the center hydraulic system and in case of its failure an alternate system must be used. The alternate system enables only extension of the landing gear. It is an electrical/mechanical system

1.6.3. Landing gear control systems - operation and signaling

General

The airplane has two main landing gears and a nose gear. During extension and retraction the main gears, nose gear, and landing gear doors are hydraulically powered from the center hydraulic system. An alternate electrical/mechanical system allows the gear to be extended in case of the center hydraulic system failure.

Landing Gear Retraction

The landing gear is normally controlled by the landing gear lever.

After take-off, when the landing gear lever is positioned to UP, the hydraulic fluid under a high pressure is supplied from the center hydraulic system to the respective actuators of the landing gear system and the gear begins to retract. The landing gear doors open and the gears retract to up position. The GEAR and DOORS lights illuminate as the landing gear retracts into the wheel wells.

After retraction, the nose gear is held up by uplocks and the main gear is held up by the door structure. The GEAR and DOORS lights extinguish. Then the landing gear lever is placed in the OFF position to depressurize the landing gear system.

The GEAR light remains illuminated and the EICAS caution message GEAR DISAGREE displays if any gear is not up and locked up after the normal transit time. The affected gear's, GEAR DOWN light remains illuminated if the gear remains in the locked down position. The DOORS light remains illuminated and the EICAS advisory message GEAR DOORS displays if any hydraulically actuated main gear door is not closed after normal transit time.

Landing Gear Extension

When the landing gear lever is moved to DN, the landing gear doors open, the gears are unlocked, and the GEAR and DOORS lights illuminate. The gears are hydraulically powered to the down and locked position. The downlocks are powered to the locked position and all hydraulically actuated gear doors close. When all gears are down and locked, the GEAR DOWN lights illuminate and the GEAR and DOORS lights extinguish.

The amber GEAR light remains illuminated and the EICAS caution messages GEAR DISAGREE, L or R SIDE BRACE, L or R DRAG BRACE displays if any gear is not locked down after the normal transit time.

The extinguished green gear down light indicates the affected gear. The DOORS light remains illuminated and the EICAS advisory message GEAR DOORS displays if any hydraulically actuated door is not closed after the normal transit time.

Alternate Landing Gear Extension System

When the center hydraulic system fails the alternate electrical/mechanical system allows to extend the landing gear.

When the ALTN GEAR EXTEND switch is moved to DN, electrical power is supplied to the electric motor (actuator) of the alternate extension system. The motor trips the locking mechanisms and releases all door and gear uplocks. The landing gear free-fall to the down and locked position.

When all gears are down and locked, the GEAR DOWN lights illuminate and the GEAR light extinguishes.

After alternate extension the DOORS light remains illuminated and the EICAS advisory message GEAR DOORS displays because all the hydraulically powered gear doors remain open.

Alternate Extension Load Limiters

The main and nose gear alternate extension load limiters (Figures 19, 20 and 21) are crush-core cartridges which fail when the system is stuck or damaged and an excessive force is applied. This failure prevents damage to the other major system components and allows unlocking of those gears which are not stuck.

Possible signaling and other symptoms

The alternate landing gear extension system is not connected to any signaling system and its de-energizing due to OFF setting of C4248 (F6) or C829 (A1) circuit breakers is not signaled. OFF setting of one of these circuit breakers prevents alternate extension of the landing gear.

1.6.4. Circuit breakers

Circuit breaker (Figure 5) is designed to protect an electrical circuit from damage caused by excessive current, typically resulting from overload or short circuit. Its operation consists in interrupting the current flow in electric circuit (opening the circuit) in case the current exceeds a rated value, i.e. the value at which a circuit breaker was designed. The greater value of current flowing through the circuit breaker is, the faster it opens. This feature of the circuit breaker is illustrated by the time-current characteristics, that is, the trip time of a circuit breaker vs. the current value.

After a circuit breaker has tripped (opened) its head (Figure 5) goes out and the white shaft (Figure 25) is visible. After removing the damage that caused the circuit breaker to open, its head should be pressed to close it and enable the current to flow again.

A circuit breaker is also a switch. Pulling the head opens the switch and pressing the head closes it.

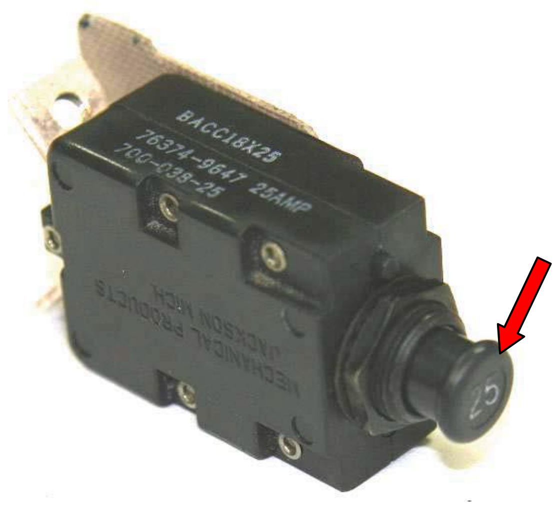


Figure 5. C829 circuit breaker removed from SP-LPC airplane. The circuit breaker in the ON/pressed setting. Red arrow indicates the circuit breaker head (Source –Boeing).

The right side of the aircraft cockpit is covered by 5 panels with circuit breakers. Each panel is 20 cm wide and 42 cm high. They are arranged next to each other from the floor level and marked with numbers from the left P6-1 to the right P6-5.

The P6-1 panel, containing circuit breakers of the alternate landing gear extension system is shown below (Figure 6).

Figure 6. P6-1 panel. A1 - C829 BAT BUS DISTR circuit breaker and F6 – C4248 LANDING GEAR – ALTN EXT MOTOR

P6-1 panel contains 56 circuit breakers arranged in 7 columns (marked with numbers from 1 to 7) and 8 rows (marked from „A” to „H”).

C829 BAT BUS DISTR circuit breaker, which after the accident, during visual inspection of the cockpit was in OFF setting, is situated on P6-1 panel on A1 position, in the bottom left corner just above the floor, in extremely peripheral portion of FO attention field, close to the right side of his seat (Figure 6). This circuit breaker, as the master one protects and powers circuits of the following downstream circuit breakers:

1. C749 2,5A (B7) CHILLER SHUTDOWN CONT
2. C804 7,5A (B1) L GEN CONT UNIT
3. C805 7,5A (B2) R GEN CONT UNIT
4. C806 7,5A (B3) APU CONT UNIT
5. C807 7,5A (B5) L GEN DRIVE DISC
6. C808 7,5A (B6) R GEN DRIVE DISC
7. C809 7,5A (B4) BUS PWR CONT UNIT
8. C828 2,5A (A5) STBY PWR CONT
9. C879 2,5A (A6) DC BUS TIE CONT
10. C906 5A (A7) HYD GEN CONT PWR
11. C1100 2,5A (C2) RAM AIR TURB-AUTO
12. C4097 2,5A (A4) BAT CUR MON PWR
13. **C4248 7,5A (F6) LANDING GEAR-ALTN EXT MOTOR**

The aforementioned thirteen circuits are protected by C829 circuit breaker with a rated current of 25A, but each of them has its own circuit breaker with rated currents from 2,5A to 7,5A, therefore much less than 25A. In case of malfunction in one of the thirteen above listed circuits, first of all an individual/independent circuit breaker of this failed circuit will be activated (tripped to open setting).

Opening C829 (A1) circuit breaker (due to exceeding the rated current or manually by pulling out its head) is not signaled in the cockpit and is not recorded by SSFDR or QAR, but this opening prevents the landing gear from being extended by the alternate system.

C4248 ALTN EXT MOTOR circuit breaker is located on the P6-1 panel on F6 position. This circuit breaker protects the electric motor (actuator) of the alternate landing gear extension system. When the landing gear is being extended by the alternate system, the actuator releases the landing gear uplocks. The landing gear free-fall to the down and locked position.

1.6.5. ETOPS

On October 31, 2011, prior to the departure, the aircraft was subjected to a technical check by a licensed ground engineer in accordance with applicable regulations, which was confirmed by relevant entry in the Aircraft Technical Log. The airplane was released for flight in accordance with ETOPS without restrictions, i.e. to operate up to 180 minutes flying time to en-route alternate aerodrome.

Prior to the departure the crew received a computer flight plan containing all the necessary information, which showed that the planned flight route at the farthest point was 122 minutes flying time from an en-route alternate aerodrome.

1.7. Meteorological information

The weather conditions at EPWA on the day of occurrence from 12:30 do 13:30 hrs, provided in METAR form are shown below:

METAR EPWA 011230Z 14004KT 100V180 9999 SCT015 BKN043 13/10 Q1022 NOSIG

METAR EPWA 011300Z 14005KT 100V170 9999 SCT015 BKN043 13/10 Q1022 NOSIG

METAR EPWA 011330Z 13004KT 090V160 9999 SCT016 BKN043 12/10 Q1022 NOSIG

The last weather information provided by the TWR Controller to the crew: wind direction 120° at the speed of 5 kts. The landing was performed in the daylight conditions.

1.8. Aids to navigation

The navigational aids listed on the EPWA approach chart were operative and available at the time of the accident. The airplane was observed on radars. The approach to landing was performed under EPWA APP radar control.

1.9. Communications

During the flight in Warsaw FIR the crew maintained a two-way radio communication with air traffic controllers, Operator's Operational Centre, MCC and with Polish Air Force F-16 pilots.

1.10. Aerodrome information

Basic data of EPWA aerodrome:

- elevation 110 m;
- two intersecting runways: RWY 15/33 - dimensions 3690x60 m and RWY 11/29 – dimensions 2800x50 m;
- runways physical characteristics: PCN 57, R/B/W/T, CONC/ASPH;
- geographical coordinates of RWYs intersection - 52°09'57"N 020°58'02"E;

The landing took place on RWY 33 equipped with ILS CAT II (Figure 7).

The rescue and firefighting equipment of Warsaw Chopin Airport on the occurrence day is shown in the table below.

EPWA AD 2.6	SŁUŻBA RATOWNICZA I PRZECIWPOŻAROWA	RESCUE AND FIRE FIGHTING SERVICES
1.	**Kategoria lotniska w zakresie ochrony przeciwpożarowej** CAT 9 ICAO	**Aerodrome category for fire fighting** CAT 9 ICAO
2.	**Wyposażenie ratownicze** - pojazdy ratowniczo-gaśnicze - 7, - pojazd ratownictwa technicznego - 1, - pojazd dowodzenia i łączności - 1, - ambulanse - 2, - ruchomy magazyn leków i sprzętu medycznego.	**Rescue equipment** - fire and rescue vehicles - 7, - technical rescue vehicle - 1, - management and communication vehicle - 1, - ambulances - 2, - mobile warehouse of medicines and medical equipment.
3.	**Możliwości usuwania uszkodzonych statków powietrznych** - przyczepa niskopodwoziowa z holownikiem, - dyszle do samolotu, Sprzęt do usuwania unieruchomionych statków powietrznych - kategoria I; max B737: - lotnicze poduszki podnośnikowe (4 zestawy), - system uprzęży do podnoszenia samolotu, - maty ziemne do budowy dróg awaryjnych.[1]	**Capability for removal of disabled aircraft** - low chassis trailer with a tug, - aeroplane tow bars, Equipment for removal of disabled aircraft: category I, max B737: - aeronautical lifting cushions (4 kits), - harness system for aircraft lifting, - ground mats for construction of emergency roads.[1]
4.	**Uwagi** [1] Kierownik Zmiany Dyżurnych Portu, tel. patrz punkt 2.2.8.	**Remarks** [1] Airport Duty Officers Supervisor, phone see point 2.2.8.

Table: EPWA rescue and firefighting equipment as of November 1, 2011
Source: AIP- Poland

Figure 7. EPWA aerodrome. Red arrow indicates the aircraft stop place.

Due to the layout of the runways and the location of the aircraft after the emergency landing EPWA aerodrome was closed until removal of the aircraft from RWY 33.

1.11. Flight recorders

On the scene the SCAAI Investigation Team protected CVR and SSFDR (Figure 8) and memory cassette from QAR (Figure 9).

Figure 8. CVR and SSFDR removed from SP-LPC airplane. (Source: SCAAI)

Figure 9. QAR recorder from SP-LPC and its memory cassette. (Source: SCAAI)

1.11.1. Honeywell SSFDR P/N 980-4700-042, S/N 6467 was removed from the rear part of the SP-LPC fuselage. It showed no external signs of damage. On November 4, 2011, under supervision of SCAAI representative the data from the recorder was read out at the Avionics Laboratory of LOT AMS Company. 145 analogue parameters and 309 discrete parameters covering approximately last 105 flight hours were recorded and retrieved from the recorder memory. The retrieved data were used for the analysis of operation of onboard aircraft systems and reconstruction of the sequence of events during LO 16 KEWR-EPWA flight.

1.11.2. Fairchild CVR A100A model P/N 93-A100-80, S/N 62909 was removed from the place of its installation. It showed no external signs of damage. On November 8, 2011, in the presence of SCAAI representative the magnetic tape from the recorder was read out in BFU (Bundesstelle für Flugunfalluntersuchung) laboratory. The good quality audio recording of all four audio tracks from the last 31 minutes and 34 seconds of the flight was retrieved. The audio recording of the crew conversations, sounds from the cockpit and radio communication were analyzed by the SCAAI Investigation Team.

1.11.3. ATM Awionika PP QAR ATM-QR4 model with the memory cassette ATM-MC5/70 P/N 254-700-0040521, S/N 0492/02 parallelly recorded the data sent to SSFDR. During visual inspection of the aircraft the QAR memory cassette was removed and protected by the SCAAI Investigation Team. On November 1, 2011 the memory cassette was read out in PLL LOT SA Department of Analysis of Flight Parameters. The data from QAR were identical with the data from SSFDR. The QAR recording covers only LO 15 and LO 16 flights, i.e. the EPWA-KEWR-EPWA route.

1.11.4. Other sources of information available to the SCAAI Investigation Team:

- recordings of air traffic radars obtained from PANSA; the recordings cover flight LO 16 from entering Warsaw FIR to landing on EPWA;
- audio recordings of ATS radio communication with SP-LPC crew;
- audio recordings of telephone communication from ATS workstation;
- recordings from airport CCTV cameras;
- audio recordings of the radio and telephone communication of the Operator’s Operations Centre.

All collected materials were analyzed by the SCAAI Investigation Team.

1.11.5. Course of events based on SSFDR recording

Time: 03:58:11 – starting engines for flight LO 16;

Time: 04:11:03 – start of taxiing;

Time: 04:19:08 – line up on RWY 04L and start of the take off procedure;

Time: 04:19:51 – lift-off and initial climb;

Time: 04:19:55 – start of the landing gear retraction, RALT=39[ft];

Time: 04:20:08 – end of the landing gear retraction, RALT = 480[ft], pressure in the center hydraulic system HYDPRC = 2600[psi], hydraulic fluid quantity in the center system – HYDQTC = 105.1[%];

Time: 04:21:07 – start of the flaps retraction (flaps from position 5 to position 1);

Time: 04:21:11 – flaps in position 1;

Time: 04:21:47 – continuation of flaps retraction (flaps from position 1 to position 0);

Time: 04:21:51 – flaps in position 0;

Time: 04:22:11 – indication of low pressure in the center hydraulic system, PRALT = 3852[ft], gross weight of the airplane GW = 162.57[t], geographical coordinates: N40º48'42", W74º 5'17";

Time: 04:22:14 – drop in the hydraulic fluid quantity in the center system HYD QTC = 10.6[%] (parameter recorded once per minute);

Time: 04:36:28 – cruise altitude, FL310;

Time: 05:08:01 – cruise altitude, FL330;

Time: 06:09:05 – cruise altitude, FL340;

Time: 09:18:08 – cruise altitude, FL370;

Time: 11:32:19 – cruise altitude, FL350;

Time: 11:44:17 – start of descent for landing at EPWA;

Time: 12:05:26 – change in setting of ALT FLAPS switch, PRALT=7712[ft];

Time: 12:10:48 – FLAPS=20, PRALT=2756[ft];

Time: 12:18:03 – abandonment of approach to landing on EPWA and diverting to a holding zone;

Time: 12:41:47 – moving the landing gear lever to DOWN position;

Time: 12:43:39 – moving the landing gear lever to UP position;

Time: 12:52:48 – moving the landing gear lever to DOWN position;

Time: 12:53:16 – moving the landing gear lever to UP position;

Time: 12:53:48 – moving the landing gear lever to DOWN position;

Time: 12:55:39 – moving the landing gear lever to UP position;

Time: 13:00:56 – moving the landing gear lever to DOWN position;

Time: 13:13:40 – moving the landing gear lever to UP position;

Time: 13:17:45 – moving the landing gear lever to DOWN position;

Time: 13:30:20 – end of holding and start of final approach;

Time: 13:32:30 – increase in the vertical g-load: VACC = 1.896[g] (an attempt of gravitational extension of the landing gear);

Time: 13:33:35 – FLAPS = 30, PRALT = 1902[ft];

Time: 13:38:23 – touchdown, GSPEED=127[kts], PITCH=5.3[deg], VACC=1.207[g];

Time: 13:38:38 – engine No. 2 fire warning;

Time: 13:38:41 – engines shutdown;

Time: 13:38:43 – end of SSFDR recording, GSPEED=91[kts].

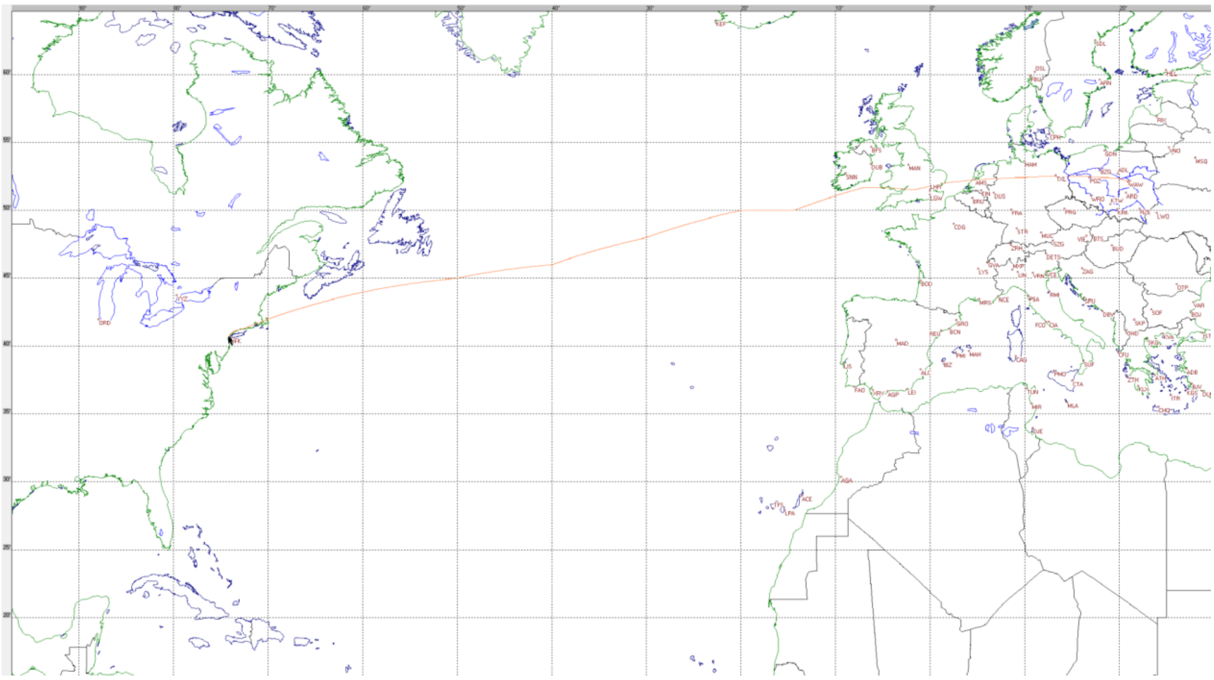


Figure 10. SP-LPC flight route based on SSFDR recording.

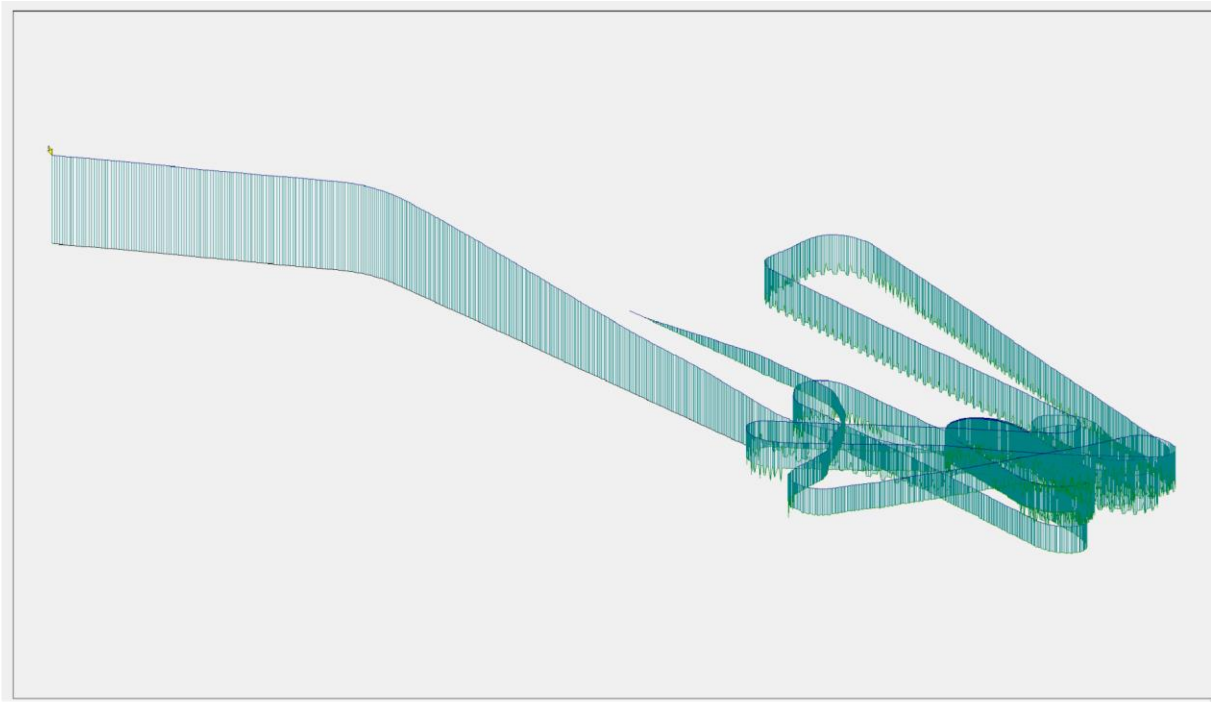


Figure 11. 3-D view of the LO 16 flight path during holding in the area of EPWA.

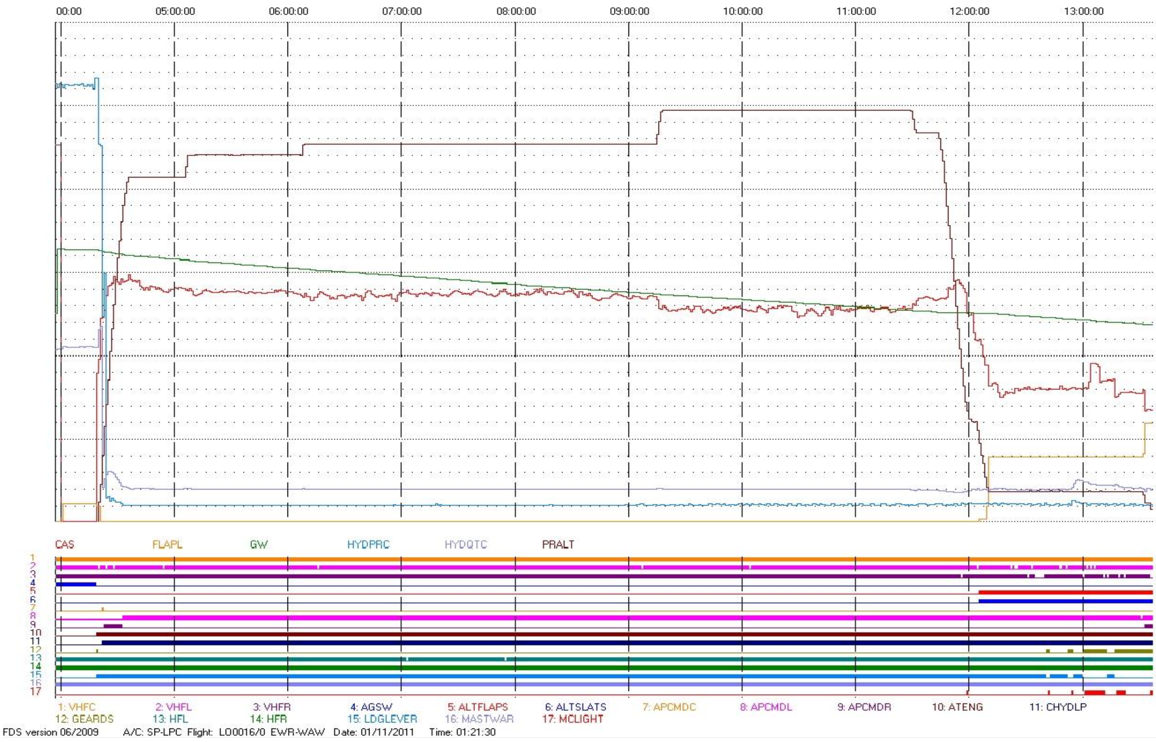


Figure 12. Flight LO 16; SP-LPC SSFDR recording.

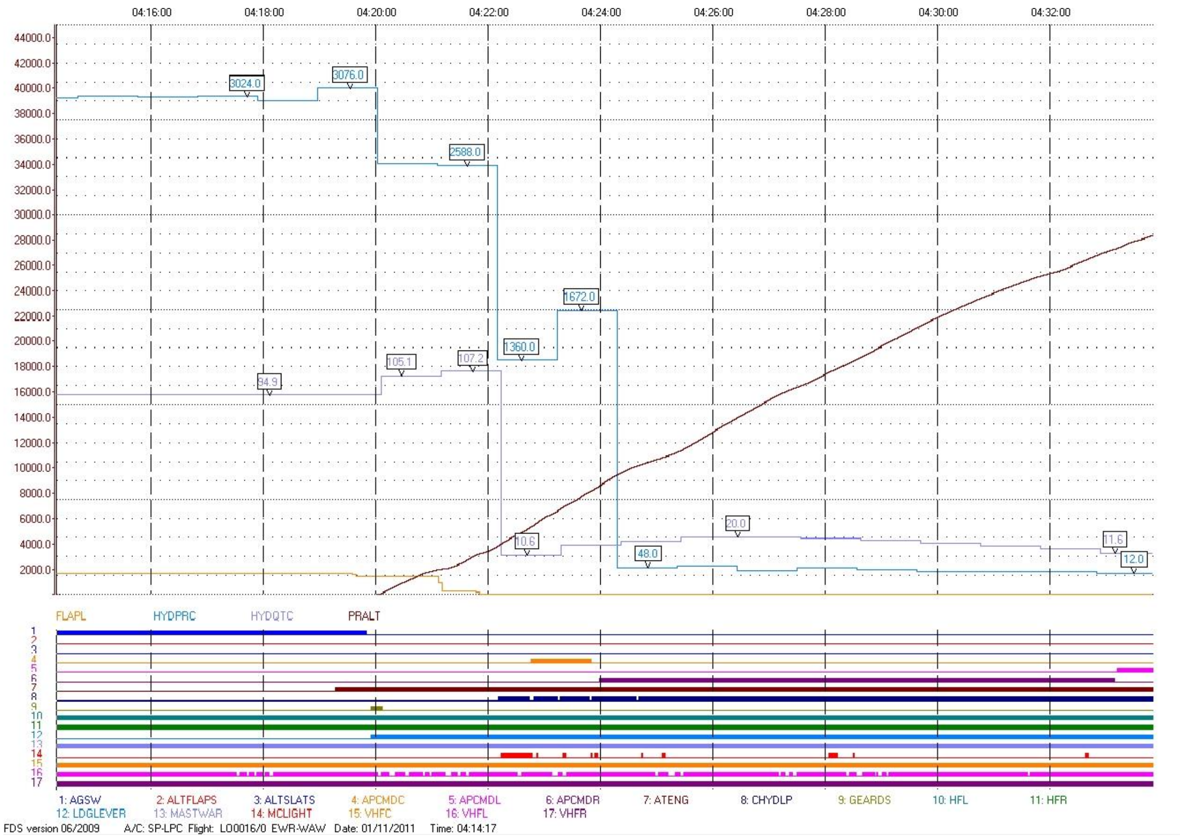


Figure 13. Pressure drop in the center hydraulic system of SP-LPC after its take-off - as recorded by the SSFDR.

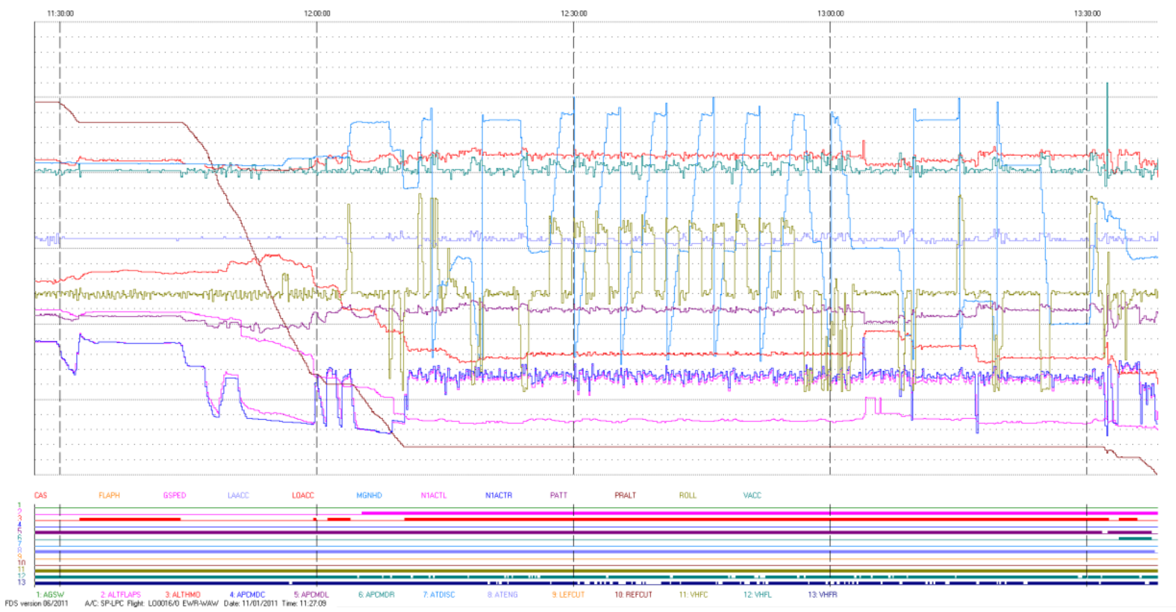


Figure 14. SP-LPC approach to landing – as recorded by the SSFDR.

1.12. Wreckage and impact information

At 13:38:23 hrs, the airplane touched down on RWY 33 with ground speed of 127 kts, pitch angle of 5.3 degrees and vertical acceleration of 1.207 g. At the touchdown time approximately 1600 kg of fuel was left in the aircraft tanks, the engines were running, and their recorded RPMs were: N1ACTL = 57%, N1ACTR = 38%. 15 seconds after the touchdown fire of engine #2 was signaled and 3 seconds later the engines were shutdown by the crew.

As a result of the gear up landing the following parts of the aircraft were damaged:

- both engines;
- airframe (mainly lower aft part of the fuselage);
- nacelles of both engines;
- components of on-board systems in the affected areas.

A detailed description of the damage to the aircraft is contained in Section 1.3 of the Report.

1.13. Medical and pathological information

None of the passengers and crew suffered any injuries during the emergency landing and during the evacuation.

Actions taken by SP-LPC crew before and during evacuation are described in Chapter 1.15 and Annex 6.

Rescue and firefighting actions taken on the ground after the landing are described in Chapter 1.15 and Annex 7.

On the day of the accident Warsaw Chopin Airport management provided psychological support to the passengers and their families. The crew was provided with psychological support by the Operator.

1.14. Fire

Prior to the airplane landing RWY 33 was covered with a layer of extinguishing foam.

During the landing the right engine caught fire, which resulted from the friction between the bottom of the nacelle and the runway surface. The friction produced an intense sparking, which was suppressed by the foam but the fire moved inside the nacelle. After the destruction of the lower part of the nacelle, the accessories located at the bottom of the engine were also destroyed.

The fire was of a local nature and was extinguished by AFB units. The extinguishing foam was delivered to the right wing and right nacelle from a monitor (deluge gun). Water was supplied in the form of a droplet stream from a hose attack line into the nacelle. STHAMEX®-AFFF 6% F-25 frothging agent was used in the action.

1.15. Survival aspects

1.15.1. Cabin crew actions

1.15.1.1. Prior to take-off

Upon arrival at the airplane, the cabin crew performed pre-departure actions in accordance with the Cabin Crew Manual. During inspection of emergency equipment CC5 found that the headphone at CC2 position (jumpseat 3R) was inoperative and marked with INOP sticker.

1.15.1.2. After take-off

The airplane take-off was normal. After the take-off CCs working in the front and the center galleys noticed problems with power supply, which was reported to the flight crew. After a while the problem was fixed.

After a certain time CC1 was called to the cockpit and informed about the failure of the center hydraulic system. At that phase of the flight CC1 did not inform the rest of the cabin crew about the failure.

The rest of the flight, until the attempt to extend the landing gear with the alternate system, was normal.

1.15.1.3. Prior to landing

Preparation of the cabin and passengers to landing in Warsaw proceeded in a standard way. About 20 minutes before the scheduled landing time on EPWA CC1 was called to the cockpit and informed about problems with the landing gear extension.

After some time CC1 was ordered by Captain to prepare the cabin and passengers to an emergency, gear up landing. CC1, using ALERT push button tried to call the heads of all sections to inform them about details of the emergency landing. However, it turned out that ALERT system was inoperative. Therefore, CC1 passed relevant information to CC4 and CC8, appointed CC4 to read an emergency announcement and ordered CC8 to train APs for exit 1L.

On Captain order CC1 was spending most of the time in the cockpit, where he was kept informed about the situation development and an expected performance of the aircraft during gear up landing, took part in arrangements for evacuation, participated in checking circuit breakers, removed all loose objects from the cockpit and secured them. Therefore, part of the crew (CC3, CC6, CC2, CC5, CC7) was not informed directly by CC1 about the situation. It was done by CC2, who obtained relevant information from CC4 and then passed it to CC3, CC6, CC5 and CC7. At the same time CC4 started reading the emergency announcement.

During the cabin preparation the passengers were calm, they carried out the crew instructions, there was no panic. The cabin crew demonstrated brace positions, secured all loose luggage and showed the emergency exits.

Mostly Polish-speaking passengers were chosen as APs to exits, with the exception for APs to over-wing exits, where half of the APs were English speakers. 16 APs were trained for all aircraft exits and for controlling passengers' movement.

Some cabin crew members had difficulties in finding the right pages in „AP Briefing & Evacuation Commands Booklet"; others, seeing that the selected assistants had problems with concentration of attention and they were able to understand only simple commands, abandoned using the text from the Booklet and used their own simple words.

In the meantime, an additional attempt was carried out to extend the landing gear in a gravitational way, i.e. by producing the vertical g-load, but that attempt also ended in failure.

According to the arrangements between Captain and CC1, the command to adopt brace position was issued by CC1. However, the crew of the rear galley began to shout "Brace position" earlier and CC1 issued the command (via PA) only after that.

1.15.1.4. After landing

Captain instructed CC1 that when the airplane would come to rest the cabin crew should begin evacuation of passengers immediately, without waiting for an order from the cockpit. CC1 passed the instruction to the rest of the cabin crew. However, when the airplane came to rest, he was not sure whether evacuation was necessary, so he entered the cockpit to receive confirmation that evacuation was necessary and only after that he opened exit 1L (Figure 15). CC4 opened exit 1R at the same time. As a result, the nose exits 1L and 1R were opened 12 seconds later that the aft ones (3L and 3 R).

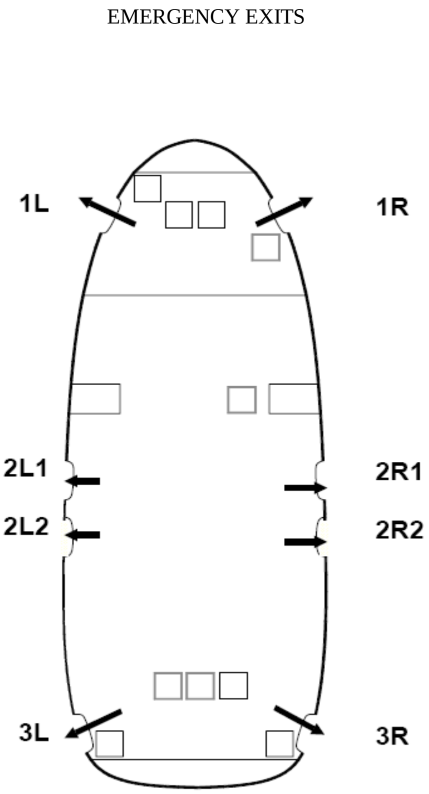


Figure 15. Designation of emergency exits.

All escape slides were inflated. The aft slides at exits 3L and 3R were set at a small angle (flat position), which was slowing down the evacuation (Figure 16).

Figure 16. Setting of the rear slides of SP-LPC airplane after emergency landing.

In the initial phase of the evacuation there was nobody who could assist passengers at the aft right slide (3R) – assistants ran away. Therefore, at some point CC2 had to slow down the evacuation significantly, so that the successive passengers did not fall on the heads of the ones sitting on the slide.

Over-wing emergency exits on the right side of the airplane (2R1 and 2R2) were not opened because after assessing the situation outside the airplane CC3 stated smoke hazard due to the engine fire. The over-wing emergency exits on the left side of the airplane (2L1, 2L2) were opened, but nobody was evacuated in this way. That was due to the fact that all passengers, directed by CC7 and CC6, very quickly moved towards the aft exits. The wing slide was inflated, but the drop step under 2L2 exit did not open.

The cabin crew used evacuation commands adequate to the situation. EVAC system was activated at 3L door by CC5, who pressed the button.

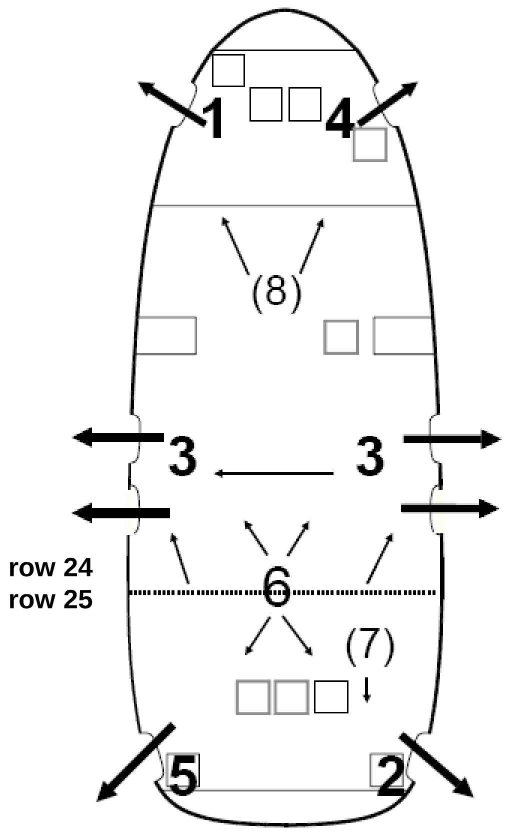
Three cabin crew members directed passengers to the active exits:

- CC8 to exits 1L and 1R;
- CC6 and CC7 to exits 3L and 3R;

the rest of the crew members carried out the evacuation at the following exits respectively: CC1 – 1L, CC4 – 1R, CC2 – 3R, CC5 – 3L (Figure 17).

B 767 300

EMERGENCY LANDING
(planned and unplanned)
Action zones assigned to each CC



CC1 – door 1L
CC2 – door 3R
CC3 – over-wing exits 2R1/2R2, 2L1/2L2
CC4 – door 1R
CC5 – door 3L
CC6 – directs pax from section C to exits 3R/3L and emergency windows
CC7 – directs pax from the first seven rows, section C to emergency windows, the rest of pax to exits 3R and 3L
CC8 – directs pax from sections A and B to exits 1L and 1R

Figure 17. Action zones of the cabin crew during emergency landing.

When all passengers left the airplane the crew checked the cabin, reported BOARD CLEAR and began to leave the airplane:

- CC4 and CC8 left the airplane via exit 1R;
- CC2, CC5, CC6, CC7, CC3, CC1, FO and CPT left the airplane via exit 3L.

CC1 and CPT left the airplane as the last ones, after several re-checks to make sure that all persons left the board. They stayed on the board more than 5 minutes after completion of the evacuation.

About 12-15 minutes after the end of the evacuation, on the police request, CC1 entered the airplane twice via door 3L. CC3 and CC7 also entered the airplane via door 3L to take their personal belongings.

The airplane crew members were waiting by the airplane for about 15 minutes for further decisions. Lack of proper coordination by the ground rescue service caused splitting the crew: CC4 and CC8 were taken by a bus with the passengers, the rest of the crew were waiting in a bus for about 1,5 hour, with no information about CC4 and CC8.

1.15.2. Rescue and firefighting action

1.15.2.1. Chronology

Time: 07:00 hrs Duty services did not report any comments to the course of duty. Airport equipment and systems operative. Meteorological conditions:

- visibility: 10 km;
- cloud base: first layer - 500 m, second layer -1300 m;
- temperature: 12° C;
- wind: 3m/s, direction: south-east.

Time: 12:23 hrs. TWR controller declared a state of uncertainty for flight LO 16 and informed KZ-DOP accordingly. The crew reported technical problems with the flaps and then with the landing gear.

Time: 12:24 hrs. KZ-DOP informed ZMR and AFB about declaration of state of uncertainty for flight LO 16.

Time: 12:25 hrs. TWR controller forwarded a detailed information on SP-LPC position (holding in „Linin” area), number of persons on the board (231) and fuel quantity (7,7 t).

Time: 12:26 hrs. TWR controller informed KZ-DOP that LO 16 crew declared EMERGENCY (landing with flaps and landing gear up). KZ-DOP declared alert for the airport services.

Time: 12:27 hrs. TWR controller declared alert for AFB, DOP, ZMR. AFB vehicles took pre-planned positions along RWY 33. KZ-DOP informed WSPR dispatcher about alert for the aircraft with 231 persons on board.

Time: 12:28 hrs. Vehicles of airport services arrived at Concentration Area No. 1.

Time: 12:55 hrs. Firefighter No. 1, commanding the operation, decided to distribute foam on both sides of RWY 33 centre line on the section: 100 m from RWY 33 THR to taxiway „D" (approximately 3000 m long).

Time: 12:59 hrs. Arrival of the external forces (PSP, WSPR ambulances) at Concentration Area No 2.

Time: 13:05 hrs. Firefighter No 1 informed all the services that the airplane would perform gear up landing.

Time: 13:15 hrs. Completion of arrangement of PSP and the city medical services vehicles in Concentration Area No 2.

Time: 13:16 hrs. The airplane at the distance of 12 miles from RWY 33. Rescue services in full readiness.

Time: 13:32 hrs. The airplane started the final approach.

Time: 13:37 hrs. The airplane in sight of the airport services. The landing gear in up position confirmed.

Time: 13:38 hrs. The airplane touchdown. The plane was moving on the surface of RWY 33, along its centre line. Visible sparks from the right engine being suppressed by the applied foam.

Time: 13:39 hrs. The airplane came to rest on RWY 33 approximately 42 m behind RWY 29 centre line. Visible fire on the right engine. The crew activated escape slides. Evacuation of passengers started.

AFB units arrived. Extinguishing of the right engine fire and protection of the airplane structure started.

The airport closed for air traffic.

Time: 13:41 hrs. Completion of the passengers evacuation. Engines being cooled down.

Time: 13:47 hrs. Transport of the passengers to the VIP lounge in the terminal. Care provided to the passengers.

Time: 13:53 hrs. Completion of the airplane searching. No passengers on the board. Nobody injured.

Time: 13:56 hrs. City ambulances left the airport area.

Time: 14:06 hrs. Completion of the rescue and firefighting operation.

Time: 14:16 hrs. PSP units left the airport.

Time: 14:48 hrs. Cancellation of alert for the airport services. Sending a report to SCAAI.

1.15.2.2. Forces and resources involved in the rescue and fire fighting operation:

- 10 rescue-firefighting units and 18 firefighters of AFB;
- 21 teams (81 firefighters) of PSP;
- 2 Airport Medical Rescue Teams and 2 resuscitation ambulances;
- 33 ambulances of WSPR (about 110 persons);
- 25 vehicles and 140 policemen securing the accident site;
- 3 vehicles and 12 members of Border Guard;
- 4 Airport Duty Operational Officers;
- 5 vehicles and 21 persons of airport security service;
- 1 vehicle and 2 airport employees of Vehicular Traffic Supervision.

In total, about 420 persons took part in the operation.

1.15.2.3. Psychological assistance for the passengers and their families/friends

Assistance for passengers and their families was provided by the Passenger Service, Airport Chaplain and LOT Victim Assistance Team. CENTRE FOR PASSENGERS (VIP Lounge) and additionally CENTRE FOR FAMILIES/FRIENDS were activated (Conference Centre in terminal);

Passengers were provided with psychological care and offered opportunity of telephone contact with the families/friends, access to information (including the Internet and TV), drinks, snacks, blankets, personal care products, etc.;

Passengers received materials related to reactions of persons involved in a potentially traumatic event, and the methods of dealing with stress.

1.15.3. Removal of the disabled airplane

Preparations for lifting the airplane were carried out by the Operator in cooperation with EPWA services. On November 1, 2011 the EPWA aerodrome had only capability to remove disabled aircraft of a maximum B737 category.

Due to the lack of proper equipment at the airport, an external company was contracted to remove the aircraft. Due to location of the company 300 km from EPWA and restrictions on movement of a truck with equipment, it arrived only November 2, 2011 morning.

The SP-LPC was lifted with harnesses and airbags originally designed for B737. The lifting operation started at 16:07 hrs and ended at 18:03 hrs on November 2, 2011.

When the airplane was lifted, a ground power source was connected and in the presence of SCAAI member, the Operator's staff and the prosecutor's office representative the C829 circuit breaker was set in ON position (pushed) and the alternate landing gear extension system was activated. The landing gear was extended and locked. The airplane was towed to the Operator's technical base.

Due to the landing of SP-LPC on RWY 15/33 close to the intersection with RWY 11/29, EPWA aerodrome was closed for air traffic for more than 29 hours.

1.16. Tests and research

In the scope of the investigation the following test, researches and analyses were carried out:

- analysis of SP-LPC operational documentation (Section 1.16.1.);
- analyses of technical documentation, tests of the aircraft systems and components (Section 1.16.2);

The US NTSB was also involved in research and expertise. It tested the failed hydraulic hose and commissioned the tests of C829 BAT BUS DISTR and C4248 LANDING GEAR - ALT EXT MOTOR circuit breakers as well as the electric actuator from the alternate landing gear extension system.

1.16.1. Airplane documentation

- All maintenance records of SP-LPC airplane from the period preceding the accident were protected and analyzed.
- Periodical technical inspections and maintenance of the aircraft were examined against the manufacturer recommendations.
- Analysis of the aircraft maintenance program was carried out; it was focused on the tasks related to the zone in which the damaged hydraulic hose was located.
- The applicable technical documentation of the individual systems and electrical circuits of the aircraft was analyzed; particular emphasis was placed on the analysis of the hydraulic system and the electrical system of the landing gear. Conclusions from the documentation analysis led to the development of the functional tests programs of the landing gear and the electrical system of the alternate landing gear extension system.

- Technical modifications of P6-1 circuit breaker panel introduced by the aircraft manufacturer were checked.
- Photographic documentation of the airplane and the occurrence site was made.
- Checklists contained in QRH (D632T001-35 LOT) related to the pressure loss in the center hydraulic system were analyzed - the conclusions of the analysis are described in Chapter 2.

1.16.2. Technical issues

1.16.2.1. The following checks and tests were effected:

- Initial inspection of the cockpit and the cabin was carried out immediately after the accident. It was found that C829 circuit breaker on P6-1 panel (located on the right side behind FO seat) at A1 position was in OFF setting (pulled out);
- On-board recorders: (CVR, SSFDR) and QAR cassette were protected; all data from these recorders were retrieved. The data were complete and consistent, they contained information on the facts described in Chapter 1;
- Members of the Commission participated in detailed inspection and inventory of aircraft damage carried out by the manufacturer's specialists;
- The Commission obtained statement of the ground engineer who performed pre-departure check at the take-off aerodrome (Newark) – the check was effected in accordance with the signed agreement and established procedures;
- It was confirmed by experiment that observation of C829 circuit breaker while seated normally in the FO seat was highly impeded;
- Experiments were carried out to verify whether C829 circuit breaker head could be inadvertently pulled out.

1.16.2.2. The following tests of SP-LPC systems, components and devices were carried out:

- 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 a Ground Power Unit, setting C829 circuit breaker in ON position and activation of the alternate landing gear extension system, the landing gear was extended and locked;

- During the landing gear extension with the alternate system the current of electric motor driving the system was measured. The value of the operating current was 2A and was within the limits (not more than 5A) and the value of the starting current was 14A (limit not more than 20A).
- Examination of inside of P6-1 panel was carried out, in particular the area of the wiring harness connected with C829 and C4248 circuit breakers. No irregularities or foreign objects were found.
- Resistance of the power supply circuit of the electric motor and resistance of insulation of the circuits connected with C829 circuit breaker were measured - no irregularities were found.
- It was found that when C829 circuit breaker was in OFF setting, disconnecting of STBY buses did not cause the STBY BUS OFF light to illuminate.
- The current of HMG VALVE, which potentially could have been activated during flight LO 16, was measured. During opening an closing the valve the current was the same (0,63 A), and was much lower than the rated current of its individual circuit breaker C906 (2,5 A).
- C829 circuit beaker and 13 other powered by C829, the electric actuator of the alternate landing gear extension system and the failed hydraulic hose were examined in certified maintenance organizations. The results of examinations are presented in sections 1.16.2.4. and 1.16.2.6.

1.16.2.3. The following tests were carried out on another BOEING B767-300ER airplane (SP-LPB), identical to SP-LPC

- The functional test of the alternate landing gear extension system was carried out and it was found that:
    - when C829 circuit breaker was in ON setting (pushed) – moving ALT GEAR EXTEND switch into DN setting caused extension of the landing gear;
    - when C829 circuit breaker was in OFF setting (pulled out) – moving ALT GEAR EXTEND switch into DN setting did not cause extension of the landing gear;
- It was confirmed that the OFF setting of C829 circuit breaker was not signaled in the cockpit by EICAS and was not recorded by SSFDR or QAR.

1.16.2.4. Measurements and tests of the circuit breakers and the actuator from the alternate landing gear extension system

1.16.2.4.1. Circuit breakers

C829 and C4248 circuit breakers were removed from SP-LPC airplane and examined in LOT Aircraft Maintenance Services (LOT AMS) – a certified maintenance organization. No abnormalities were found in the structures of the internal mechanisms of both circuit breakers from SP-LPC.

a) **C829 circuit breaker –** average pull-out force (OFF setting force) was 1,5 kG and was within the specified limits (0,61-5,44 kG). The current of 28,5A during 1 hour did not trip the breaker, while the current of 50A (200% of the rated current) caused that the breaker tripped in 25 seconds (according to the applicable documentation 15-55s).

b) **C4248 circuit breaker -** average pull-out force (OFF setting force) was 2,6 kG and was within the specified limits (0,61-5,44 kG). The current of 8,63A during 1 hour did not trip the breaker, while the current of 15A (200% of the rated current) caused that the breaker tripped in 14,5 seconds (according to the applicable documentation 15-55s).

Both circuit breakers were regarded operative (Annex 4). Additionally the circuit breakers were sent to NTSB for extra tests. No abnormalities were found (Annex 2). The final opinion of Boeing on the conducted tests is presented below:

"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".

c) **Other circuit breakers** - the twelve other circuit breakers powered via C829 circuit breaker were tested.

The tests consisted in measurement of the trip time of the breakers subjected to the current equal to 200% of the rated current.

The tests results were in accordance with the manufacturer requirements (taking into account admissible measurement errors).

1.16.2.4.2. Electric actuator from the alternate landing gear extension system, S/N 794, P/N 724D100-3 (Figure 18)

a) During the test of the alternate landing gear extension system the starting and operating currents of the electric actuator driving the system were measured. They were 14A and 2A respectively. According to CMM EATON S257T400-1 (-3) 32-35-01 the operating current (Io) should not exceed 5A, and the starting current should not exceed 10xIo i.e. 20A for the tested actuator. Therefore, both values were within the specified limits.

b) The actuator of the alternate landing gear extension system was removed and sent to NTSB for measurements and functional testing. The tests did not show any faults in the functioning of the component (Annex 3). Part of the expert opinion on the actuator prepared under NTSB supervision is presented below:

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.

Figure 18. Electric actuator of the alternate landing gear extension system (Source - SCAAI).

1.16.2.5. Load limiters

Visual inspection of the alternate landing gear extension system components was carried out. None of the three load limiters showed signs of overload in the system (Figures 19, 20 and 21).

Figure 19. Load limiter of the alternate landing gear extension system (nose gear).
(Source – SCAAI)

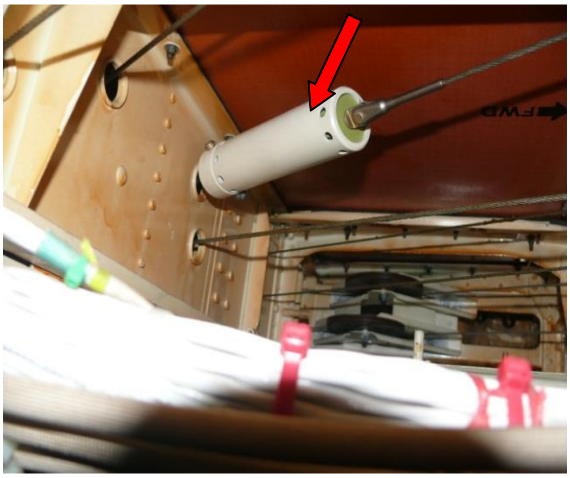


Figure 20. Load limiter of the alternate landing gear extension system (left main gear).
(Source – SCAAI)

Figure 21. Load limiter of the alternate landing gear extension system (right main gear).
(Source – SCAAI)

1.16.2.6. Hydraulic system

1.16.2.6.1. Hydraulic hose

On November 2, 2011 in the course of SP-LPC lifting from the runway the place of the hydraulic fluid leakage from C system was identified. It was damaged flexible hydraulic hose (according to AIPC p/n 32-32-54-05, item 152: AS4624J-0300SS) connecting the hydraulic system on the right leg of the main landing gear with the C hydraulic system on the airframe. Its fracture initiated the occurrence (Figures 22, 23 and 24).

Visual inspection carried out in Poland revealed the fracture in the area of the metal band around the tip of the hose.

The hydraulic hose with photographic documentation was sent to NTSB for examination to determine the cause of the fracture. The examination results are contained in (Annex 1) to this Report. A section of the examination report is presented below:

> *"To determine the fracture 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 zone of the damaged hydraulic hose 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 irregularities related to the hydraulic system were found.

In June 2000, Boeing released a service bulletin for the installation of the hydraulic hose due to inadequate service life of the Kevlar hose. These hoses had been installed in production since 1995 (as such, SP-LPC was delivered with the Kevlar hoses); however, it was determined that the minimum bend radii were exceded causing the hoses to leak. Boeing took the action to create a new bracket and swivel fitting installation in order to provide better hose life and released a service bulletin (767-32-0162) that contains a kit of parts and installation instructions. Boeing also released a 'Fleet Team Digest' article describing the history and the service action that operators can take.

However, the service bulletin category was low (non-mandatory) and the time for its incorporation was not specified. It was left to the discretion of operators. In that situation, based on its own assessment and previous experience, the Operator decided not to incorporate the bulletin on SP-LPC.

Figure 22. Damaged hydraulic hose (marked with red circle) on SP-LPC right main gear.
(Source – SCAAI)

Figure 23. Close-up of the damage to the hydraulic hose (marked with red circle) on SP-LPC right main gear. (Source – SCAAI)

Figure 24. Damage to the hose from hydraulic system of SP-LPC airplane.
(Source – SCAAI)

1.16.2.6.2. Hydraulic fluid

Tests of the hydraulic fluid samples collected from SP-LPC hydraulic systems in 2005, 2007 and 2010 were carried out. Parameters of the fluid samples met applicable requirements.

1.17. Organizational and management information

1.17.1. State Commission on Aircraft Accidents Investigation

State Commission on Aircraft Accidents Investigation was notified about the intention to perform an emergency landing when the airplane was still airborne. The first members of the Commission were at the scene about 15-20 minutes after the completion of the evacuation.

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

The Draft Final Report was sent to NTSB, Operator and PP PL.

NTSB did not make any comments, but the Manufacturer made some comments, which were partially incorporated into the Final Report.

Operator's comments were partially incorporated in the Final Report and a comment of PP PL was fully incorporated into the Final Report.

1.17.2. Foreign Authorities

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 SCAAI was supported by NTSB in the scope of consultations and technical expertise as well as other issues related to the investigation conducted.

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

1.17.3. Operator’s Operations Centre and MCC

At 4:39 hrs the crew informed the Operator’s Operations Centre via ACARS about the hydraulic system failure. The crew also requested analysis of the situation and suggestions on whether to continue the flight or turn back to the take-off aerodrome.

The message received from MCC at 05:01 hrs suggested continuing the flight to the planned destination and following QRH recommendations. Later the Commission learned that the basic rule of dealing with emergency situations by Operations Centre was suggesting to crews taking decisions in accordance with QRH and Operational Instruction and avoiding suggestions that could lead a crew to a decision inconsistent with the above documents.

MCC analyzed the failure based on information from the crew. After reviewing the aircraft documentation and QRH and consultation with a B767 ground engineer, no further analysis was undertaken and no further action was considered related to probability of escalation of the non-normal situation on board the aircraft.

As a result, only when the alternate landing gear extension system turned out inoperative and the crew asked MCC for consultation with a B767 ground engineer and a B767 instructor pilot, an action enabling the consultations was initiated.

Within a few minutes the SP-LPC crew was contacted with B767 instructor pilot, but contact with a ground engineer was possible only after about 20 minutes, because his radio station was inoperative. Use of the nearest radio was impossible due to restrictions on access to its location.

In that situation the ground engineer had to drive from his place to the Operations Centre located in Operator’s building outside the airport. The necessity of driving shortened the effective time available for the consultation from over an hour to 43 minutes.

1.18. Additional information

A detailed psychological analysis of performance and cooperation of the flight crew members was carried out in order to explain and understand the course of the occurrence. The data sources for this expert opinion were:

- interviews with CPT and FO conducted by psychologist;
- visual inspection of B767-300 cockpit;
- accident documentation;
- analysis of the flight crew communication (CVR recordings);
- communication with the Operator’s Operations Centre and MCC;
- post-accident interviews conducted with the flight crew by SCAAI members;
- consultations with SCAAI experts.

1.18.1. Crew characteristics

CPT - employed in PLL LOT SA since 1981, flight time on B767 as a Commander over 12432 hrs, prior to the accident he had been a Captain for 22 years, he had never coped with emergency situations caused by a technical failure. In an interview he cited three emergency situations associated with other circumstances such as fainting a passenger and twice – deterioration in weather conditions. The general feeling of mental and physical health on the accident day - good.

FO - employed in PLL LOT SA since 1996, flight time on B767 1981hrs. Experience with emergency situations: on October 24, 2008 during a flight from New York to Warsaw as FO he experienced an emergency landing with the use of the alternate landing gear extension system; the course of landing was in accordance with the applicable procedures.

Prior to the accident flight the pilots had performed four flights together without any problems. During interviews conducted individually they declared peaceful, harmonious cooperation, positive attitudes towards each other, high estimation of professional skills and high mutual trust. They started the flight duty rested, refreshed, in good psychophysical condition.

Chief Flight Attendant - employed in PLL LOT SA since 1972, cabin crew instructor.

1.18.2.Course of occurrences during flight LO 16

Prior to the flight the crew carried out the applicable procedures and checks – no irregularities were found.

CPT was Pilot Flying (PF) and FO was Pilot Monitoring (PM).

After the take-off the hydraulic fluid from the central hydraulic system leaked out and the pressure in this system decreased. Te central hydraulic system powers among others the landing gear control system.

After analysis of the situation, consultation with the Operator’s Operations Centre and according to QRH, the crew decided to continue the flight to Warsaw.

During approach to landing on EPWA the flight crew carried out the procedure of the landing gear extension with the alternate system twice, but the landing gear remained retracted. After failure of the second attempt the crew abandoned the approach, reported the situation to an air traffic controller and requested assistance from the Operator’s Operations Centre.

Approximately at 12:25 hrs the crew declared EMERGENCY situation. The airplane was directed to a holding zone and the Operator’s Operations Centre contacted the crew with experts.

FO carried out actions recommended by an expert: checked the switch of the alternate extension of the landing gear, circuit breaker on panel P-11 and twice left his seat to inspect circuit breakers. He checked circuit breakers on his knees because it was the only way to see P6-1 panel in detail. During the second check the Captain requested CC1 to monitor and check actions of FO who cycled the recommended circuit breakers on P6-1 panel. However, the recommendations did not relate to C829 circuit breaker located at A1 position. They related to C4248 circuit breaker at F6 position. Having completed the above actions, FO reported to the Operations Centre and to Captain that the circuit breakers had been checked.

Captain stated that he was focused on the flight control and monitored FO actions only as far as he could do it from his position. He expressed the opinion that as a Pilot Flying and a Captain he could not abandon the flight control. According to the Captain's explanation, location of P6-1 panel prevented him from its visual inspection and FO had more comfortable conditions for checking the circuit breakers.

In the meantime crews of two F-16s of the Polish Air Force checked SP-LPC visually from the air and informed the SP-LPC crew that the landing gear was still in the retracted position, but the tail skid was extended. Then the crew carried out an attempt to extend the landing gear in a gravitational way, which ended in failure.

Due to low fuel quantity and unsuccessful attempts to extend the landing gear, the crew decided to execute an emergency landing with the landing gear retracted.

1.19. Useful or effective investigation techniques

Standard techniques were used in the course of the investigation.

2. ANALYSIS

Introduction

Upon arrival of the SCAAI Investigation Team at the scene initial inspection of the cockpit and the passenger cabin was carried out. It was done by the Investigation Team member in the presence of a policeman and the Captain. During the inspection it was found that in the cockpit, on P6-1 panel the C829 circuit breaker on A1 position was in the OFF setting (pulled out). A circuit breaker in OFF setting has a visible white shaft which enables identification of the setting (Figure 25, description in section 1.6.4.).

A circuit breaker in OFF setting should be marked by ground engineers, and if not, it is abnormal situation and a reason/cause of OFF setting should be determined.

Due to the above the airplane documentation was analyzed to determine the role of C829 circuit breaker. Documentation showed that C829 protected 13 circuits including the alternate landing gear extension system. OFF setting of the circuit breaker caused, among others, that the actuator of the alternate landing gear extension system could not be powered when needed (normal extension of the landing gear was not possible due to failure of the center hydraulic system).

Figure 25. P6-1 panel in the cockpit (section with C829 circuit breaker).
(Source – SCAAI)

After confirmation that C829 circuit breaker protects the alternate landing gear extension system the Investigation Team decided to extend the landing gear using this system. After execution of the applicable procedure the landing gear was extended and locked.

The successful extension of the landing gear with the alternate system showed that all components of that system were operative (even after the emergency landing) and that the cause of the failure to extend the landing gear during LO 16 flight was open C829 circuit breaker.

2.1. Hypotheses

Due to the above findings, the Commission's actions were directed to determination why the C829 circuit breaker was open after the landing. Two hypotheses of a cause of the opening were formulated :

a) technical factors (discussed in section 2.2):

- excessive current flowing through C829 circuit breaker or;
- a malfunction of the circuit breaker consisting in the fact that it opened due to an internal damage;

b) human factors (discussed in section 2.3) consisting in the assumption that the circuit breaker was inadvertently or intentionally (for example to check or reset) mechanically opened by pulling its head, and then:

   - in case of unintentional opening its OFF position was unnoticed or ignored;
   - in case of intentional opening it was not set ON again.

In order to verify the above hypotheses, a number of tests were carried out and an expert opinion on the flight crew was commissioned. The tests are discussed in section 1.16. and described in Annexes 2, 3 and 4. The expert opinion is in Annex 5 and some conclusions from it are used in section 2.3.

The analysis of the 13 circuits protected by C829 circuit breaker was also carried out (Annex 4) and its summary and conclusions are presented in section 2.2.

2.2. Analysis of the circuits powered via C829 – verification of technical factors hypothesis

C829 BAT BUS DISTR circuit breaker is located on P6-1 panel at A1 position. This circuit breaker with a rated current of 25A, is powered by 28V DC and protects 13 circuits. Each of those circuits has its own independent circuit breaker with rated currents from 2,5A to 7,5A, therefore much less than the C829 rated current.

All thirteen circuits powered via C829 circuit breaker were analyzed. The analysis was conducted to determine whether these circuits:

- are active during normal flight when all airplane systems are operative and a flight is performed in accordance with applicable procedures;
- were active during flight LO 16 flight, and if so, what were the symptoms of their activity and whether that activity could have caused C829 to trip;
- should be active during flight LO 16 flight, and if they were not active, why not and what the symptoms were.

2.2.1. Circuit 1 – CHILLER SHUTDOWN CONT – C749 (2,5A)

The aircraft is equipped with a system for cooling food in galleys - AIR CHILLER SYS. If there is smoke or fire in cargo compartments or Equipment Cooling (EQ) system the AIR CHILLER SYS could cause spreading of smoke or fire. Therefore, to prevent this the AIR CHILLER SYS is automatically switched off by CHILLER SHUTDOWN circuit. The SHUTDOWN circuit is powered and protected by C749 (2,5A) and C829 (25A) circuit breakers.

No signaling of malfunction is associated with this system. In the absence of power resulting from opening C749 or C829 circuit breaker, in the case of fire or smoke, AIR CHILLER would not turn off automatically.

Conclusion 1. *During a normal flight CHILLER SHUTDOWN CONT circuit is not active and it was not active during LO 16 flight, since there were no conditions which would require its activation.*

2.2.2. Circuits 2, 3 and 4 – L, R, APU GENERATOR CONTROL UNIT C804 (7,5A), C805 (7,5A), C806 (7,5A)

28V DC power via C804, C805 and C806 circuit breakers is a backup power supply for three GCUs. GCUs control operation of 115V 400Hz generators driven by the engines and APU. All three GCUs are interchangeable.

The internal power supply of GCU is an autonomous device powered from permanent magnet generator (PMG) and during normal operation of the engines/APU does not require any additional power supply from 28V DC. External power supply for GCUs is needed only for communication between GCU and BPCU when the engines and APU generators do not operate.

Opening of C804, C805 and C806 circuit breakers (lack of power in their circuits) is not signaled in any way and does not prevent the proper operation of generators.

Conclusion 2. *During a normal flight L, R, APU GENERATOR CONTROL UNIT circuits are not active and they were not active during LO 16 flight, since there were no conditions which would require their activation.*

2.2.3. Circuits 5, 6 – L/R DRIVE DISC - C807 (7,5A), C808 (7,5A)

L/R DRIVE DISC circuits **protected by** C807 and C808 circuit breakers allow remote disconnection of an IDGs from their driving engines. Solenoids installed inside the drives of IDGs are disconnecting elements.

C807 and C808 circuit breakers are powered via C829 circuit breaker and opening one of them does not produce any messages. Open circuit breaker prevents manual disconnection of the respective IDG drive. The drive can be disconnected automatically due to exceeding the IDG oil temperature.

Conclusion 3. *During a normal flight L/R DRIVE DISC circuits are not active and they were not active during LO 16 flight, since there were no conditions which would require their activation.*

2.2.4. Circuit 7 – BUS POWER CONT UNIT (BPCU) – C809 (7,5A)

BPCU controls AC network operation and communicates with GCUs. The unit has an internal memory which can record some occurrences related to malfunction of AC 115V 400Hz power supply.

In the air the unit may be powered from BATTERY BUS-SECONDARY via C829 and C809 circuit breakers (main power) or from DC R BUS via C803 circuit breaker (secondary power).

BPCU circuit is the only 28V DC consumer protected individually by C809 circuit breaker and collectively by C829 circuit breaker, which operates during each flight and on the ground in normal configuration of the airplane.

If there were problems with BPCU (internal, serious BPCU damage) it would be manifested as a strange uncontrolled switching of power supply systems of the airplane. However, in such a case, in the protection cascade C809 (7,5A) circuit breaker would open first, not C829 (25A) circuit breaker.

Possible signaling and other symptoms

During a normal flight or on the ground in normal configuration lack of power from C809 BUS PWR CONT UNIT via C829 circuit breakers does not prevent normal operation of BPCU because the secondary power is provided from DC R BUS via C803 circuit breaker. In this situation, in the cockpit there is no indication of BPCU malfunction .

A short-circuit inside BPCU would cause opening of C809 and C803 circuit breakers and loss of control over AC networks.

In the scope of analysis of this circuit breaker recordings of BPCUs related to flight LO 16 were read out. The messages „SERIAL DATA LINK FAILED" for left and right GCUs were found. Such a message indicates malfunction of the BPCU/GCU interface during operation of a generator.

In normal configuration of the aircraft, after engines shutdown, BPCU and GCU are powered at least from BATTERY BUS-SECONDARY and „SERIAL DATA LINK" preserves correctness of operation.

In LO 16 flight C829 circuit breaker was open, which discontinued power supply from BATTERY BUS-SECONDARY to BPCU and GCU. As long as the engines were working, there were no abnormalities in GCU-BPCU communication. GCU was powered from the internal power supply and BPCU from 28V DC R BUS. Upon shutdown of the engines the networks were disconnected from the generators and BPCU completely lost power supply which caused the loss of „SERIAL DATA LINK".

At that time GCU was still powered by the internal power supply and still operated, but lost „SERIAL DATA LINK" with BPCU because BPCU was not powered. As a result, GCU generated the message "SERIAL DATA LINK FAILED".

Conclusion 4. *During LO 16 flight BPCU was operating as designed all the time and generated "SERIAL DATA LINK FAILED" message, which allowed to determine that at the time of the engines shutdown C829 circuit breaker had already been open. After LO 16 flight, the C809 circuit breaker of a rated current of 7.5A was in the ON/closed setting. Therefore if the BUS POWER CONT UNIT did not cause C809 circuit breaker to trip, it did also not cause tripping C829 circuit breaker with the rated current of 25A (assuming that both circuit breakers were operative).*

2.2.5. Circuit 8 – STBY PWR CONT - C828 (2,5A)

STBY PWR CONT circuit protected by C828 circuit breaker controls STBY BUS connection.

During a normal flight relay connecting STBY BUS is in an inactive state. Therefore, de-energizing its circuit by opening C828 o C829 circuit breaker does not affect the operation of the circuit and is not signaled. If in such conditions there was a need to disconnect STBY BUS, the bus would not disconnect and the light STBY BUS OFF would not illuminate.

Conclusion 5. *During a normal flight STBY PWR CONT circuit is not active and it was not active during LO 16 flight, since there were no conditions which would require its activation.*

2.2.6. Circuit 9 – DC BUS TIE CONT – C879 (2,5A)

C879 DC BUS TIE CONTR circuit breaker powers the circuit switching 28V DC networks (L DC BUS and R DC BUS).

During normal operation of L DC BUS and R DC BUS networks there will be no symptoms or messages signaling opening of C879 circuit breaker.

In case of failure of one of the TRUs, L DC BUS would not connect with R DC BUS and one of the buses (with the damaged TRU) would remain without power and EICAS would not display TR UNIT message (page STATUS/MAINTENANCE) which should be displayed in such a situation.

Conclusion 6. *During a normal flight DC BUS TIE CONT circuit is not active and it was not active during LO 16 flight, since there were no conditions which would require its activation.*

2.2.7. Circuit 10 – HYD GEN CONT PWR - C906 (5A)

This circuit supplies power (via C829 and C906 circuit breakers) to the system controlling start of HMG (HYDRO MOTOR-GENERATOR) in the absence of power from both AC generators in the air.

In such case HYD MTR GEN SHUTOFF valve is powered and it opens fluid flow from C hydraulic system to HMG. C 906 circuit breaker also powers signaling HMG operation on EICAS.

During a normal flight there are not any messages or symptoms of C906 opening. In the case of loss of power from left and right AC generators HMG would not start to operate.

The conditions for activation of HMG on SP-LPC occurred on November 1, 2011 at 13:38:43 hrs, i.e. after shutdown of the engines (and IDGs). At that time the airplane was in AIR configuration. It we assume that after IDGs shutdown the main battery was active for at least 2s, there were conditions for opening HMG VALVE and loading C906 supply circuit. However, HMG was not activated because C829 was open and C HYD SYS was out of order.

Conclusion 7. *During a normal flight **HYD GEN CONT PWR** circuit is not active. After LO 16 landing probably existed conditions for its activation. After engines shutdown C906 circuit breaker was ON/closed which means that its circuit was not damaged or overloaded.*

To confirm the above conclusion, a functional check of HMG VALVE and measurements of its currents during opening and shutting were carried out on SP-LPC airplane. In both cases the valve motor current was 0,63 A, which was much lower than the rated current of C906 circuit breaker (2,5 A). The valve opening was communicated by EICAS message HYD GEN VAL (Fig. 31).

The above check and measurements prove that HMG valve on SP-LPC was operative, and if activated after landing, it would not cause opening C829, since its operational current was 0,63A, i.e. much lower than the rated current of C829 circuit breaker (25A).

In addition, in case of the valve failure the C906 (2,5A) circuit breaker would have to open first. However, after the flight C906 was ON/closed, which proves that there was no excess current in its circuit.

2.2.8. Circuit 11 – RAM AIR TURB-AUTO – C1100 (2,5A)

This circuit supplies power (via C829 and C1100 circuit breakers) to control automatic deployment of RAT (RAM AIR TURBINE).

In a normal flight there are no symptoms or signaling associated with OFF setting of C1100 circuit breaker. If conditions for automatic deployment of RAT had occurred, RAT would not have deployed. Manual deployment of RAT would be possible.

RAT activates automatically in the AIR configuration if the RPMs of both engines are below 50% and the aircraft speed is above 80 kts.

At 13:38:42 hrs the engine fuel cut-off valves (LEFCUT, REFCUT) were activated and one second later (the FDR recording ended at 13:38:43) the engines speeds were: L_ENG 67.8%, R_ENG 72% and the aircraft speed was 88 kts.

Therefore, at that time there were no conditions for RAT deployment since engines RPMs were too high (above 50%). Later both the airplane speed and the engines RPMs were decreasing.

Calculations show (Annex 4) that after 2,7s the airplane speed was approximately 80 kts, so it was below the level of RAT deployment and still decreasing, while engines RPMs were: L_ENG=54,3%, R_RNG=58,5%, so still above the level of RAT deployment. In conclusion, the conditions for automatic activation of RAT never existed, so the circuit protected by C1100 circuit breaker was not active/loaded during flight LO 16.

Conclusion 8. *During a normal flight RAM AIR TURB-AUTO circuit is not active and it was not active during LO 16 flight, since there were no conditions which would require its activation.*

2.2.9. Circuit 12 - BAT CUR MONITOR PWR C4097 (2,5A)

M10212 BAT CURRENT MONITOR monitors the charge current> 20A and discharge current> 6A of the M223 main battery. M10212 is powered with 28V DC via C829 and C4097 BAT CUR MON PWR.

If the main battery powers STBY buses or when the STBY POWER switch is in AUTO position and TRU is faulty, MN BAT DISCH message is generated on EICAS and BAT DISCH on P5 panel illuminates.

BAT CUR MONITOR also monitors the main battery charging current in the cycle “constant current-constant voltage”. In the case of irregularities in the charging cycle MN BAT CHGR message is displayed on EICAS.

During normal operation there is no indication of opening C4097 or C829 circuit breaker. In the case of TRU failure there would not be MN BAT DISCH message on EICAS and BAT DISCH light would not illuminate. If the battery charge cycle was disturbed MN BAT CHGR message would not be produced.

Conclusion 9. *During a normal flight BAT CUR MONITOR PWR circuit is not active and it was not active during LO 16 flight, since there were no conditions which would require its activation.*

2.2.10. Circuit 13 – LANDING GEAR-ALT EXT MOTOR - C4248 (7,5A)

Alternate landing gear extension circuit is protected individually by C4248 (7,5A) circuit breaker and collectively by C829 (25A) circuit breaker. Extension of the landing gear with the alternate system is possible only if both C829 and C4248 circuit breakers are in ON/pushed setting.

Alternate extension of the landing gear is effected by 28V DC electric motor, which drives the mechanical system releasing landing gear locks.

During LO 16 flight an attempt was made to activate this system, but it failed and the landing gear remained in retracted position. The plane landed with the landing gear retracted, and after the flight C829 circuit breaker was in OFF/pulled setting while and C4248 circuit breaker was in ON/pushed setting.

This was an abnormal situation because the circuits are designed so that in the case of excessive current in a particular circuit, an individual circuit breaker with a lower rated current opens/sets OFF (in the analyzed case it should be C4248 with a rated current of 7,5 A) and only if it had not worked C829 with a rated current of 25A should have been opened/set OFF.

Looking for causes of the abnormal situation outlined above, SP-LPC was lifted up from the runway and an attempt was made to extend the landing gear with the alternate landing gear extension system. The attempt was successful, the landing gear was extended and locked.

The test showed that all the components of the alternate landing gear extension system were operative, but to confirm this preliminary conclusion, further tests and measurements were made on the SP-LPC:

- the current of the electric motor driving the alternate landing gear extension system was measured;
- visual inspection was carried out as well as measurements of resistance of the wires supplying power to the motor and resistance of their insulation.

All measured parameters met applicable requirements.

As the next step the components of the alternate landing gear extension system were removed from SP-LPC and subjected to specialist tests.

LOT AMS certified maintenance organization tested C829 and C4248 circuit breakers. X-ray examination showed no abnormalities in their internal structure, the forces required to set them in ON/closed and OFF/opened setting, and the trip times after exceeding the rated currents twice were within the standard limits.

C829 and C4248 circuit breakers were also examined by Boeing. The tests and measurements showed that the circuit breakers met the technical requirements and had no defects.

In addition, a functional checks of the 12 individual circuit breakers powered via C829 breaker were performed. The checks consisted in measuring their trip time with a current of 200% of a rated current. Measurements results were in accordance with the manufacturer requirements (taking into account admissible measurement errors).

The actuator from the alternate landing gear extension system was examined by EATON company. The tests showed that the actuator was operating as designed and its parameters were within standard limits (except for two, which were considered to be not significant).

Load limiters in the alternate landing gear extension system did not show overloads, which indicated that even after the emergency landing, the system was fully operative and operated without excess loads, resulting, for example, from mechanical deformations and/or jamming.

All of the above described analyzes, checks and tests confirmed that all tested components of the alternate landing gear extension system were mechanically and electrically fit and that no electric overloads occurred, which could cause C829 circuit breaker to trip.

Consequently, in the further part of the investigation, the Investigation Team considered a hypothesis involving human factor.

2.3. Analysis of the crew operation – verification of human factor hypothesis

This hypothesis assumes that C829 circuit breaker was accidentally or intentionally set OFF/opened by pulling its head, and then:

- in case of unintentional opening, its OFF setting was unnoticed or ignored;
- in case of deliberate opening (e.g. cycling), it was not set ON/pressed again.

To confirm one of the above assumptions, it was necessary to determine when C829 circuit breaker opened. Consequently, an appropriate experiment (Annex 4) was carried out, which allowed to determine that OFF setting of C829 circuit breaker was not signaled by EICAS.

2.3.1. Attempt to determine the time when C829 circuit breaker was set OFF

Based on the tests and flight LO 16 analysis, the Investigation Team concluded that it had not been possible to determine the exact time of the circuit breaker opening because that fact was not signaled by any warning system and was not recorded by the onboard recorders. Therefore, an attempt was made to determine the probable time interval in which the opening occurred.

a) Based on analysis presented in section 2.2.4., it was only possible to determine that at the time of the engines shutdown (after emergency landing) C829 circuit breaker had already been in OFF setting.

b) Taking into account the fact that the cause of failure of the landing gear extension with the alternate system was OFF setting of C829 circuit breaker, components of the system were operative (the landing gear was extended on the ground after C829 circuit breaker was set ON), the Investigation Team concluded that **C829 circuit breaker had been open prior to the attempt to extend the landing gear that took place during the approach to landing on EPWA.**

c) Both flight crew members stated that the Pre-Flight Check on KEWR had been performed in accordance with the applicable procedures and no irregularities had been identified.

d) If the Pre-Flight Check procedure described in "Boeing 767 Operations Manual, Part B, Volume 1, Normal Procedures, page NP.21.1." "(Figure 26) was performed correctly in Newark, that means that during that check C829 circuit breaker was still in ON/closed setting.

767 Operations Manual

Do the remaining actions after a crew change or maintenance action.

Maintenance documents .... Check

FLIGHT DECK ACCESS SYSTEM switch .... Guard closed

FLIGHT RECORDER switch .... NORM

SERVICE INTERPHONE switch .... OFF

RESERVE BRAKES and STEERING
RESET/DISABLE switch .... Guard closed

Verify that the ISLN light is extinguished.

Circuit breakers .... Check

Emergency equipment .... Check

Figure 26. Section of Boeing 767 Operations Manual related to check of circuit breakers.

2.3.1.1. Circumstances contributing to inadvertent opening of C829 circuit breaker during the flight from Newark to Warsaw

On the basis of the analysis described in paragraphs a), b), c) and d) of section 2.3.1, it may be presumed that the C829 circuit breaker was **inadvertently opened in a time between the Pre-Flight Check in Newark** and the attempt to extend the landing gear during the approach to landing in Warsaw.

Such a scenario is supported by the following facts and factors:

a) the location of C829 circuit breaker contributed to the physical contact of its head with objects placed in its immediate vicinity;

b) in the past, some operators contacted Boeing due to concerns about circuit breakers on P6 panels which were located in the vicinity of feet, cleaning equipment, flight bags, etc., and accidental openings or damage occurred. Therefore, Boeing developed a “guard” to protect circuit breakers located in the lower parts of the panel. Boeing offered the guard on a charged basis;

c) Boeing started to install the guard in the production process starting from the 863 production line (SP-LPC was 659 production line).

The above facts indicate that Boeing 767s had problems with proper protection of the P6 panel which were noticed by operators and reported to the manufacturer. The manufacturer responded to those concerns and first offered the guard on a charged basis and then introduced it into manufacturing process.

The guards for the circuit breakers on the P6 panel were not installed on SP-LPC airplane.

In addition, it should be noted that the need to extend the landing gear with the alternate system arose at the most disadvantageous moment:

d) **after a long flight with awareness of the failure** – in such a situation vigilance decreases and an individual is not able to select relevant stimuli out of many possible stimuli occurring in environment. The critical stimuli, requiring some action, may not be detected, e.g. because other monotonous stimuli were acting for long periods, or because an individual in a particular situation produced a negative expectation that the critical stimulus would not appear. Studies show that a long-term performance of repetitive detection tasks reduces vigilance and individuals ignore stimuli to which they should respond. This phenomenon is well known in aviation as limitation in functioning the pilots’ cognitive processes especially in a difficult situation;

e) **during approach to landing** - the aviation psychology knows a phenomenon that pilot excessively focuses on essential (in his opinion) task. Narrowing of the field of visual perception is observed in such cases. Focus on a particular section of the sensory work field causes that the stimuli occurring in the peripheral field of vision are not noticed. Probably a similar situation might have occurred in the investigated accident. The OFF setting of C829 BAT BUS DISTR circuit breaker could have been unnoticed due to its extremely peripheral location, lack of signaling and multi-level engagement of the pilots' cognitive processes in other activities essential in the critical situation;

f) **in the most difficult phase of the flight surprising and unexpected circumstances appeared,** which could create a hazard to the pilots' and passengers' lives. In the case of a very strong negative emotions the field of attention is narrowing and a strong focus is placed on critical details of an occurrence. An individual can not pick up information potentially available and focuses on the most threatening elements of the situation. All attention resources of an individual are committed to a difficult situation to such extent that there is lack of them to deal with parallel challenges and to solve additional problems. Acting in the time deficit a pilot can make improper decisions, inadequate to the existing situation and may be subject to illusions and delusions resulting from disorder of sensory perception. So called tunnel vision may occur, as well as ignoring important information, inaccurate perception of equipment malfunctions and inadequate responses to these malfunctions.

Inadvertent opening C829 circuit breaker during LO 16 flight was highly probable because of the technical factors (location of the circuit breaker, lack of signaling, lack of guards) and human factors (long flight with a failure of the hydraulic system and detection of another failure during the landing approach, which is the most difficult phase of the flight).

The Commission took the above circumstances into consideration, but stated that it can not be determined that the crew inadvertently set OFF the C829 circuit breaker during flight LO 16 from Newark to Warsaw.

2.3.1.2. Circumstances contributing to failure to detect the OFF setting of C829 circuit breaker during the Pre-Departure Check in Newark

It could also happen that C829 circuit breaker was set OFF much earlier, for example during maintenance/ground handling or during previous flights, and the LO 16 crew did not notice it during Pre-Departure Check in Newark.

Such a scenario is supported by the following facts and factors:

a) the Pre-Departure Check was performed in another time zone (6 hours difference) and in the early morning time (according to LMT time in Poland). It should be noted that a jet lag may have affected inter alia, pilots' skills/operator's capabilities. Human efficiency falls to the lowest value between 3:00 hrs and 6:00 hrs in the morning;

b) no signaling of C829 setting in the cockpit, which prevented detection of its setting during previous flights, e.g. on the basis of indications by warning systems;

c) no recording of C829 setting by QAR, which prevented maintenance personnel from detection of its setting on the basis of records analysis;

d) location of the circuit breaker in inaccessible and poorly visible place, which impeded identification of its setting by a flight crew and maintenance personnel;

e) the circuits protected by C829 circuit breaker were not active during normal flights, except for the BPCU main power supply circuit which stops operating after opening C829 circuit breaker, but in this case the secondary power supply is automatically connected, so opening of C829 circuit breaker is still unnoticeable for the flight crew.

The scenario described in this section is as likely as the one described in the previous section.

Taking into consideration the facts and factors described in sections 2.3.1.1. and 2.3.1.2. the Commission stated that it was impossible to determine when and under what circumstances the C829 circuit breaker was set OFF/tripped.

2.3.2. Analysis of the approach to landing

During the approach to landing on EPWA aerodrome the flight crew carried out the procedure of the landing gear extension with the alternate system, but the landing gear was not extended.

At this moment the critical phase of the flight began. It was assessed by the crew as having features of a precarious situation. The crew took actions to find additional information necessary to solve the problem.

The pilots checked the correctness of execution of the landing gear extension procedure (with the use of the alternate system) against instruction from QRH.

Actions taken in accordance with the checklist HYDRAULIC SYSTEM PRESSURE (C only) from QRH D632T001-35LOT (page 13.4) did not led the crew to the successful extending of the landing gear with the alternate system. The crew carried out the actions up to the item:

ALTN GEAR EXTEND switch……………………….………DN (Figure 27)

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▼ HYDRAULIC SYSTEM PRESSURE (C only) continued ▼

ALTN FLAPS selector . . . . Set to extend or retract flaps as needed

Alternate Gear Extension

Landing gear lever . . . . OFF

Action is **not** reversible
Maximum 250K/.75M

ALTN GEAR EXTEND switch . . . . DN

After gear down lights illuminate:

Landing gear lever . . . . DN

RESERVE BKS & STRG switch . . . . ON

If C1 ELEC HYD PRIMARY PUMP PRESS light is illuminated:

Nose wheel steering is inoperative.

Do **not** accomplish the following checklists:

GEAR DOORS
RESERVE BRAKE VALVE
TAILSKID

Landing Checklist

Speedbrake . . . . **DOWN**
Landing gear . . . . Down
Flaps. **20**

■ ■ ■ ■

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Figure 27. Section from HYDRAULIC SYSTEM PRESSURE (C only) checklist.

After this action GEAR DOWN lights did not illuminate, therefore the crew could not proceed to the next step prescribed in the checklist, i.e. moving the landing gear lever to DN position:

LANDING GEAR LEVER...DN.

The HYDRAULIC SYSTEM PRESSURE (C only) checklist did not include the case of malfunction of the alternate landing gear extension system and did not contain any instructions for the flight crew on how to proceed in the case of failure of the alternate system. Lack of such instructions also related to the HYDRAULIC SYSTEM PRESSURE (L and C) and HYDRAULIC SYSTEM PRESSURE (R and C).

The above mentioned checklists did not refer also to Chapter 14 (Non-Normal Checklists, Landing Gear).

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▼ **GEAR DISAGREE continued** ▼

1 Choose one:

◆ Landing gear lever **UP**:

Observe the gear EXTEND OR EXTENDED limit speed of 270 K/.82 M.

Flight with gear down increases fuel consumption and decreases climb performance. Refer to the Gear Down performance tables in Performance Inflight chapter for flight planning.

■ ■ ■ ■

◆ Landing gear lever **DN and any** gear down (green) lights **not** illuminated:

▶▶ **Go to step 2**

◆ Landing gear lever **DN and all** gear down (green) lights **illuminated**:

SP-LPA through SP-LPE
GND PROX/CONFIG
GEAR OVRD switch . . . . OVRD
SP-LPG
GND PROX
GEAR OVRD switch . . . . OVRD

Accomplish normal landing.

■ ■ ■ ■

2 Landing gear lever . . . . OFF

▼ **Continued on next page** ▼

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Figure 28. Section from GEAR DISAGREE checklist.

GEAR DISAGREE checklist contained in the above Chapter included the case of partial failure in extension of the landing gear (failure to extend one of the legs – Figure 28), but did not include the option that all three legs were not extended.

D632T001-35LOT QRH for B767 developed by the manufacturer for the Operator and applicable at the occurrence time did not contain sufficient guidance for crews on procedures applicable in the case of malfunction of both landing gear extension systems. There was no appropriate checklist for such a situation, e.g. ALL GEAR UP LANDING;

Checklists for emergency (non-normal) situations should be unambiguous and clear. They can not contain any ambiguities or create options for different interpretations related to actions to be undertaken by a crew in a particular situation. Checklists should include only instructions, which, if carried out step by step, allow a crew to resolve a particular problem. If necessary, checklists should also contain references to other checklists.

In the case of a direct threat to the lives of the crew and passengers, a pilot is looking for information to make a proper analysis of hazardous circumstances and take an action based on his best judgment. However, under stress the processes of recalling information can be impeded and subject to disorder. In such a situation only actions based on checklists contained in QRH ensure execution of all actions in a proper order and flight crews are trained to follow the checklists and rely on them in non-normal situations.

Situational awareness of the flight crew changed dynamically when unexpected and dangerous malfunction of the alternate landing gear extension system occurred. QRH did not contain proper instructions or information which would provide a solution to the difficult situation which occurred on the aircraft. The pilots lost confidence in the basic document and were forced to look quickly for information necessary to solve the problem. An extreme maximization of their cognitive effort took place.

A need to undertake the tasks and decisions in a complex probabilistic situation with insufficient information and a very high level of estimated risk was an additional psychological burden experienced by the flight crew.

Captain emphasized in an interview that he was highly focused on the flight control. He expressed the opinion that as PF and Captain of the aircraft he could not abandon the flight control and because of that he did not monitor fully FO during circuit breakers cycling. According to Captain’s explanation FO had more comfortable conditions for checking the circuit breakers and location of P6-1 panel prevented Captain from visual inspection.

Analysis of voice recordings from the cockpit allowed to find the information about the flight crew actions and their mental condition. The pilots were able to remain calm and self-controlled, the form of expression was clear, with procedural phraseology and content relevant to the course of events. While waiting for expert assistance from Operations Centre attempts to reset circuit breakers were carried out by FO as indicated by a ground engineer – unfortunately without the expected extension of the landing gear. During preparation for the emergency landing a strain, impatience and nervousness were increasing - but with preservation of a good verbal communication. In his statements Captain repeatedly expressed concern for the passengers.

Additional workload for FO was repeated reading and analysis of checklist from QRH, intensive cooperation with Captain, maintaining communication with F-16 pilots and the Operations Centre, execution of the actions recommended by the experts, preparation of the cockpit for the emergency landing and cooperation with the Chief Flight Attendant.

In implementing recommendations of experts from Operations Centre FO checked and cycled indicated circuit breakers on P6-1 panel. However, the recommendations related to C4248 circuit breaker at F6 position and did not relate to C829 circuit breaker located at A1 position. Therefore, the recommendations from Operations Centre were not effective and did not lead to the landing gear extension and FO reported to the Operations Centre and to Captain that the circuit breakers had been checked.

Emotional strain could have perturbed the processes of perception and could also reduce the pilots' vigilance. In such conditions the critical stimuli, requiring some action, may not be detected, e.g. because other monotonous stimuli were acting for long periods, or because an individual in a particular situation produced a negative expectation that the critical stimulus will not appear. Studies show that a long-term performance of repetitive detection tasks reduces vigilance and individuals ignore stimuli to which they should respond.

2.4. Summary of LO 16 flight analysis; technical factors (airplane) and human factors (flight crew)

One of significant groups of causes of aviation accidents are so-called "dormant/hidden factors". Pilots have made and will make errors, so it is important to consider the broad context which contributed to an occurrence or could have led to it, despite the fact that the crew had not made a blatant error. Why had not the existing system prevented the accident?

In response to this question the model developed by James Reason may be useful.

Reason's model assumes that aviation is very well protected by several layers of defenses, therefore individual deficiencies rarely cause negative effects. According to Reason, aviation accidents result from numerous violations of an organization defenses. Violations may be "active", which have immediate negative effects or "dormant/hidden", which exist in a system long before the accident occurs, but their destructive character becomes active only in specific operational circumstances.

Active deficiencies are usually related to the first line personnel (pilots, air traffic controllers, maintenance personnel, etc.).

Dormant/hidden factors/conditions are usually created by individuals separated from an accident in time and space. These factors/conditions may include defects in equipment design and manufacturing, improper procedures, training, operation of equipment or management of the air fleet and organization of support for flight crews in the air.

The following circumstances occurred in the investigated accident:

1. The crew did not find in the QRH information directly related to their situation.
2. MCC (Operations Centre), despite engagement of expert support, was unable to provide effective assistance to the crew.

3. Acting under the influence of stress and time pressure could have resulted in:
    a. dysfunction of the process of receiving and processing information by FO, which could contribute to the inability to identify the circuit breaker setting;
    b. narrowing PF field of activity solely to a perfect fulfillment of his priority tasks and only partial monitoring of FO activity, to the extent possible from PF position. It should be noted, that PF maintained communication with the ACC controller, the F-16 crews and the MCC ground engineer, passing his instructions to FO, who was outside his seat with headphones removed.

From the Reason's theory standpoint, the combination of active (3) and dormant/latent (1 and 2) factors led to the accident.

2.5. Analysis of SP-LPC airplane evacuation

During preparation of the cabin and passengers to emergency landing some cabin crew members had difficulties in finding the right pages in *AP Briefing & Evacuation Commands Booklet.*

When the cabin crew members instructed APs, they noticed that the selected passengers had problems with concentration of attention and they were able to understand only simple commands. Therefore the cabin crew members did not follow fully the Booklet but used their own words.

According to the arrangements, the command to adopt brace position was issued by CC1, but he did it after the command had been issued by the crew of the aft galley.

Captain decided, that when the airplane came to rest the cabin crew should begin evacuation, without waiting for an order from the cockpit. It was a deviation from the standard procedure because according to QRH evacuation is to be initiated by the flight crew and this scenario is applied during training. Due to an impression of normal landing CC1 decided to make sure whether evacuation was necessary, which caused that the nose exits were opened 12 seconds later that the aft ones.

The evacuation was successful, none of the passengers and the crew suffered any injuries. It was possible due to actions of the cabin crew, who demonstrated flexibility in untypical situation. In addition, self-control of the crew should be assessed very highly because that prevented panic on the board.

When CC1 detected failure of ALERT system, he did not wait until all cabin crew members gather, but conveyed relevant information to selected CCs, who conveyed it to the rest of CCs, what was not in accordance with an applicable procedure.

2.6. Analysis of the operation of Operator's Operations Centre

At 4:39 hrs the crew informed the Operations Centre via ACARS about the hydraulic system failure. The crew also requested analysis of the situation and suggestions on whether to continue the flight or turn back to the takeoff aerodrome.

The response from the Operations Centre suggested continuing the flight to the planned destination and following QRH recommendations.

The SCAAI Investigation Team determined that after analysis of the information from the crew received via ACARS, MCC did not consider a need of expert support to the crew during the flight. As a result, when the crew requested consultation with a ground engineer and an instructor pilot of B767, only then the process of searching for the right persons commenced.

A few minutes after the request the SP-LPC crew was contacted with an instructor pilot of B767, but contact with a ground engineer was possible only after about 20 minutes, since the ground radio station designated for this purpose was faulty and the ground engineer had to drive to the Operations Centre. Use of a nearest radio station was impossible due to restrictions on access to its location.

The Investigation Team determined that the Operator's Operations Centre did not have a risk assessment system and anticipation of emergency situation escalation, what contributed to the time deficit, which was a key factor for successful solution of the emergency situation.

Analysis of the Operations Centre actions in the investigated occurrence did not entitle the Commission to conclude that the applicable rules or procedures were breached. However, the Commission concluded that situation in which contact of the ground engineer with the crew was impossible due to failure of the radio which was intended solely for this purpose, was a serious negligence. The alternative was driving to the Operations Centre.

2.7. ETOPS analysis

The airplane was released for the flight in accordance with ETOPS without restrictions, i.e. to operate up to 180 minutes flying time to en-route alternate aerodrome.

Prior to the departure the crew received a computer flight plan containing all the necessary information, which showed that the planned flight route at the farthest point was 122 minutes flying time from en-route alternate aerodrome.

Failure of the center hydraulic system which occurred a few minutes after the take-off had no impact on the capability to continue the flight along the planned route.

The Investigation Team analyzed Operator's documentation related to ETOPS operations and did not find any irregularities.

3. CONCLUSIONS

3.1. Commission findings

The SCAAI Investigation Team stated the following facts:

3.1.1. Both members of the flight crew had valid licenses and ratings to perform the flight.

3.1.2. Both members of the flight crew were rested and had valid Aero-Medical Certificates.

3.1.3. All members of the cabin crew had valid ratings to perform their duties on board of B767-300 airplane and had valid Aero-Medical Certificates.

3.1.4. The airplane had valid Certificate of Airworthiness and was maintained and operated in accordance with applicable regulations.

3.1.5. The airplane Take-off Weight and location of it centre of gravity were within the limits specified in AFM.

3.1.6. The Pre-Departure Check was effected by a ground engineer from the contracted maintenance organization in accordance with the Operator’s requirements.

3.1.7. The ground engineer did not find any failures or irregularities.

3.1.8. After the take off, during retraction of the landing gear and flaps the hydraulic fluid from the central hydraulic system leaked out and the pressure in this system dropped.

3.1.9. The pressure drop was signaled on the hydraulic panel (SYS PRESS) and on EICAS (C HYD SYS PRESS) and recorded by the flight recorder.

3.1.10. After completion of HYDRAULIC SYSTEM PRESSURE (C only) procedure contained in QRH and consultation with the Operator's MCC, the flight crew decided to continue the flight to Warsaw.

3.1.11. The fluid leakage from the central hydraulic system prevented extension of the landing gear according to the normal procedure on Warsaw aerodrome.

3.1.12. During the landing approach in Warsaw the crew carried out the procedure of the landing gear extension with the alternate system but it was unsuccessful.

3.1.13. The flight crew requested radio communication with the ground maintenance personnel, but it was impossible because the ground radio station designated for this purpose was inoperative.

3.1.14. Due to failure of the above mentioned ground radio station Operator's Operations Centre contacted the flight crew with the ground engineer, but the time available for the technical consultation was shortened by 20 minutes.

3.1.15. The time deficit caused that the ground engineer was not able to fully analyze diagram of the alternate landing gear extension system.

3.1.16. FO, executing the expert recommendations checked all of the circuit breakers on the P6-1 panel.

3.1.17. In addition, the FO, executing the expert recommendation, pulled out and reset the C4248 ALTN EXT MOTOR circuit breaker. The expert did not provide instruction to reset the C829 circuit breaker nor did the FO do so.

3.1.18. After the actions of 3.1.16 and 3.1.17 did not result in extension of the gear using the alternate extend system, the captain instructed the FO to recheck the circuit breaker panel again, this time in the presence of the Chief Flight Attendant (CC1).

3.1.19. Advisory support provided by Operator's Operations Centre did not lead the crew to extension of the landing gear with the alternate system.

3.1.20. FO reported to Operations Centre and to Captain that the circuit breakers had been checked.

3.1.21. Captain was focused on the flight control and monitored FO actions only as far as he could from his position.

3.1.22. The crew carried out an attempt to extend the landing gear in a gravitational way, but it also ended in failure.

3.1.23. After a series of unsuccessful attempts to extend the landing gear the crew decided to carry out an emergency gear up landing.

3.1.24. Operator's Operations Centre did not take into consideration possibility of escalation of the non-normal situation.

3.1.25. Airport services prepared the runway for landing by covering it with foam.

3.1.26. The airplane touched down on EPWA RWY 33 at 13:39 hrs.

3.1.27. When the airplane was moving on the runway, sparks were coming out of the right engine and they were suppressed by the applied foam; then the engine interior caught fire.

3.1.28. When the airplane came to rest, the crew evacuated the passengers and LSP extinguished the fire.

3.1.29. During the landing the airplane sustained serious damage, which caused its withdrawal from service.

3.1.30. The weather conditions had no impact on the course of the accident.

3.1.31. At the time of the accident the navigational aids on EPWA were operational and available.

3.1.32. SSFDR, CVR and QAR recorders installed on the aircraft were operating during the flight LO 16 and they were read out after the flight.

3.1.33. During inspection of emergency equipment prior to LO 16 flight the headphone at CC2 station was inoperative and marked with INOP sticker.

3.1.34. CC1 was informed about the center hydraulic system failure immediately after it occurred but at that phase of the flight he did not inform the rest of the cabin crew about the failure.

3.1.35. When ALERT system was needed, it turned out that it was inoperative.

3.1.36. During preparation of the cabin for the landing the passengers were calm, they followed the crew instructions, there was no panic.

3.1.37. Some members of the cabin crew had difficulties in finding the right pages in *AP Briefing & Evacuation Commands Booklet*; others, seeing that the selected assistants had problems with attention concentration, used their own simple words.

3.1.38. The crew of the aft galley began to shout BRACE POSITION before CC1 issued the command via PA.

3.1.39. CPT decided that the cabin crew should begin evacuation of the passengers immediately after stopping the airplane, without waiting for an order from the cockpit. That was a flexible adaptation of the planned action to a situation since it was not sure that the crew would be able to give any commands after landing.

3.1.40. When the airplane came to rest, CC1 decided to make sure whether evacuation was necessary, which caused that the nose exits were opened 12 seconds later that the aft ones.

3.1.41. Over-wing emergency exits on the right side of the airplane were not opened because of smoke hazard due to the engine fire.

3.1.42. During the evacuation none of the passengers or crew suffered any injuries.

3.1.43. After evacuation cabin crew members were waiting by the airplane for about 15 minutes for further decisions.

3.1.44. Organization and coordination of the passengers movement to a designated area or means of transport was unsatisfactory.

3.1.45. About 420 persons took part in the rescue-firefighting operation.

3.1.46. Psychological assistance for passengers and their families/friends was provided by Warsaw Chopin Airport and the Operator.

3.1.47. The airport had no capability to remove disabled B767 airplane.

3.1.48. SP-LPC was lifted with harness and airbags designed for B737.

3.1.49. Due to the time needed for removal of the airplane from the runway EPWA aerodrome was closed for air traffic for more than 29 hours.

3.1.50. C829 circuit breaker protects 13 circuits including the alternate landing gear extension system, which is individually protected by C4248 circuit breaker.

3.1.51. Each of the thirteen circuits powered from BATTERY BUS-SECONDARY via C829 circuit breaker with the rated current of 25A has its own independent individual circuit breaker with rated currents from 2,5A to 7,5A.

3.1.52. Electrical and mechanical parameters of C829 and C4248 circuit breakers removed from SP-LPC airplane were in accordance with applicable specifications.

3.1.53. Individual circuit breakers of all thirteen circuits protected by C829 circuit breaker were operative and after flight LO 16 were in ON/closed settings.

3.1.54. The system of alternate landing gear extension did not work due to the fact that C829 circuit breaker located on P6-1 panel was in the open position at the time of alternate gear extension actuation.

3.1.55. During visual inspection of the cockpit after the airplane came to rest C829 circuit breaker was open.

3.1.56. It was confirmed by experiment that observation of C829 circuit breaker while seated normally in the FO seat was highly impeded.

3.1.57. After LO 16 flight, when SP-CPL airplane was lifted, C829 circuit breaker was set in ON position and the alternate landing gear extension system was activated, the landing gear was extended and locked.

3.1.58. Opening of C829 circuit breaker prevents the landing gear from being extended by the alternate system.

3.1.59. Opening of C829 (A1) circuit breaker is not signaled in the cockpit and is not recorded by SSFDR or QAR.

3.1.60. After LO 16 flight all components connected to C829 circuit breaker or related to the alternate landing gear extension system were operative and no electric overloads occurred in the examined circuits, which could cause C829 circuit breaker to trip.

3.1.61. C829 circuit breaker had been opened before the attempt to extend the landing gear, which took place during the approach to landing on EPWA.

3.1.62. The guards for the circuit breakers on the P6-1 panel were not installed on SP-LPC airplane.

3.1.63. The head of C829 circuit breaker removed from SP-LPC airplane showed traces of scratches and abrasions.

3.1.64. The Commission considered a hypothesis about involvement of human factor in the opening of C829 circuit breaker, but was unable to determine when and under what circumstances C829 circuit breaker might have been opened.

3.1.65. The *HYDRAULIC SYSTEM PRESSURE (C only)* checklist did not include the case of malfunction of the alternate landing gear extension system and did not contain any instructions for the flight crew on how to proceed in such a situation. Lack of such instructions also related to the *HYDRAULIC SYSTEM PRESSURE (L and C)* and *HYDRAULIC SYSTEM PRESSURE (R and C).*

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

3.1.67. GEAR DISAGREE checklist contained in Chapter 14 included the case of partial failure in extension of the landing gear (failure to extend any of the legs – Figure 28).

3.1.68. The crew did not find in the QRH information directly related to their situation.

3.1.69. Operator did not have effective procedures, which would enable specialist support for the crew.

3.1.70. Acting under the influence of stress and time pressure could have resulted in:

3.1.70.1. dysfunction of the process of receiving and processing information by FO, which could contribute to the inability to identify the circuit breaker setting;

3.1.70.2. narrowing PF field of activity solely to a perfect fulfillment of his priority tasks and only partial monitoring FO actions, to the extent possible from PF position.

3.1.71. The load limiters in the alternate landing gear extension system did not show any signs of mechanical overload in the system.

3.1.72. Fracture of the hydraulic hose was caused by its possible kinking.

3.1.73. The last inspection of the zone of the failed hydraulic hose was carried out in March 2011 and no irregularities were found.

3.1.74. The Operator had not incorporated Boeing Service Bulletin SB-767-0162 on SP-LPC which mitigates the hose kinking issue by adding a new swivel mount installation.

3.1.75. Parameters of the fluid samples from the airplane hydraulic system met applicable requirements.

3.2. Causes of the accident

1. Failure of the hydraulic hose connecting the hydraulic system on the right leg of the main landing gear with the center hydraulic system, which initiated the occurrence.
2. Open C829 BAT BUS DISTR circuit breaker in the power supply circuit of the alternate landing gear extension system in the situation when the center hydraulic system was inoperative.
3. The crew's failure to detect the open C829 circuit breaker during approach to landing, after detecting that the landing gear could not be extended with the alternate system.

Factors contributing to the occurrence were as follow:

1. Lack of guards protecting the circuit breakers on P6-1 panel against inadvertent mechanical opening; from 863 production line the guards have been mounted in the manufacturing process (SP-LPC was 659 production line).
2. C829 location on panel P6-1 (extremely low position), impeding observation of its setting and favoring its inadvertent mechanical opening.
3. Lack of effective procedures at the Operator's Operations Centre, which impeded specialist support for the crew.
4. Operator's failure to incorporate Service Bulletin 767-32-0162.

4. SAFETY RECOMMENDATIONS

4.1. Proposed interim safety recommendations and responses from the organizations concerned

Nine interim safety recommendations were proposed in 2012 as part of the "Interim Statement of the State Commission on Aircraft Accidents Investigation on investigation into air accident No 1400/2011". Four proposed recommendations were sent to Boeing Company (via NTSB), four to PLL LOT and one to PP PL.

The proposed interim safety recommendations and responses from the organizations concerned are presented below.

4.1.1. Recommendations proposed to Boeing Company and the responses received Jan 31, 2014 (verbatim):

Following an analysis of the flight crew activities related to the accident of B767 airplane, registration marks SP-LPC **- gear up landing** - which occurred on 1 November 2011 at Warszawa-Okęcie (EPWA) aerodrome, on the basis of the evidence which has been gathered so far (the investigation has not been completed yet), State Commission on Aircraft Accident Investigations states the following facts:

- The checklist included in D632T001-35LOT QRH (Quick Reference Handbook) related to loss of pressure in the central hydraulic system (page 13.4) did not lead the crew to the final stage of the successful extending of the landing gear by using the alternate system. The crew carried out the action listed on page 13.7 **HYDRAULIC SYSTEM PRESSURE (C only)**:

  ALTN GEAR EXTEND switch…….........……..DN

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

  LANDING GEAR LEVER…………………...DN.

- The checklist ***HYDRAULIC SYSTEM PRESSURE (C only)*** (QRH, page 13.4) <u>does not take into account the lack of ability</u> to extend the landing gear by using the alternate system - no matter what caused its malfunction. The checklist does not contain any instructions on how to proceed in case of malfunction of the landing gear alternate 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 do 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 does not include a possibility of malfunction of the landing gear alternate extension system. It includes the possibility of partial extension of the landing gear (any leg of the landing gear not extended). It does 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 B767 D632T001-35LOT applicable at the occurrence time, developed by the manufacturer, does not contain any guidance for the crews concerning procedures in case of malfunction of both landing gear extension systems (primary and alternate). There is lack of appropriate checklist e.g. **ALL GEAR UP LANDING**.

- Based on technical researches conducted to date SCAAI may conclude that the most likely cause of malfunction of the landing gear alterna te extension system was the OFF setting of C829 BUT BUS DISTR circuit breaker during the attempt to extend landing gear with the alternate system. Another issue is an explanation of what was/could have been the reason that at that time the circuit breaker was in the OFF setting.

Therefore, at this stage of the accident investigation, first of all having regard to the safety of flight operations, State Commission on Aircraft Accidents Investigation recommends:

4.1.1.1. Taking into account the above conclusions of the Commission, verify and modify the following checklists:

- ***HYDRAULIC SYSTEM PRESSURE (C only)***
- ***HYDRAULIC SYSTEM PRESSURE (L and C)***
- ***HYDRAULIC SYSTEM PRESSURE (R and C)***
- ***GEAR DISAGREE***

Boeing response to proposed recommendation 4.1.1.1.

Boeing has reviewed the checklists mentioned in the referenced Interim Statement from the SCAAI. We verify that these checklists were applicable on November 1, 2011 to the event 767 and are currently in effect for all 767 operators. With respect to this recommendation's reference to modifying checklists, please see Boeing's responses to the SCAAI's specific recommendations below.

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

Boeing response to proposed recommendation 4.1.1.2.

Boeing does not agree that an additional subsection should be added to the current checklist. Quick Reference Handbook (QRH) Non-Normal Checklists (NNC) are intended to give the crew direction based on a single failure of a specific function or system. The QRH is a compact reference manual, and combinations of all possible multiple failures of all systems are not included due to the complexity that would result.

The checklist instructions advise that system controls are assumed in the normal configuration for the phase of flight before the start of the NNC. In the context of this event, normal configuration means that all relevant circuit breakers are in the proper (closed) position.

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

Boeing response to proposed recommendation 4.1.1.3.

Boeing does not agree that a separate checklist should be added for an all-gear-up landing. Section 14 of the QRH contains the checklist to be used in the event that the landing gear position disagrees with the landing gear lever position. This checklist includes instructions to utilize the alternate system to lower the gear. If any gear down (green) light is still not illuminated, the checklist instructs the crew to plan to land on available gear, which includes the case where no gear is available.

The Flight Crew Training Manual provides further guidance in the case of gear disagree combinations. One of these combinations is for all gear up (or partially extended); the guidance provided includes the expectation that the engines will contact the ground first and the instruction to utilize the rudder in order to maintain the runway centerline.

4.1.1.4. Introduce a mandatory Bulletin providing for physical protection of the circuit breakers located in the areas of direct contact with shoes, equipment for cleaning, luggage etc., in which the breakers may be damaged or unintentionally set in the OFF positions. This applies to all B767 operators which did not mount such a protection on the aircraft below production line No 863.

Boeing response to proposed recommendation 4.1.1.4.

Boeing is currently in the process of creating a service bulletin that will provide instructions and a kit of parts to operators regarding adding circuit breaker guards consistent with those installed in production beginning with line number 863. We anticipate that this bulletin will become available to operators in the first quarter of 2014.

4.1.2. Recommendations proposed to PLL LOT and the responses received Aug 14, 2012 (verbatim):

Following an analysis of the flight crew activities related to the accident of B-767 airplane, registration marks SP-LPC **- gear up landing** - which occurred on 1 November 2011 at Warszawa-Okęcie (EPWA) aerodrome, on the basis of the evidence which has been gathered so far (the investigation has not been completed yet), State Commission on Aircraft Accident Investigations states the following facts:

- The checklist included in D632T001-35LOT QRH (Quick Reference Handbook) related to loss of pressure in the central hydraulic system (page 13.4) did not lead the crew to the final stage of the successful extending of the landing gear by using the alternate system. The crew carried out the action prescribed on page 13.7 **HYDRAULIC SYSTEM PRESSURE (C only)**:

  ALTN GEAR EXTEND switch…….........……..DN

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

  LANDING GEAR LEVER…………………...DN.

- The checklist ***HYDRAULIC SYSTEM PRESSURE (C only)*** (QRH, page 13.4) <u>does not take into account the lack of ability </u>to extend the landing gear by using the alternate system - no matter what caused its malfunction. The checklist does not contain any instructions on how to proceed in case of malfunction of the landing gear alternate 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 do not refer also to the Chapter ***Non-Normal Checklists, Landing Gear, Section 14).***

- ***GEAR DISAGREE*** checklist contained in the same Chapter (page 14.12) also does not include a possibility of malfunction of the landing gear alternate extension system. It includes the possibility of partial extension of the landing gear (any leg of the landing gear not extended). It does 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 B767 D632T001-35LOT applicable at the occurrence time, developed by the manufacturer, does not contain any guidance for the crews concerning procedures in case of malfunction of both landing gear extension systems (primary and alternate). There is lack of appropriate checklist e.g. **ALL GEAR UP LANDING**;

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

Therefore, at this stage of the accident investigation, first of all having regard to the safety of flight operations, State Commission on Aircraft Accidents Investigation recommends:

LOT Polish Airlines in consultation with B767 manufacturer:

4.1.2.1. Taking into account the conclusions of the Commission, verify and modify the above cited checklists.

PLL LOT response to proposed recommendation 4.1.2.1.

In a framework of verification of the cited checklists, we recommend that in HYDRAULIC SYSTEM PRESSURE (C only) procedure the „After gear down lights illuminate" section is to be removed.

PLL LOT have introduced GEAR UP LANDING procedure referring to GEAR DISAGREE procedure.

In GEAR DISAGREE procedure we propose to enter: "Any, or all gear down (green) light not illuminated". The gear up landing technique is described in FCTM and is known to the crews.

In summary, the above recommendation is partially implemented.

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

PLL LOT response to proposed recommendation 4.1.2.2.

Regarding the above recommendation PLL LOT does not see enough grounds for its implementation at this stage.

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

PLL LOT response to proposed recommendation 4.1.2.3.

Regarding the above recommendation PLL LOT does not see enough grounds for its implementation at this stage.

4.1.2.4. In consultation with B767 manufacturer mount physical protection of the circuit breakers located in the areas of direct contact with shoes, equipment for cleaning, luggage etc., in which the breakers may be damaged or accidentally set in wrong positions. This applies to all B767 airplanes used by the operator, which do not have such a protection.

PLL LOT response to proposed recommendation 4.1.2.4.

In the scope of the above recommendation, on June 27, 2012, the Continuing Airworthiness Management Office requested Boeing to develop a Service Bulletin, which would allow to mount a physical protection of the circuit breakers located in the areas of direct contact with shoes, equipment for cleaning, luggage etc. We are currently waiting for an offer to carry out this work.

4.1.3. Proposed recommendation to PP PL and the response received Jan 7, 2014 (summary)

Following an analysis of the flight crew and the airport services activities related to the accident of B767 airplane, registration marks SP-LPC **- gear up landing** - which occurred on November 1, 2011 on EPWA aerodrome, on the basis of the evidence which has been gathered so far (the investigation has not been completed yet), State Commission on Aircraft Accidents Investigation states the following fact:

- After the evacuation there was no proper organization and coordination of the quick and smooth movement of the passengers to the designated area or designated means of transport.

Therefore, at this stage of the accident investigation, first of all having regard to the safety of flight operations, State Commission on Aircraft Accidents Investigation recommends:

Management of Warsaw Chopin Airport:

Develop procedures for quick and smooth movement of passengers to a designated area or designated means of transport after evacuation.

PP PL response to the SCAAI recommendation:

Air accident No 1400/11, which occurred on November 1, 2011 on Warsaw Chopin Airport, involving B-767 airplane, registration marks SP-LPC, was analyzed in detail by services responsible for conducting and coordination of rescue and firefighting operations at the airport.

The conclusions of this analysis were discussed on January 27, 2013 during Safety Committee meeting with representatives of PP PL internal cells, state services, military, PANSA and ground handling agents. During the meeting an analysis of the accident was presented and the conclusions and preventive recommendations related to this occurrence were discussed, including the aspects related to the organization of movement of passengers after evacuation from an aircraft. These aspects were also an element of the *Accident* 2012 exercise.

In addition, the aspects of alerting, reaching a proper reaction time and smooth regrouping of forces and resources are a fixed component of "partial" exercises which regularly take place at Chopin Airport in Warsaw on an average quarterly basis.

The last but not least element, which is worth noting is the implementation of the Local Emergency Response Action Plan (LERAP), which ensures coordination of activities related to flow of passengers from an occurrence site to the airport boundary.

Since September 23, 2013 Warsaw Chopin Airport has had the ability to remove disabled aircraft of Boeing 787 category.

After conclusion of the investigation SCAAI has not formulated additional safety recommendations.

5. ANNEXES

1. Hydraulic Hose Examination Report (NTSB)
2. Circuit Breakers Examination Report (BOEING)
3. Electric Actuator Examination Report (EATON)
4. Electrical Circuits & Components (SCAAI)
5. Psychological Opinion (SCAAI)
6. Evacuation of Passengers (PLL LOT)
7. Rescue & Firefighting Action (PP PL)

THE END

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NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

June 29, 2012

MATERIALS LABORATORY FACTUAL REPORT Report No. 12-072

A. ACCIDENT INFORMATION

Place	:	Warsaw, Poland
Date	:	November 11, 2011
Vehicle	:	Boeing 767
NTSB No.	:	DCA12WA009
Investigator	:	Joseph Sedor NTSB-Accredited Representative

B. COMPONENTS EXAMINED

Hydraulic hose

C. DETAILS OF THE EXAMINATION

A landing gear hydraulic hose, as shown in Figures 1 and 2, was submitted to the NTSB Materials Laboratory for examination to determine the failure mechanism for the hose. The submitted hose was an Aeroquip AC127J-0300SS hose. The high pressure, 0.625 inch hose consisted of a two-layer Teflon® hose covered with a two-ply pressure sleeve that consisted of a textile outer layer with a Kevlar® inner layer. The hose had a flareless crimp, male connector on each end. Each connector was made up of a barb, called a nipple, which the Teflon hose was fitted over. The nipple, hose and pressure sleeving were then covered with a metal collar called the socket.

During the initial visual examination, a hole was observed in the sleeving in the area near the nipple and socket of one end of the hose. Underneath the damaged sleeving, a crack in the inner hose was found. A close-up photograph of the crack is shown in Figure 3. The crack went through the entire thickness of the hose. After removing the nipple, socket and sleeving from the hose, the crack was examined under magnification using a 5x to 50x stereo zoom microscope to determine the cause of the crack. Under magnification, it was determined that the crack was a result of two full thickness fractures in the hose wall as shown in Figure 4.

To determine the facture mechanism, the fracture surfaces of the crack were examined using a scanning electron microscopy (SEM). An overall photograph of the crack under magnification is shown in Figure 3. Under magnification, it was found that the two fracture surfaces did not match and material was missing. This observation is consistent with two interacting fractures that resulted in a loss of a small piece of hose between the two fractures. The primary fracture surface had flattened, smeared surface, indicative of significant crack recontact damage and no identifiable fractures features could be visualized. The secondary fracture surface, as shown in Figures 5-7, exhibited several distinct fracture features consistent with those identified in ASTM C1256[1,2]. Branching fractures as shown in Figure 8 and fine fibrils as shown in Figure 9 are typical signatures in slow crack growth in polymeric materials. Based on the direction of crack growth, the initial fracture likely initiated on the right side of the crack (with the nipple/socket located above the crack) and on the interior surface of the hose as shown in Figure 7. 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 (Aeroquip/Easton), 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.

Nancy B. McAtee
Chemist

[1] Fractures in polymers often behave similarly to fractures in glass.
[2]. ASTM C1256-93 *Standard Practice for Interpreting Glass Fracture Surface Features*

Figure 1. Overall photograph of accident hydraulic hose.

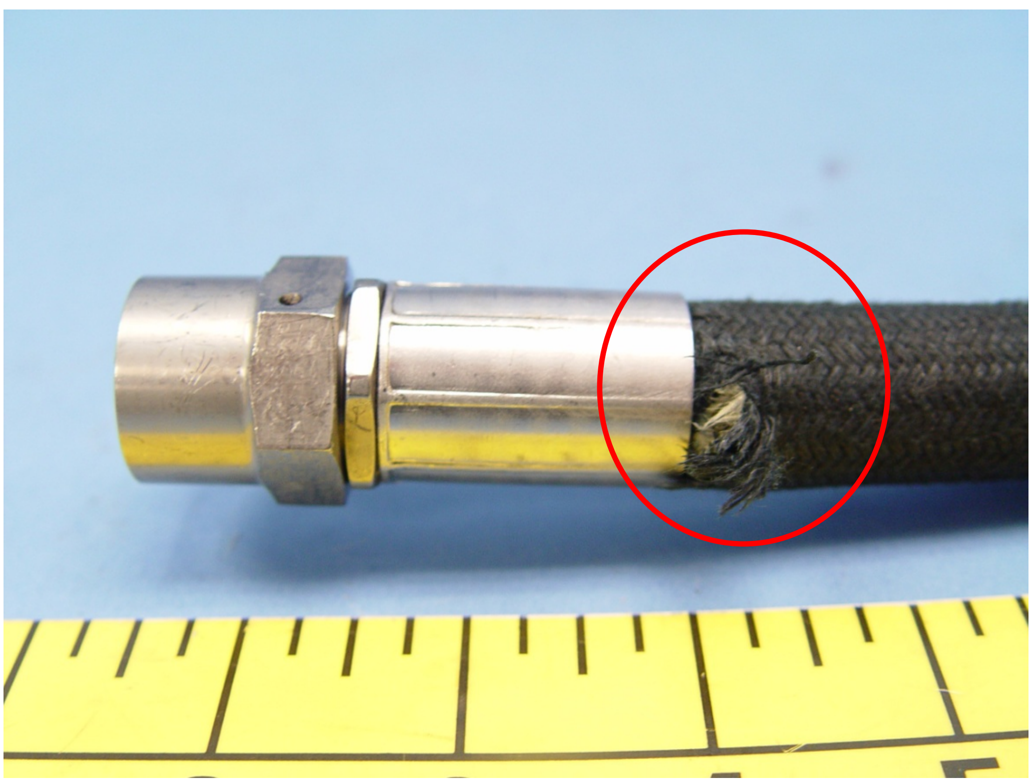


Figure 2. Close-up photograph of damage to hydraulic hose (area highlighted in red circle).

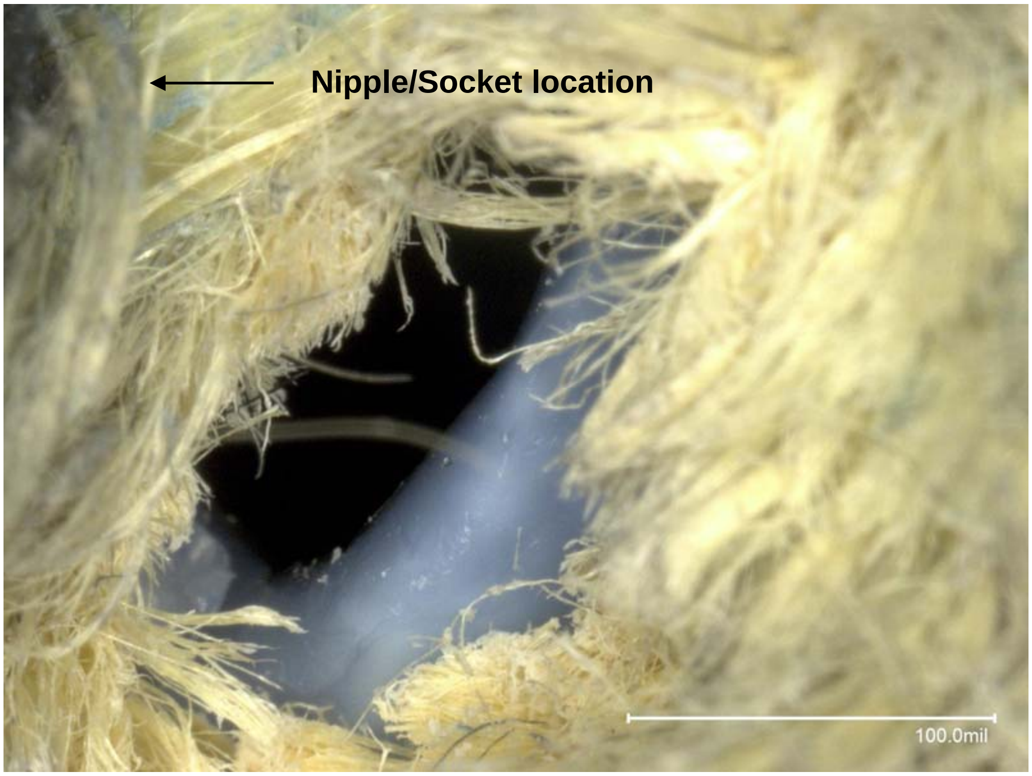


Figure 3. Close-up photograph of hole.

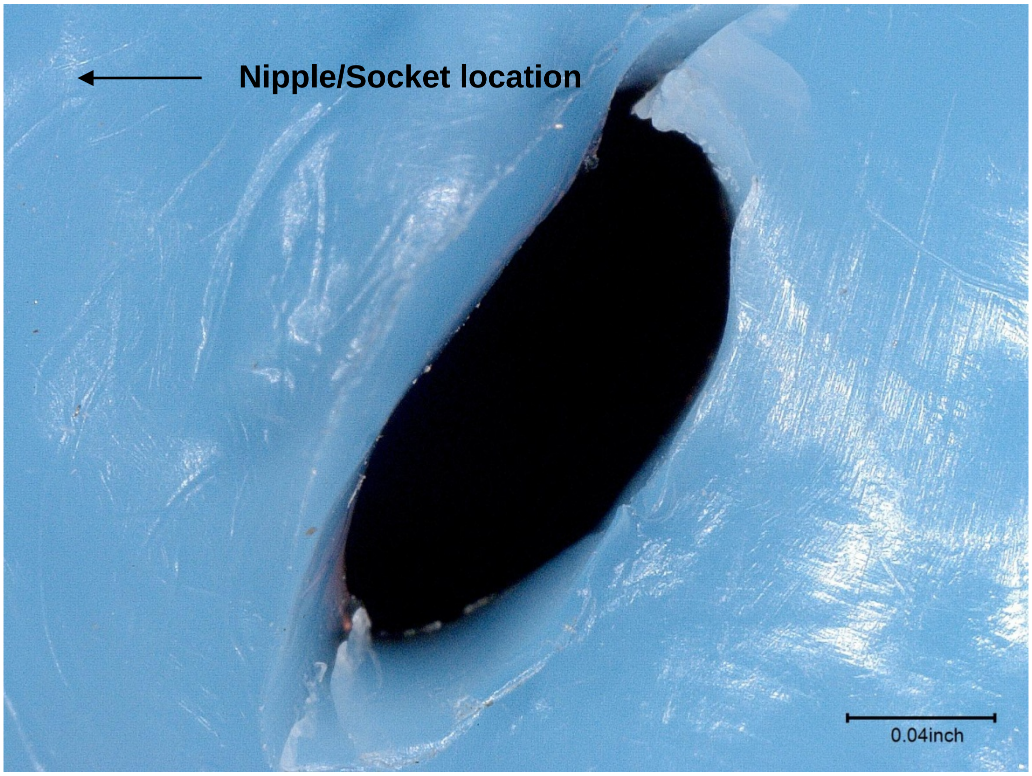


Figure 4. Close-up photograph of crack in hose sidewall.

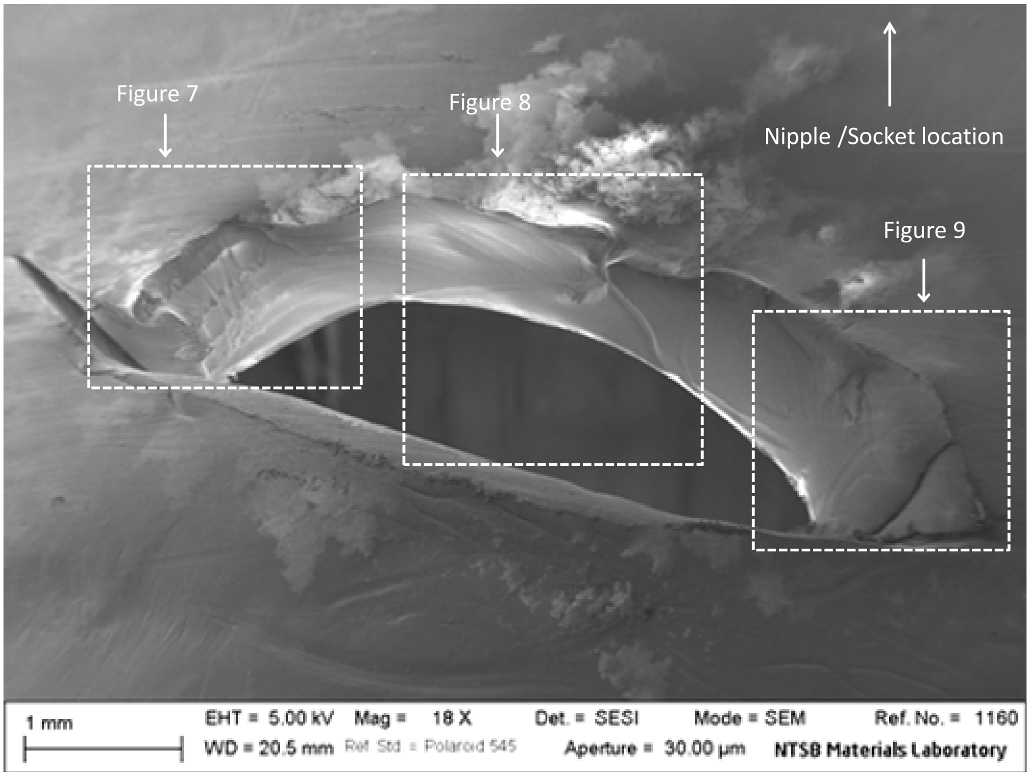


Figure 5. SEM image of crack with areas of interest highlighted.

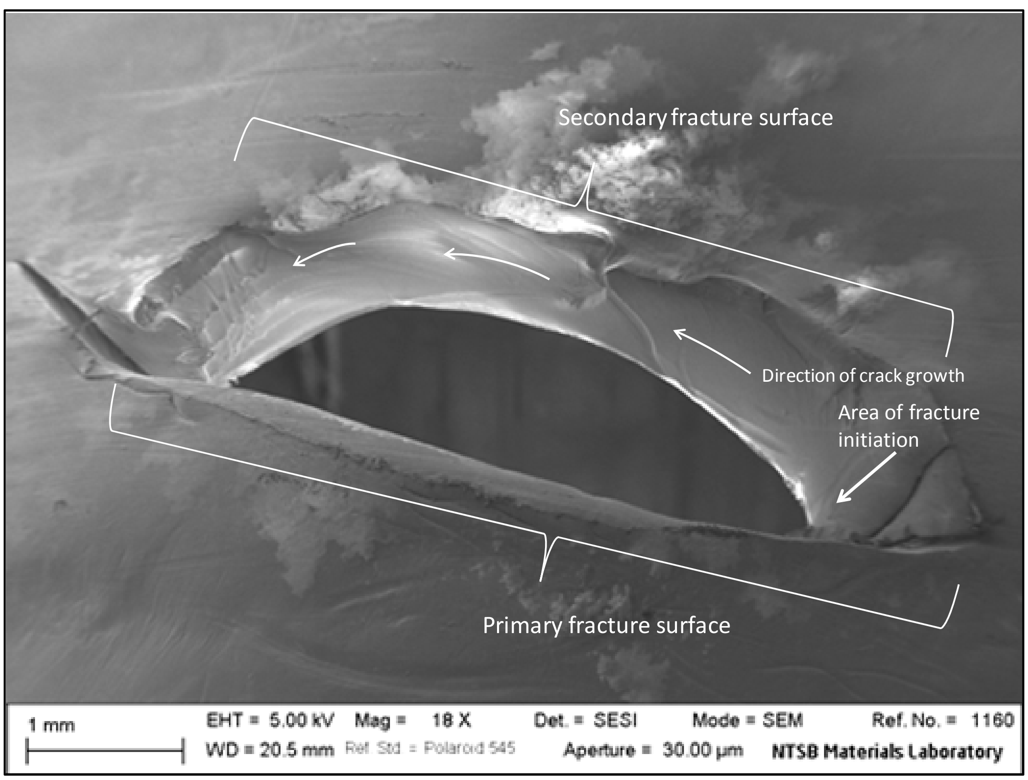


Figure 6. SEM image of crack with fracture features annotated.

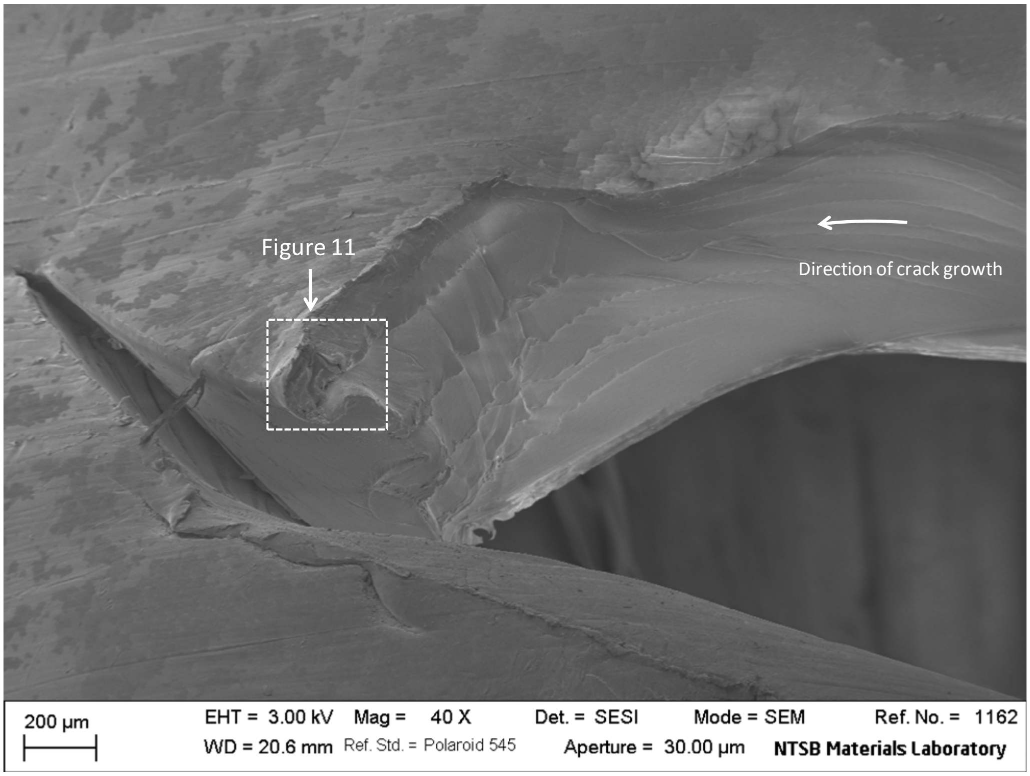


Figure 7. SEM image of left side of secondary fracture surface.

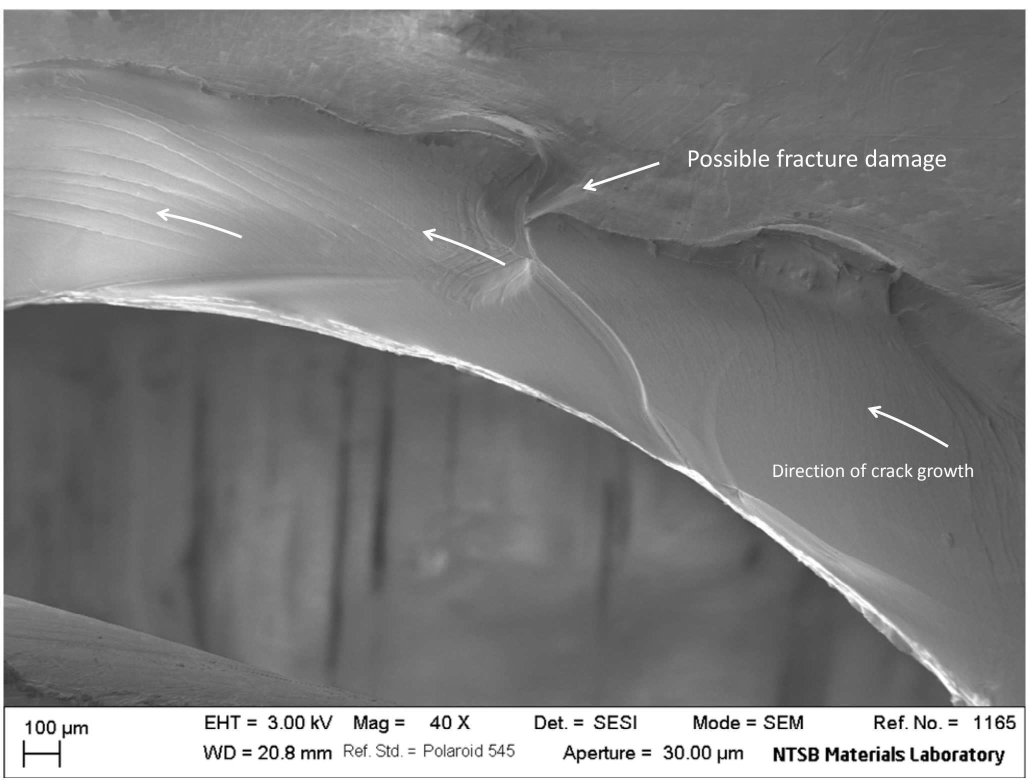


Figure 8. SEM image of center section of secondary fracture surface.

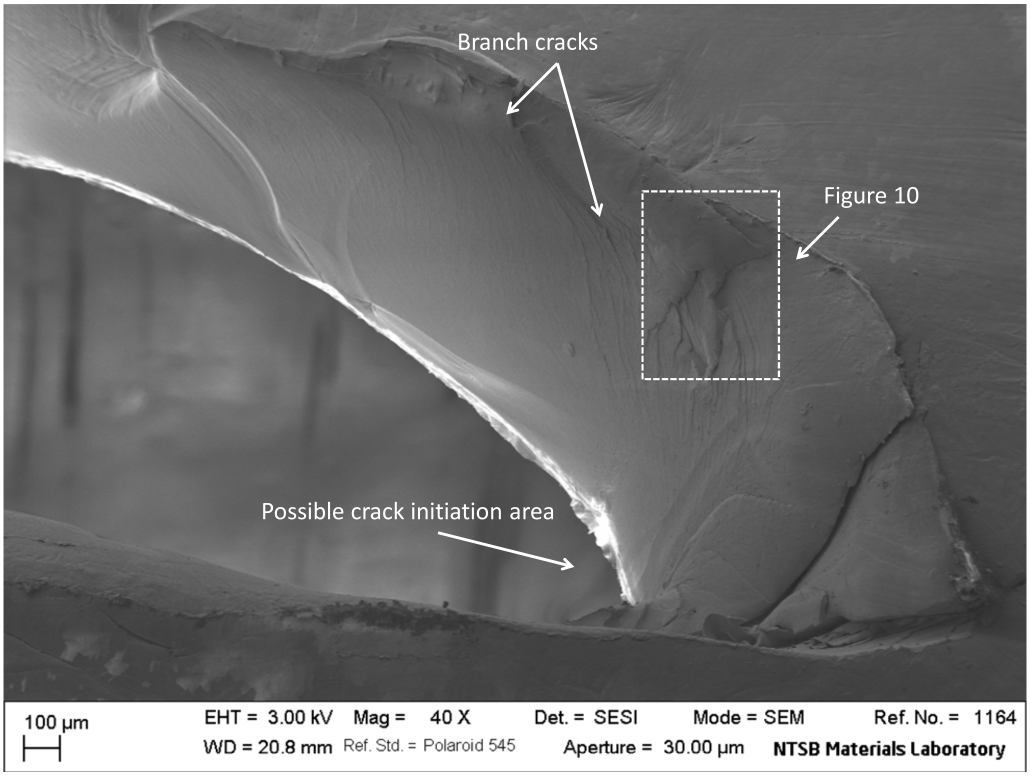


Figure 9. SEM image of center section of secondary fracture surface and crack initiation area.

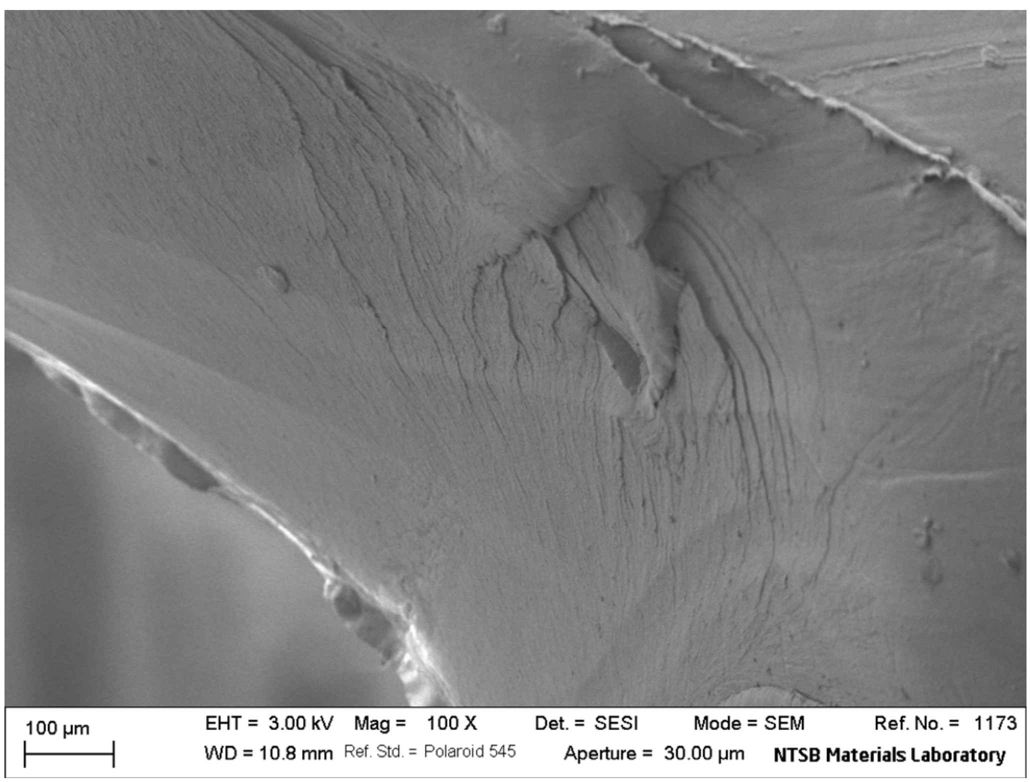


Figure 10. Close-up SEM image of branch cracking and directional crack markings.

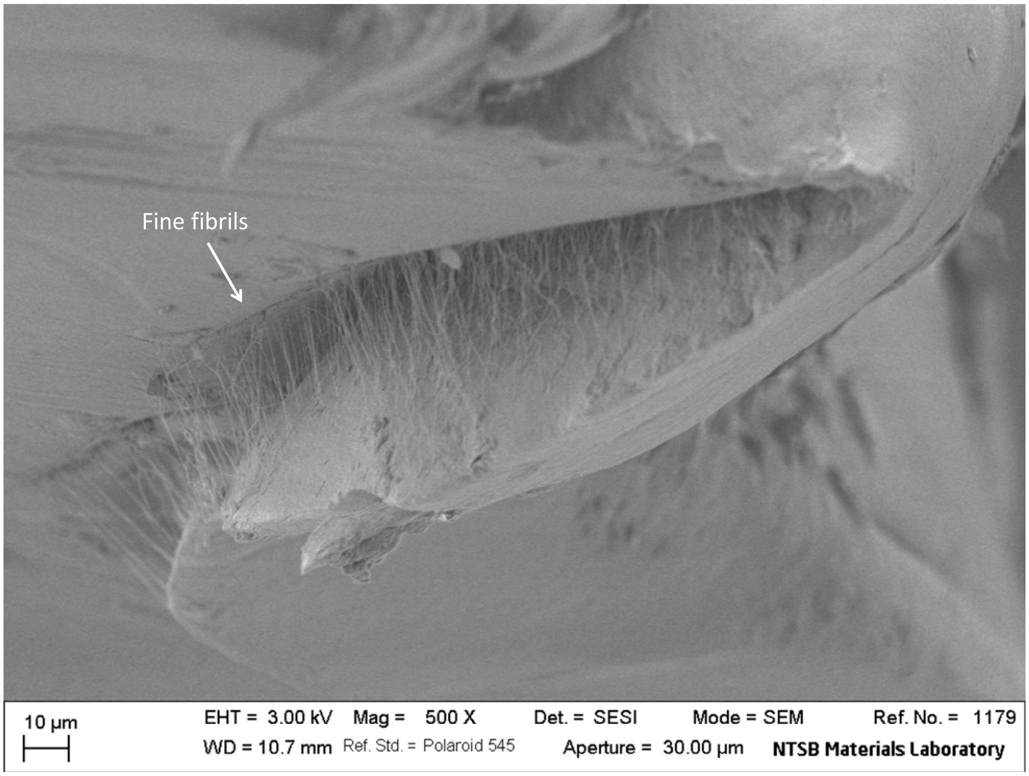


Figure 11. Close-up SEM image of fine fibril formation.

Equipment Quality Analysis Report

Boeing Commercial Airplanes

CUSTOMER: NTSB

EQA NUMBER: AS11546R

DATE: March 6, 2012

MODEL NUMBER: 767-300EREM

AIRPLANE NUMBERS: VN293 / SP-LPC

SUBJECT: ***Examination of Circuit Breaker C829 (Battery Bus Distribution) and Circuit Breaker C4248 (Landing Gear Alternate Extend Motor) Removed from a 767-300EREM Airplane, VN293***

IDENTIFICATION:

Part name:	Circuit Breaker (C829)
Boeing part number:	BACC18Z7R
Supplier part number:	2TC6-71/2
Supplier:	Klixon, Texas Instruments
Date code:	9651

IDENTIFICATION:

Part name:	Circuit Breaker (C4282)
Boeing part number:	BACC18X25
Supplier part number:	700-038-25
Supplier:	Mechanical Products
Date code:	9647

REFERENCES:

(a) NTSB Accident Number DCA12WA009
(b) SR 1-2053370341
(c) COSP report number: 2011-1420
(d) Boeing Part Standard BACC18Z REV AC
(e) Boeing Part Standard BACC18X REV U
(f) Boeing Part Specification BPS-C-144 REV B
(g) LOT Workshop Engineering Order TWPA/767/0963/11/R00
(h) Wiring Diagram Manual D280T134, section 24-33-11
(i) Wiring Diagram Manual D280T134, section 32-35-11

BACKGROUND:

Per references (a, b & c), a Polskie Linie Lotnicze (LOT) S.A. 767-300 (VN293) performed a successful “all wheels up” landing in Warsaw, Poland on November 1, 2011 due to the failure of the landing gear alternate extend system to extend the landing gear.

The landing gear alternate extend motor circuit breaker (C4248) and the battery bus distribution circuit breaker (C829) that supplies 28 VDC power to C4248 were removed from the airplane and eventually sent to Boeing’s Equipment Quality Analysis (EQA) group for examination.

BACKGROUND HISTORY:

The Polish State Commission for Aircraft Accident Investigation (SCAAI) opened an investigation of the event. Following recovery of the airplane from the runway, the SCAAI conducted extensive mechanical and electrical testing on the subject circuit breakers as outlined in reference (g). Both breakers were shipped to the National Transportation Safety Board (NTSB) under a request for Boeing EQA to repeat this testing and to conduct a visual examination of the interior components of both breakers. This examination and testing documented in this report was conducted under the direction of the NTSB.

SUMMARY:

No fault could be found with either circuit breaker. The electrical and mechanical properties of both circuit breakers were as specified per references (d, e & f).

EXAMINATION AND TEST RESULTS:

The box was received under control of the NTSB. It had not been opened and appeared undamaged. Figures 1 and 2 show the box containing the two circuit breakers as received.

Figure 1: Box as received.

Figure 2: Close-up view of the shipping label on top of box.

The box was then opened and the contents were removed. Figures 3 through 9 show the removed packaging, the removed circuit breakers and their condition “as received”.

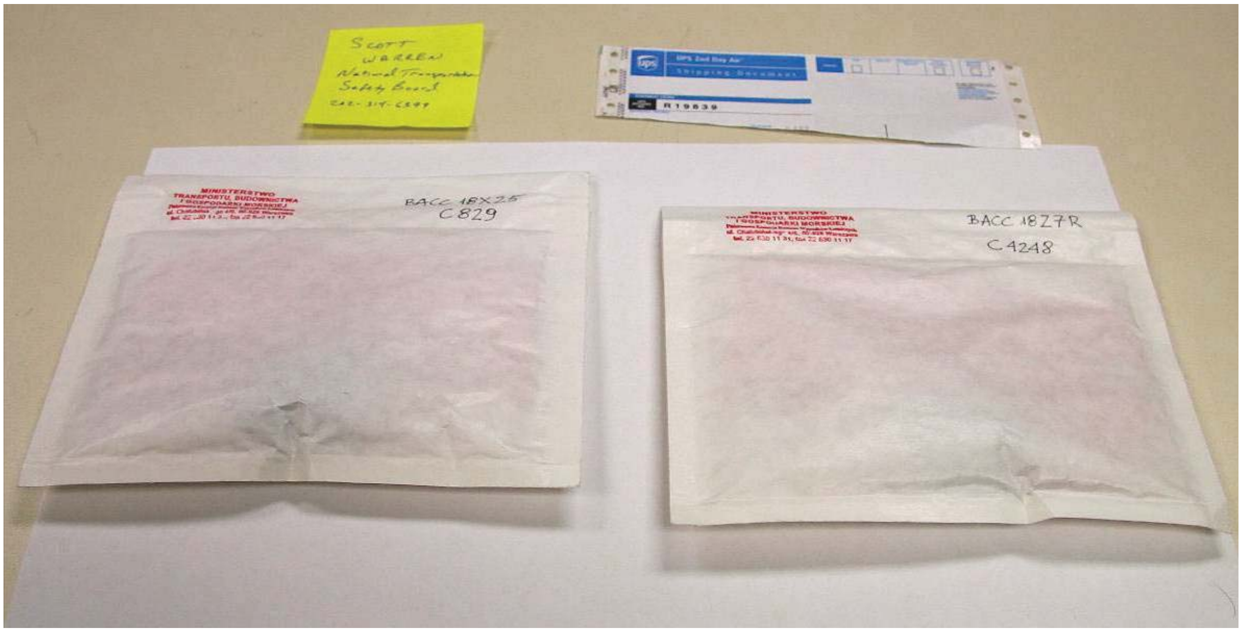


Figure 3: Envelopes containing each circuit breaker.

Figure 4: Circuit breaker BACC18X25 was removed from the packaging.

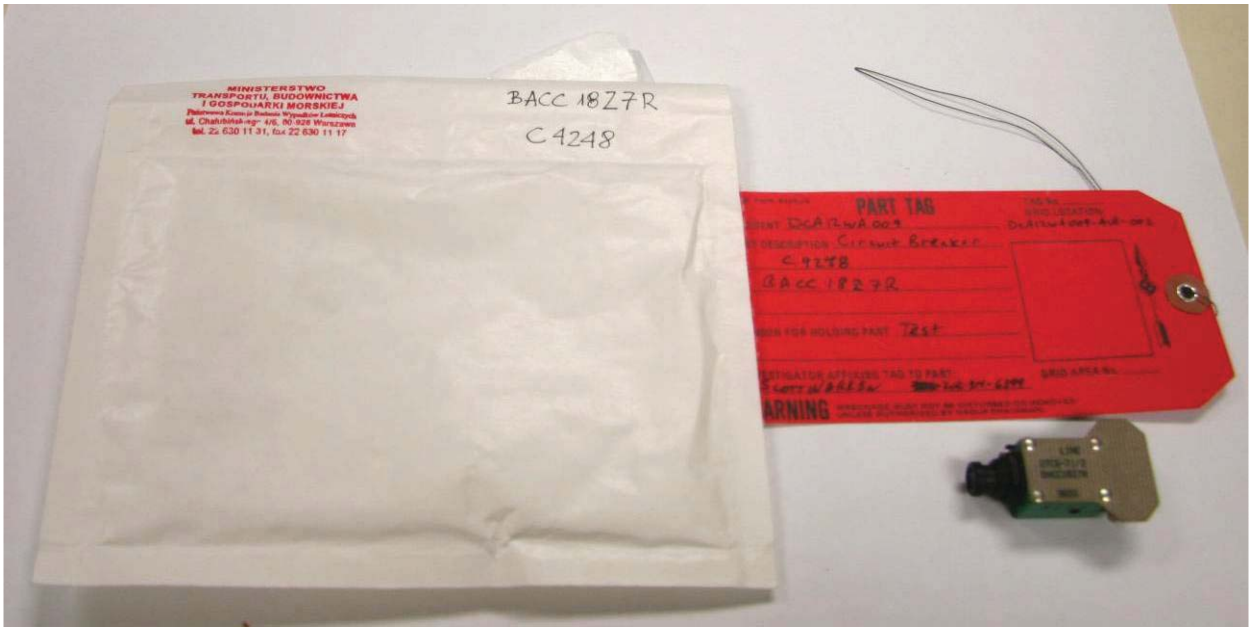


Figure 5: Circuit breaker BACC18Z7R was removed from the packaging.

The BACC18Z7R circuit breaker was photographed in the “as received” condition; see Figures 6 and 7.

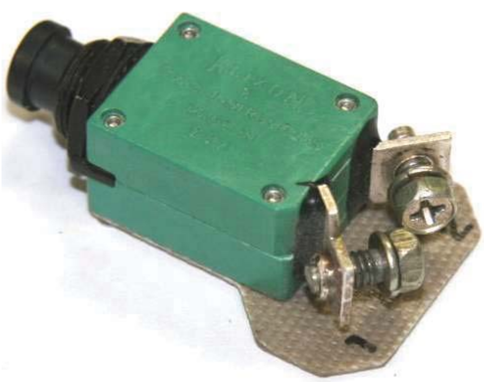


Figure 6: BACC18AZ7R circuit breaker in the “as received” condition.

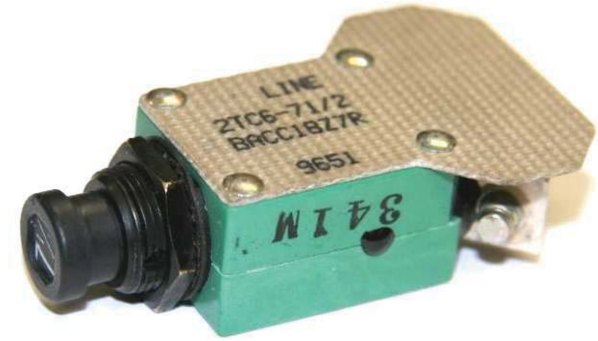


Figure 7: BACC18Z7R circuit breaker in the “as received” condition.

The BACC18X25 circuit breaker was photographed in the “as received” condition; see Figures 8 and 9.

Figure 8: BACC18X25 circuit breaker in the “as received” condition.

Figure 9: BACC18X25circuit breaker in the “as received” condition.

EXAMINATION AND TEST RESULTS:

The electrical characteristics of the circuit breakers were tested using a suite of calibrated, general purpose test equipment. The following is a list of the test equipment used to test the electrical properties of the circuit breakers:

1. A transistor load bank (Transistor Devices Inc. P/N DLF 200) was used as a calibrated load for a 100 ADC power supply (HP P/N 6456B) to test the current specifications of each circuit breaker.

2. Calibrated voltage and current measurements were made with two precision multimeters (Fluke P/N 289) and a digital oscilloscope (Tektronix P/N DPO 7254).

3. Two clamp-on current probes (Fluke P/N i1010 and Tektronix P/N A622) were also used for current verification.

4. A Vitrek 944i dielectric analyzer was used to make calibrated insulation resistance and dielectric leakage current measurements.

Both circuit breakers were tested for dielectric leakage current and insulation resistance properties. The recorded tests were conducted per reference (f). The results for both circuit breakers are shown in Table I.

TABLE I. Insulation Resistance & Dielectric Leakage Current Test Results for BACC18X25 & BACC18Z7R

Insulation resistance	**@ 500 VDC**	**Time 1 minute**	**Insulation resistance (100 MΩ minimum)**
BACC18Z7R			176 GΩ
BACC18X25			170 GΩ
Dielectric leakage current	**@ 1500 VAC**	**Time 1 minute**	**Leakage current (2mA maximum)**
BACC18Z7R			853nA
BACC18X25			966nA

The electrical performance characteristics of the two circuit breakers were recorded and provided separately in Table II and Table III. The testing was performed in accordance with references (d and e).

TABLE II. Electrical Test Results for BACC18Z7R Ambient Temperature: 73 degrees F			
Test	**@ Percent Rated Current**	**Specified Trip Time**	**Actual Time**
Ultimate Trip Time	115 %	Min 1 hour	Did not trip in 60 sec.
Ultimate Trip Time	138 %	Max 1 hour	56 seconds
Overload Calibration	200 %	Min 5 seconds to Max 20 seconds	13 seconds
Voltage drop	115 %	Max voltage drop not specified	183 mV
Contact resistance	115%	Max contact resistance not specified	0.020 Ω

Figure 10 shows the oscilloscope image of current versus time for the 200% current overload trip-time test of circuit breaker BACC18Z7R.

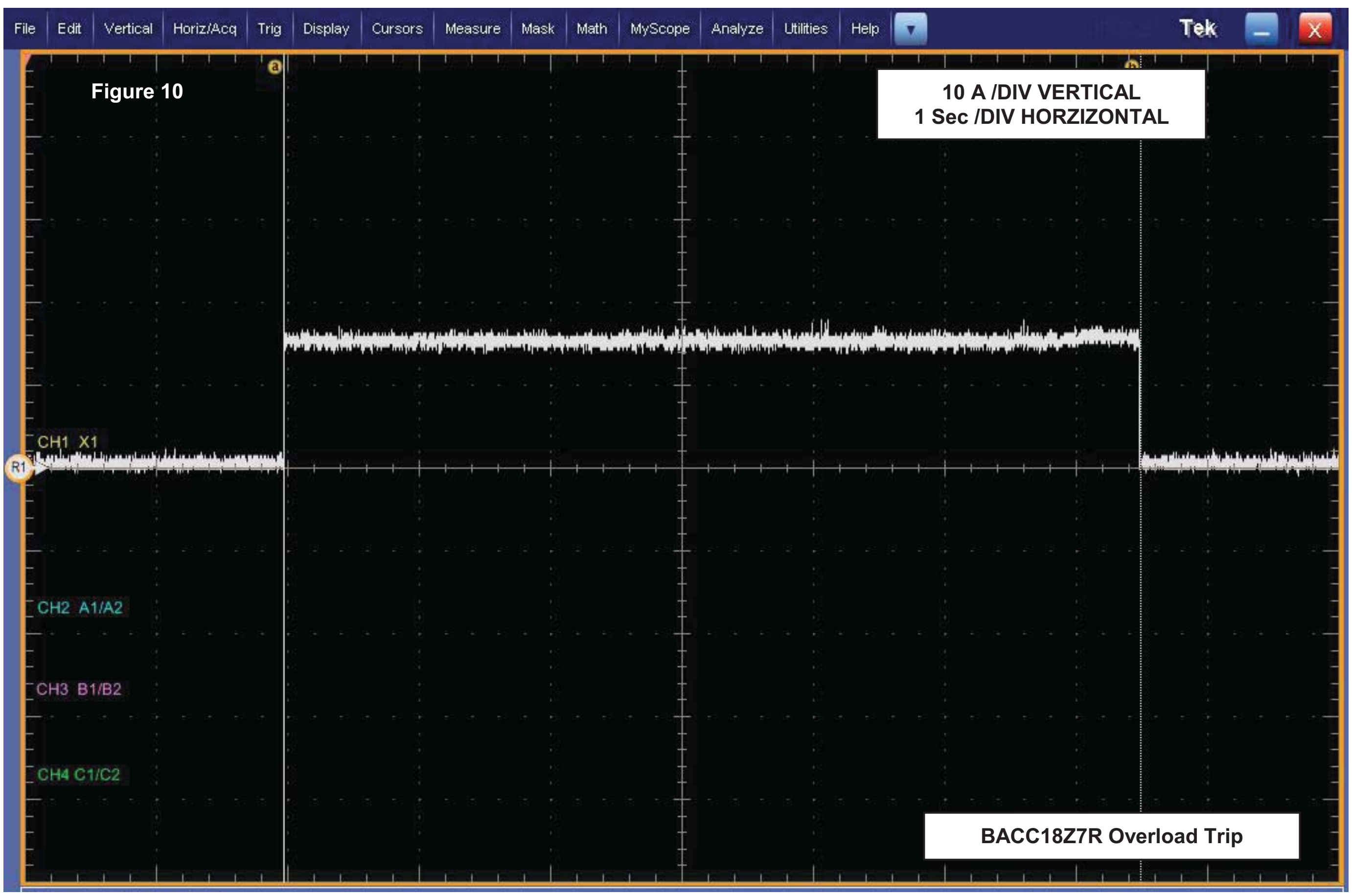


TABLE III. Electrical Test Results BACC18X25
Ambient Temperature 73 degrees F

Test	@ Percent Rated Current	Specified Trip Time	Actual Time
Ultimate Trip Time	115 %	Min 1 hour	Did not trip in 60 sec.
Ultimate Trip Time	138 %	Max 1 hour	203 Seconds
Overload Calibration	200 %	Min 12.5 seconds to Max 55 seconds	16 seconds
Voltage drop	115 %	Max voltage drop not specified	167 mV
Contact resistance	115%	Max contact resistance not specified	0.020 Ω

Figure 11 shows the oscilloscope image of current versus time for the 200% overload current trip-time test of circuit breaker BACC18X25.

Figure 11

The operating force of each circuit breaker was tested using the fixture shown in Figure 12. The pull-out and reset force test results were found to be per the reference (d and e) specifications. The results are shown in Mechanical Test Results Tables IV and V.

Figure 12: Operating force test setup.

TABLE IV. Mechanical Force Test Results BACC18Z7R

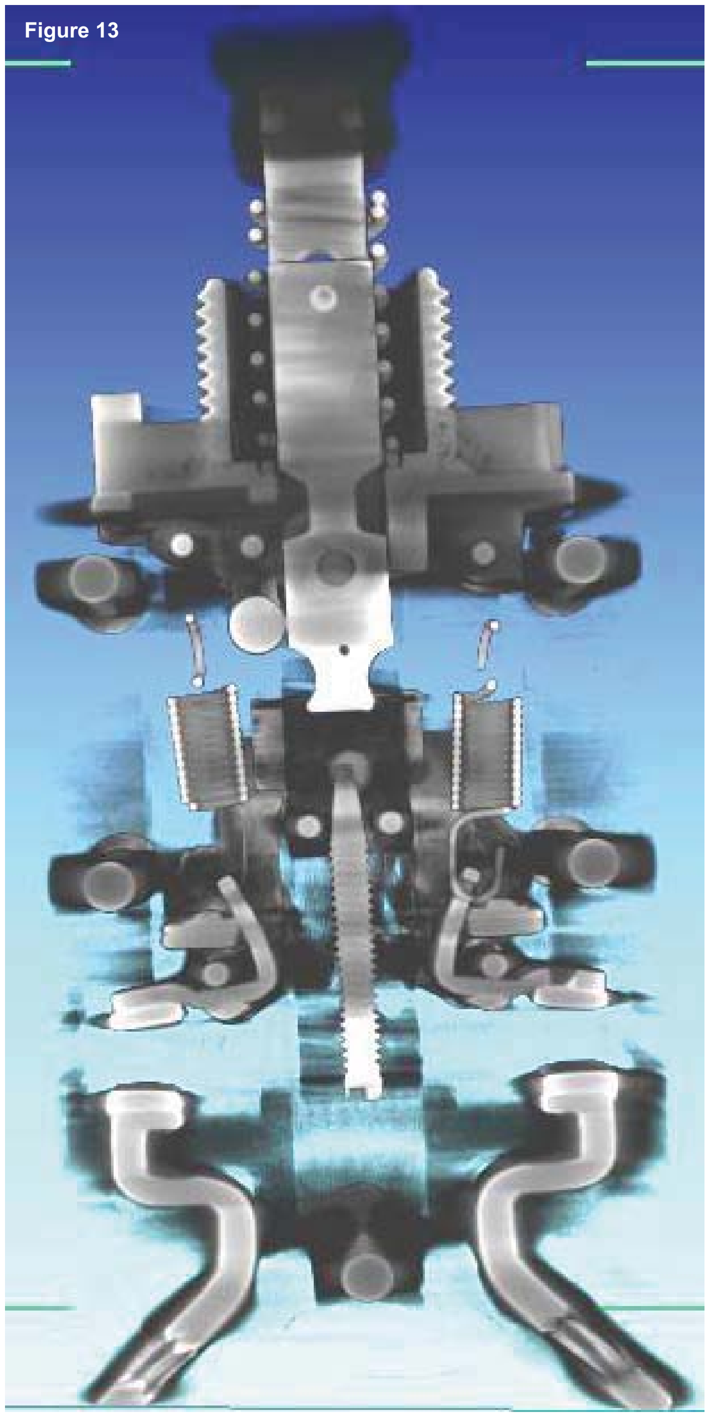
Operating Force	Specified Force	Actual Force (X5)
Pull-out	Min 1.5 to Max 5 Lbs	3.8, 3.5, 4.0, 4.5, 4.3
Reset	Min 1.0 to Max 5 Lbs	2.0, 1.9, 1.9, 2.3, 2.1

TABLE V. Mechanical Force Test Results BACC18X25

Operating Force	Specified Force	Actual Force (X5)
Pull-out	Min 1.35 to Max 12 Lbs	4.4, 4.9, 4.1, 3.9, 4.2
Reset	Min 2.0 to Max 16 Lbs	8.1, 8.0, 8.0, 7.7, 8.4

Computed tomography (CT) images were taken of each circuit breaker before disassembly; see figures 13 and 14. There were no obvious anomalies observed.

BACC18X25 CT Image Figure 13



BACC18Z7R CT Image Figure 14

DISASSEMBLY:

Figure 15 shows the BACC18X25 circuit breaker disassembled.

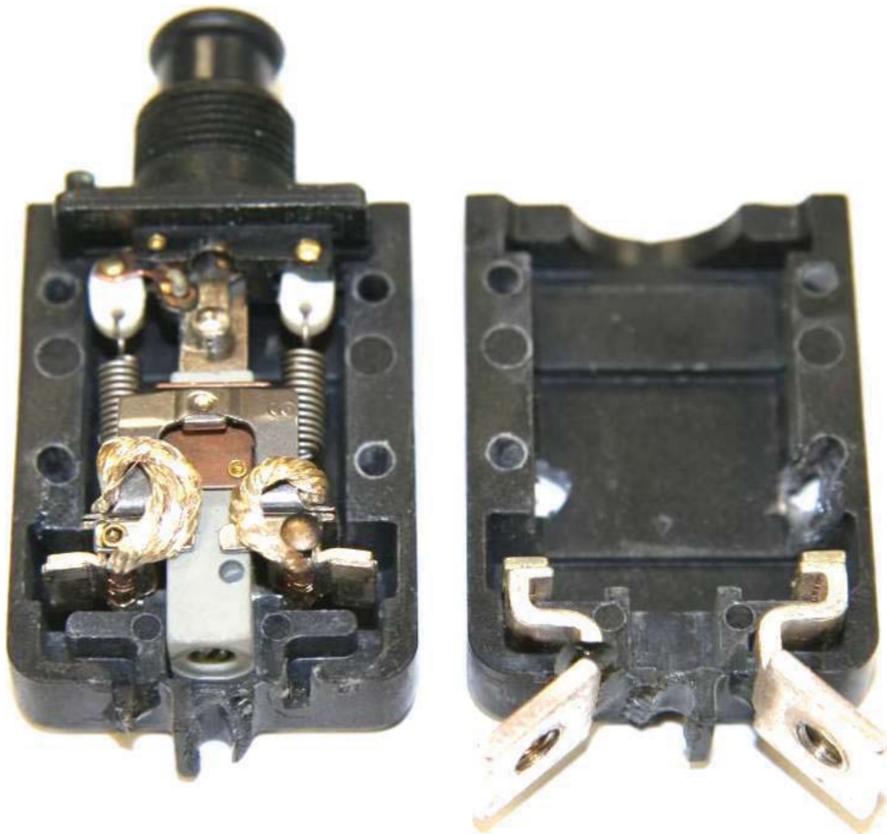


Figure 15: BACC18X25 housing open.

Figures 16 and 17 show the circuit breaker button and shaft. Slight damage on the button was caused by the push-pull fixture utilized in the mechanical properties testing.

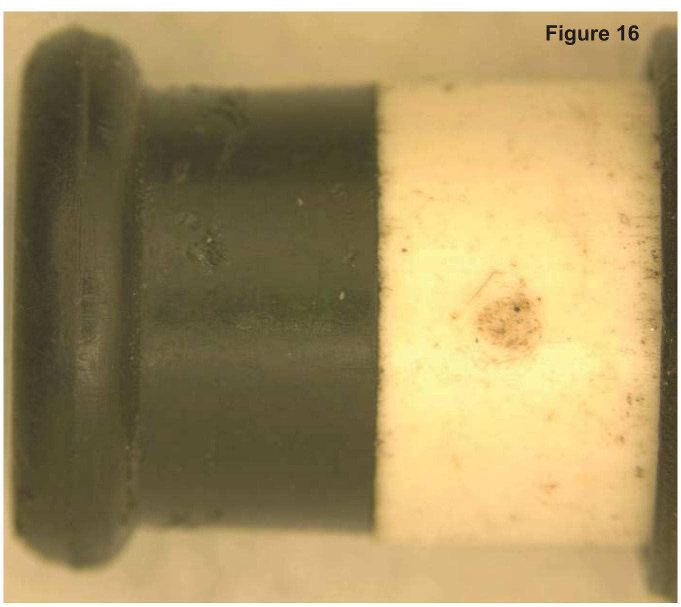


Figure 16

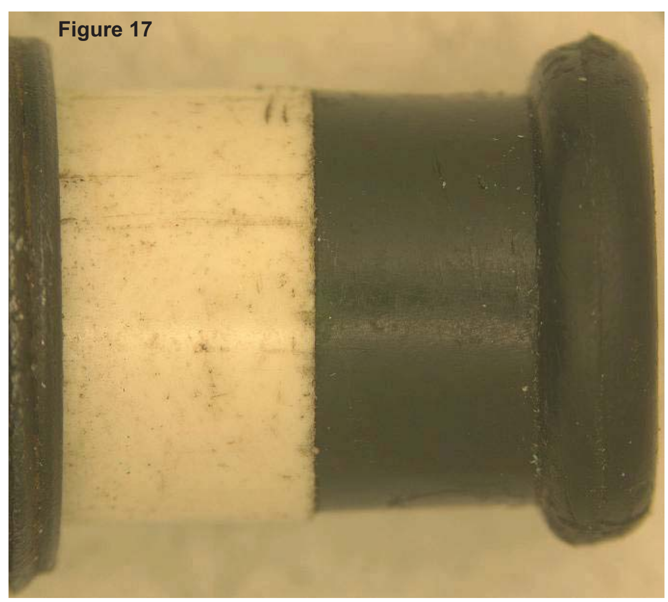


Figure 17

The contacts from the BACC18X25 circuit breaker are shown in figures 18 through 21. The condition of the contacts was unremarkable.

Fixed Contact 1

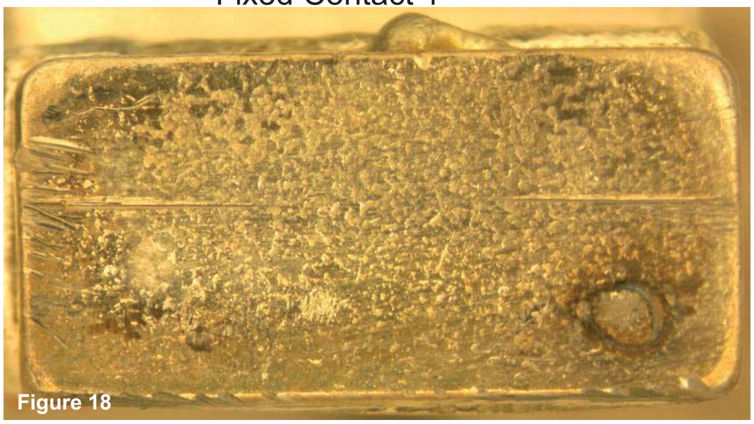


Figure 18

Fixed Contact 2

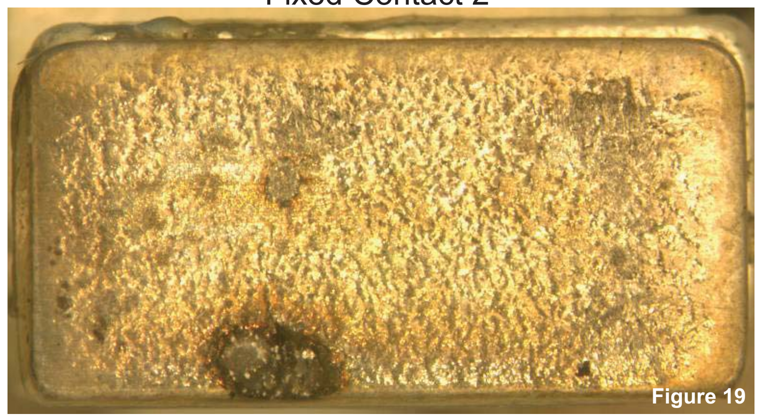


Figure 19

Movable Contact 1

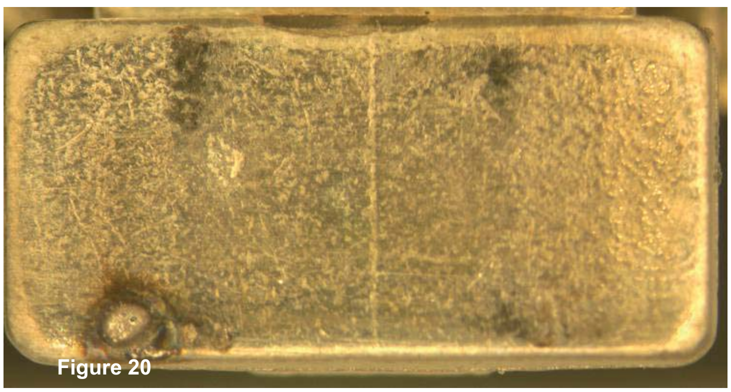


Figure 20

Movable Contact 2

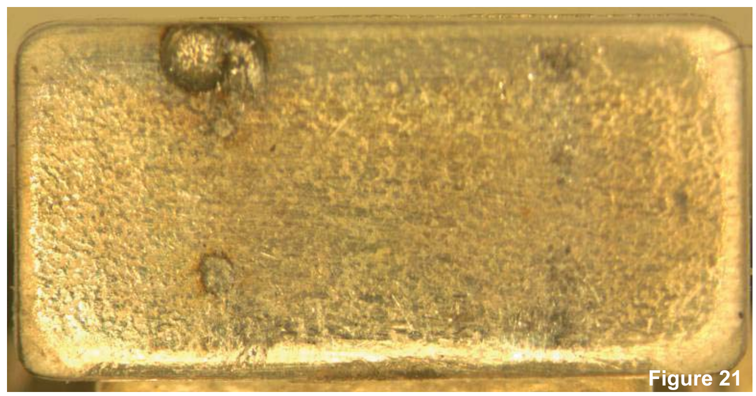


Figure 21

Figure 22 shows the BACC18Z7R circuit breaker disassembled.

Figure 22: The BACC18Z7R circuit breaker disassembled.

The contacts from the BACC118Z7R circuit breaker are shown in figures 23 through 26. The condition of the contacts was unremarkable.

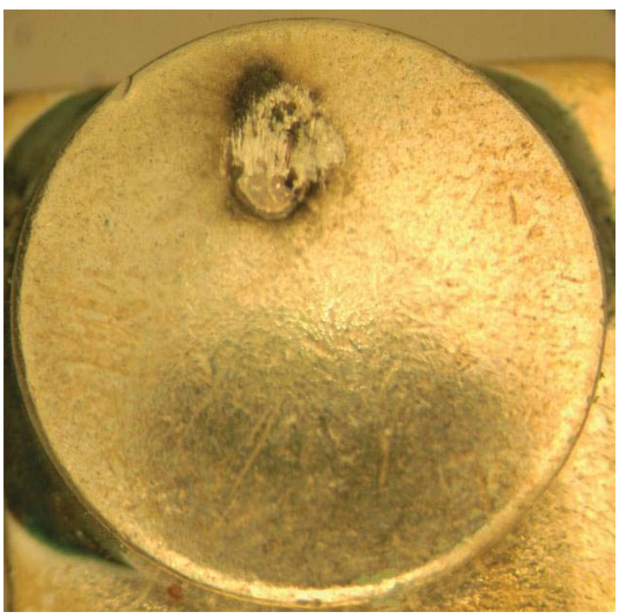


Figure 23: BACC18Z7R fixed contact 1.

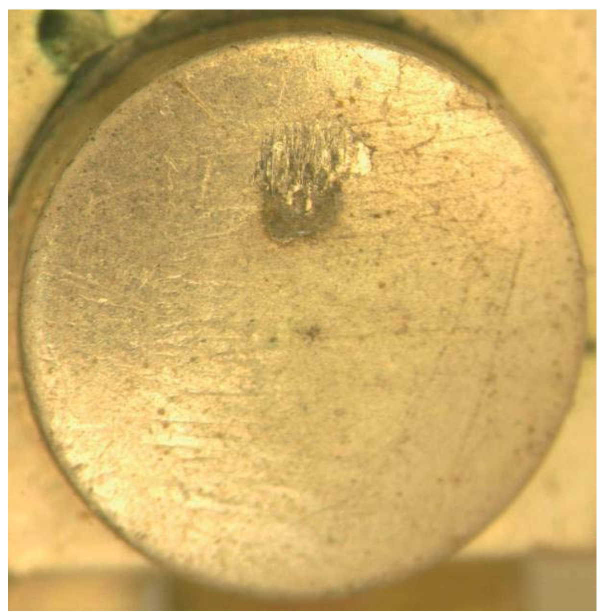


Figure 24: BACC18Z7R fixed contact 2.

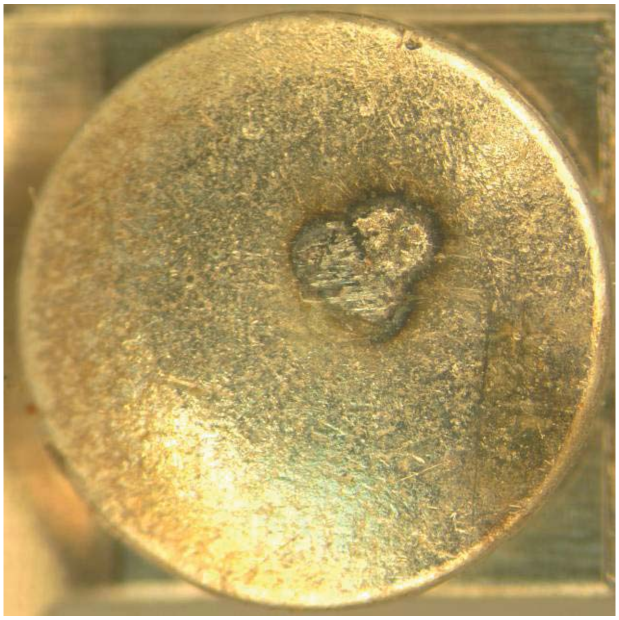


Figure 25: BACC18Z7R moveable contact 1.

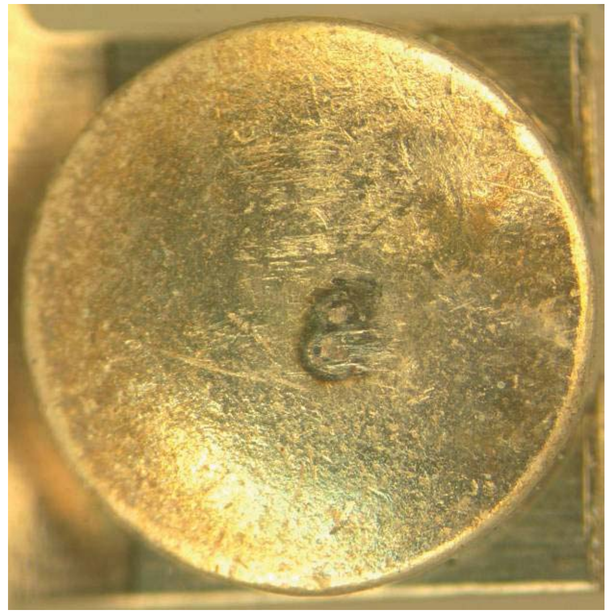


Figure 26: BACC18Z7R moveable contact 2.

Figures 27and 28 show the circuit breaker button and shaft. Slight damage on the button was caused by the push-pull fixture utilized in the mechanical properties testing.

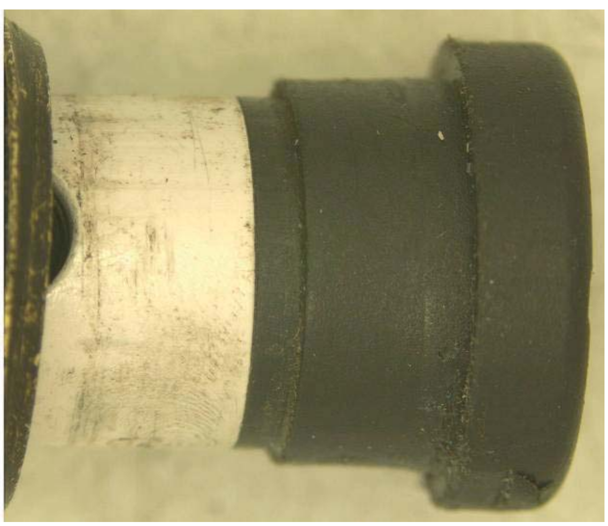


Figure 278: The BACC18Z7R button and shaft.

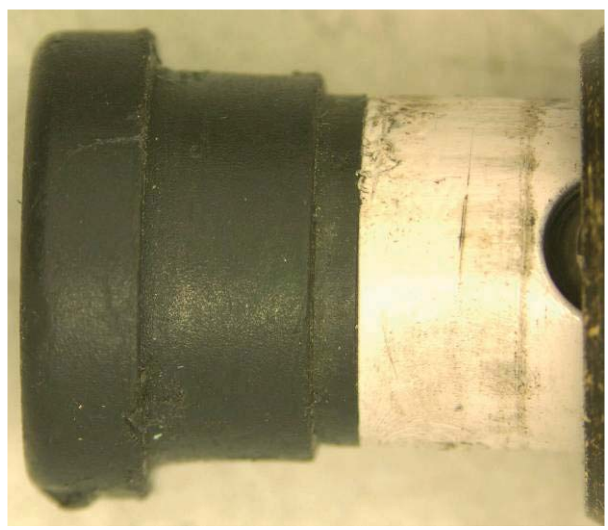
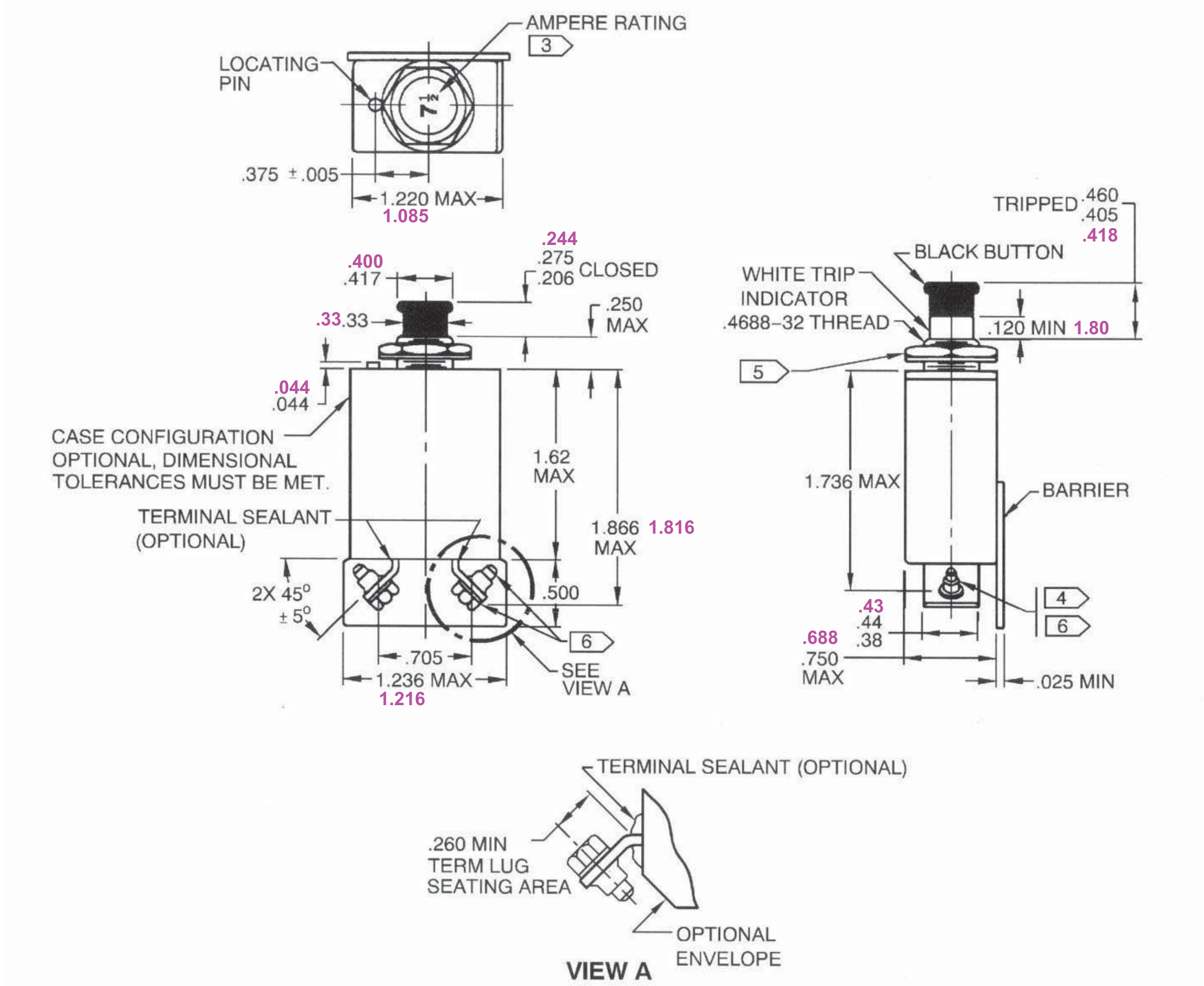


Figure 28: BACC18Z7R button and shaft.

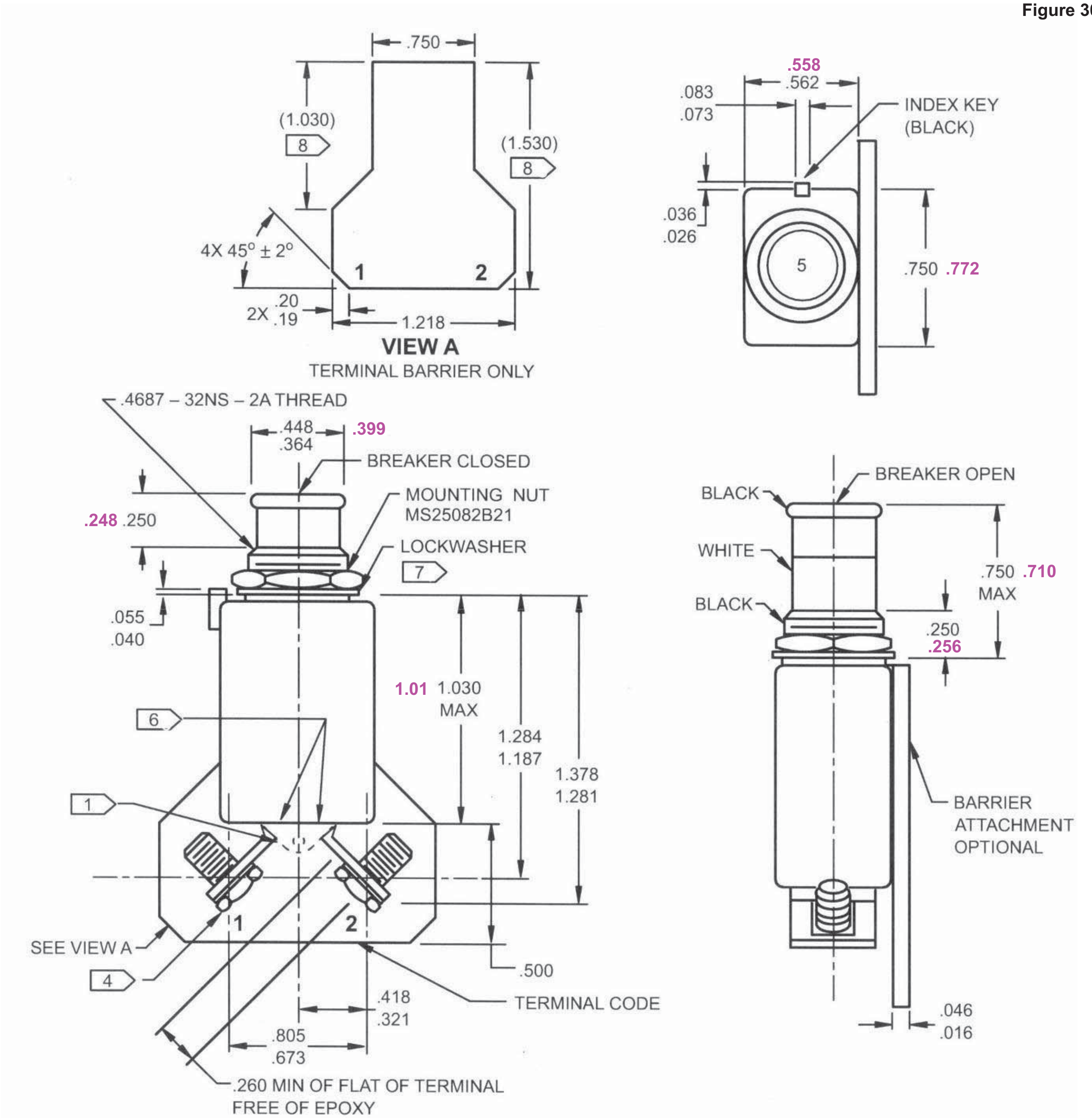
Dimensional measurements of each circuit breaker were compared to those of the applicable part standard (figures 29 and 30, magenta fonts).

Figure 29



BACC18X25

Figure 30



BACC18Z7R

CONCLUSION:

Both the BACC18X25 battery bus distribution and the BACC18Z7R 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. This was verified by a visual examination of the internal components.

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

DISPOSITION:

The circuit breakers were re-packaged and placed back into the box under the control of the NTSB. Evidence tape was placed over the box and the box was returned to the NTSB secured area.

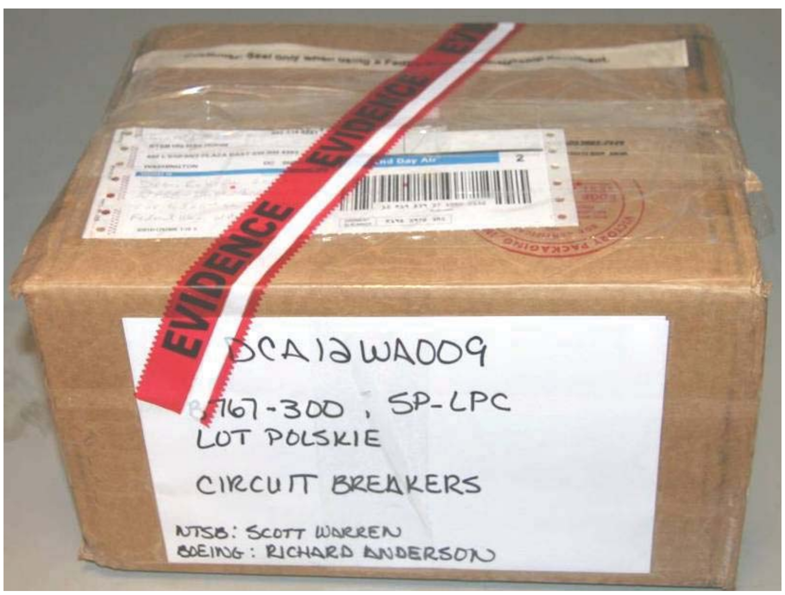


Figure 31 Box re-sealed and placed in secure area.

Prepared by *Signature on file* Concurrence *Signature on file*

QE: Joe Esposito
CC: Scott Warren, Craig Justus, Jay ONeal, Jeff Harrington,
Date: 09-January-12
Subject: 724D100-3 S/N 794 Test and Evaluation Report

1.0 Scope:

This document outlines the findings of the test and evaluation regarding:
Electric Actuator, Rotary, Alternate Landing Gear Assembly
Eaton Part Number: 724D100-3
Actuator Serial Number: 794
D. C. Motor 5122D100-3 S/N: 798

2.0 Incoming Visual Examination:

Upon arrival, actuator SN 794 was operational. Visual examination revealed that the unit was dirty and greasy. The MFD on the ID plate was 1-97. A review of unit history indicates that the actuator has never been returned to Eaton for repair or overhaul.

3.0 Test per ATP 724A103:

The unit was tested per ATP724A103. The unit passed all but two sections of the ATP.

Section 5.6.3 800 in-lb minimum stall torque in the clockwise direction at 23.0 VDC is below specification; observed results vary from 755-795 in-lbs.

Section 5.7 bonding resistance of .005 ohms maximum is above specification at .007 ohms.

4.0 Teardown and Evaluation:

For the purposes of this evaluation a teardown is not deemed necessary.

5.0 Conclusion

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.

ANNEX 4
to Final Report on investigation into accident to B767-300, SP-LPC

ANALYSES AND TESTS OF SELECTED CIRCUITS AND COMPONENTS OF SP-LPC ELECTRICAL SYSTEM

TABLE OF CONTENTS

1. <u>Description and analysis of C829 BAT BUS DISTR circuits</u>

Description

BAT BUS DISTR circuit breaker (C829) is located on P6-1 panel on A1 position (Fig.1). The rated current of this breaker is 25A. During normal work (STBY POWER switch on P5 panel in the AUTO position) buses of this circuit BATTERY BUS-PRIMARY and SECONDARY BUS are powered via contacts of K106 MAIN BAT XFR relay from L TRU (Transformer Rectifier Unit 115V AC/28V DC). If the switch is in the BAT position or in the AUTO position and the L TRU voltage drops the buses are powered via contacts of K104 MAIN BAT relay from the main battery (the main battery must be connected via BAT switch (P5 panel)).

C829 circuit breaker belongs to SECONDARY BUS circuits. The following circuits are powered via their own circuit breakers (located on P6-1 panel) from C829:

1. C749 2,5A (B7) CHILLER SHUTDOWN CONT
2. C804 7,5A (B1) L GEN CONT UNIT
3. C805 7,5A (B2) R GEN CONT UNIT
4. C806 7,5A (B3) APU CONT UNIT
5. C807 7,5A (B5) L GEN DRIVE DISC
6. C808 7,5A (B6) R GEN DRIVE DISC
7. C809 7,5A (B4) BUS PWR CONT UNIT
8. C828 2,5A (A5) STBY PWR CONT
9. C879 2,5A (A6) DC BUS TIE CONT
10. C906 5A (A7) HYD GEN CONT PWR
11. C1100 2,5A (C2) RAM AIR TURB-AUTO
12. C4097 2,5A (A4) BAT CUR MON PWR
13. **C4248 7,5A (F6) LANDING GEAR-ALTN EXT MOTOR**

Possible signaling and other symptoms

Each of the 13 aforementioned systems powered from BATTERY BUS-SECONDARY via C829 circuit breaker with a rated current of 25A, has its own independent circuit breaker with a rated current much smaller than C829.

During the flight or on the ground in the normal configuration of the aircraft, the only significant active consumer is BPCU protected by C809 (7,5A). The other systems are inactive or are protected by circuit breakers with the rated current of only 2,5A.

If there were problems with BPCU (internal, serious BPCU damage) it would be manifested as a strange uncontrolled switching of power supply systems of the airplane and also C803 circuit breaker would open. In the protection cascade 7,5A circuit breaker would switch off first but not 25A circuit breaker.

Other systems which potentially could have been activated were: alternate landing gear extension system, HMG and RAT. However, also in case of failure of one of these systems the first circuit breaker which would have opened would have been an individual protection breaker rather than C829 (25A).

The OFF setting of C829 circuit breaker does not generate any message or signal during flight and on the ground. The OFF setting of this circuit breaker would cause that a particular circuit, associated with this breaker would not operate.

After LO16 flight it was found that C829 BAT BUS DISTR circuit breaker on A1 position on P6-1 panel was in OFF setting.

Fig. 1. P6-1 panel. C829 BAT BUS DISTR on A1 position

1.1. Circuit 1 – CHILLER SHUTDOWN CONT

Description

The aircraft is equipped with a food cooling system in galleys - AIR CHILLER SYS. If there is smoke or fire in cargo compartments or Equipment Cooling (EQ) system the AIR CHILLER SYS could cause spreading of smoke or fire. Therefore, to prevent this the AIR CHILLER SYS is automatically switched off by CHILLER SHUTDOWN circuit.

The system is switched off automatically by K1285 CHILLER LATCH relay. The coil of the relay on one end is powered via (C829) BATTERY BUS-SECONDARY and C749 CHILLER SHUTDOWN CONT and on the other end (minus) of the coil is supplied from buttons arming fire extinguishing systems in the cargo compartments: S1 FORWARD CARGO FIRE and S2 AFT CARGO FIRE or smoke detection sensor of EQ system.

Possible signaling and symptoms

No signaling of malfunction is associated with this system. In the absence of power resulting from opening the circuit breaker, in the case of fire fighting in cargo compartments or smoke in EQ, AIR CHILLER would not turn off automatically.

1.2. Circuits 2, 3, 4 – L, R, APU GENERATOR CONTROL UNIT

Description

28V DC power from BATTERY BUS-SECONDARY (respectively C804, C805 and C806 circuit breakers) is BACKUP power supply for GCUs (Generator Control Unit). Each GCU protects and controls operation of one 115V 400Hz IDG (Integrated Drive Generator). All three GCUs are interchangeable.

The internal power supply of GCU is an autonomous device powered from permanent magnet generator (PMG) and during normal operation of the L, R, ENG/APU does not require an additional power supply from BATTERY BUS. External power supply for GCU is needed only for communication between GCU and BPCU when engines (generators) do not operate.

Possible signaling and other symptoms

Opening of C804, C805 and C806 circuit breakers is not signaled in any way and does not prevent the proper operation of a generator.

1.3. Circuits 5, 6 – L/R DRIVE DISC

Description

The system allows remote disconnection of IDG from L/R ENG driving gearbox. A solenoid installed inside the constant speed drive of IDG is a disconnecting element. The power from BATTERY BUS-SECONDARY (C829) is supplied respectively via C807 (L GEN) and C808 (R GEN) and further via 2-3 contacts of GEN DRIVE switch (when pressed), the A2-A3 contacts of K1293 relay (when fuel supply to engine is on) to DISCONECT SOLENOID IDG.

Possible signaling and other symptoms

Setting C829 or C807/C808 circuit breakers in OFF positions (and de-energizing of this system) does not produce any messages. OFF setting of one of the circuit breakers prevents manual disconnection of the respective IDG drive (the drive still can be disconnected automatically due to exceeding temperature of IDG oil). Disconnecting the IDG drive causes a drop in IDG oil pressure and illumination of DRIVE light on P5 panel.

1.4. Circuit 7 – BUS POWER CONT UNIT

Description

BPCU (BUS POWER CONTROL UNIT) controls AC network operation and communicates with GCUs. The unit has an internal memory which can record some occurrences related to malfunction of AC 115V 400Hz power supply.

The unit may be powered from one of the three sources: EXT PWR (ground power), BATTERY BUS-SECONDARY (C829) via C809 circuit breaker (main power) or via C803 circuit breaker (secondary power).

Possible signaling and other symptoms

Setting C809 BUS UNIT PWR CONT circuit breaker in OFF position due to an external cause does not interfere with the BPCU operation because the secondary power remains (via DC R BUS (C803)).

In this situation, there will be no indication of BPCU malfunction.

A short-circuit inside BPCU would cause opening of C809 and C803 circuit breakers and loss of control over AC networks.

1.5. Circuit 8 – STBY PWR CONT

Description

C828 circuit breaker is associated with the circuit controlling connection of STBY BUS. This circuit breaker supplies (plus) the coil of K109 STBY PWR relay from BATTERY BUS-SECONDARY. Ground to the relay coil is supplied from S1 STBY POWER switch located on P5 panel when the switch is in OFF position.

Therefore, the relay is active when STBY BUS is disconnected.

Possible signaling

During normal flight STBY PWR switch (P5) is set in AUTO position which means that K109 relay is in an inactive state. Therefore, de-energizing the circuit by opening the C828 and C829 circuit breakers does not affect the operation of the system and is not signaled. If there was a need to disconnect STBY BUS, the bus would not disconnect and the light STBY BUS OFF would not illuminate.

1.6. Circuit 9 – DC BUSTIE CONT

Description

C879 DC BUS TIE CONTR circuit breaker powers the circuit switching 28V DC networks. Under normal conditions, the voltage from BATTERY BUS-SECONDARY (C829) via C879 DC BUS TIE CONT is supplied to the contacts of switches S9 L BUS TIE and S10 R BUS TIE (on P5 panel) connected in series.

Under normal conditions the switches are in AUTO position, their contacts are closed and the voltage from C879 is supplied to the coil of K108 DC TIE RELAY.

Under normal conditions the negative circuit of this relay via K123 CTR BUS ISLN is connected to M10213 DC TIE CONTROL UNIT. This unit monitors the voltage on L DC BUS and R DC BUS supplied from L TRU and R TRU respectively.

In case of failure of one of the TRU, M10213 supplies ground to K108 relay and connects L DC BUS with R DC BUS which causes that both networks are powered.

Possible signaling and symptoms

During normal operation of L DC BUS and R DC BUS networks there are no symptoms or messages signaling opening of C879 circuit breaker. In the case of failure of one of the TRUs, L DC BUS would not connect with R DC BUS and one of the buses (with damaged TRU) would remain without power but EICAS would not display the message (page STATUS/MAINTENANCE) TR UNIT which should be displayed in such a situation.

1.7. Circuit 10 – HYD GEN CONT PWR

Description

This circuit supplies power to the system controlling start of HMG (HYDRO MOTOR-GENERATOR) in the absence of power at the left and right AC buses during flight.

The voltage from C829 circuit breaker via C906 circuit breaker and closed 10-11 AIR contacts of relay K148 is supplied to the two relays “sensing” the presence of voltage in the left and right AC buses (K859 R AC BUS and K858 L AC BUS - contacts closed in the absence of AC voltage), via M1230 TIME RELAY relay to OPEN coil of K860 HYD GEN CONT relay.

This relay via its B2-B1 contacts supplies power to V147 HYD MTR GEN SHUTOFF relay which opens fluid flow from C HYDRO to HMG. This circuit breaker also powers EICAS signaling of HMG operation.

Possible signaling and other symptoms

During a normal flight there would not be any messages or symptoms of OFF setting of the circuit breaker. In the case of power loss in the left and right AC buses HMG would not start operating.

1.8. Circuit 11 – RAM AIR TURB-AUTO

Description

This circuit (C1100 circuit breaker) supplies power for control of automatic deployment of RAT (RAM AIR TURBINE).

The voltage from BATTERY BUS-SECONDARY (C829) is supplied via C1100 circuit breaker, K213 (AIR/GND SYS 2) relay, S614 RAT AIR SPEED switch (speed>80kts), engine speed cards (speed <50%) to K235 RAT DEPLOY relay, which supplies power to RAT GEAR MOTOR in EXTEND circuit. On the ground this circuit breaker supplies power to the RAT retraction circuit.

Possible signaling or other symptoms

In a normal flight there are no symptoms or signaling associated with OFF setting of the circuit breaker. If the conditions for automatic deployment of RAT had occurred, RAT would not have deployed. Manual deployment of RAT would have been possible.

1.9. Circuit 12 - BAT CUR MONITOR PWR

Description

M10212 BAT CURRENT MONITOR monitors the charge current> 20A and discharge current> 6A of the M223 main battery. M10212 is powered via C4097 BAT CUR MON PWR from SECONDARY BAT BUS (C829 circuit breaker).

If the main battery powers STBY buses (STBY POWER switch in BAT position), or when the switch is in AUTO position and TRU (Transformer Rectifier Unit) is faulty, MN BAT DISCH message is generated on EICAS and BAT DISCH on P5 panel illuminates.

BAT CUR MONITOR also monitors the main battery charging current in the cycle “constant current-constant voltage”. In the case of irregularities in the charging cycle MN BAT CHGR message is displayed on EICAS.

Possible signaling and other symptoms

During normal operation (STBY POWER switch in AUTO position) there is no indication of the system malfunction. If STBY POWER switch is in BAT or AUTO position, in the case of TRU failure there would not be MN BAT DISCH message on EICAS and BAT DISCH light would not illuminate. If the battery charge cycle had been disturbed MN BAT CHGR message would not be produced.

1.10. Circuit 13 – LANDING GEAR-ALT EXT MOTOR

Description

Alternate extension of the landing gear is effected by DC 28V electric motor (operation towards EXT), which drives the mechanical system releasing NOSE, L and R GEAR locks.

After setting S605 LDG GR ALTN SEL (on P3-1) in ALTN position the electric power via C4248 circuit breaker and S607 LDG GR ALT EXT LIMIT switch is supplied to the electric motor which rotates in EXT direction.

After completing movement the S607 limit switch contacts move to EXT position, the power supply circuit opens and the motor stops.

Return to the initial state starts after setting S605 switch in OFF position. Then the motor is powered from L DC BUS via C1177 circuit breaker and closed COM-NC contacts of the S606 limit switch (NOT RETR state) and the mechanism returns to the initial state. After reaching the initial state NOT RETR contacts open and the motor is de-energized.

Possible signaling and other symptoms

The alternate landing gear extension system is not connected to any signaling system and its de-energizing due to OFF setting of C4248 (F6) or C829 (A1) circuit breakers is not signaled. OFF setting of one of these circuit breakers prevents alternate extension of the landing gear.

2. <u>Measurements and checks of selected B767-300 aircraft circuits</u>

On 3 November 2011, BOEING B767-300 airplane, registration marks: SP-LPB (the same type as SP-LPC) was lifted in LOT AMS hangar. The configuration of the aircraft was prepared for functional test of the alternate landing gear extension system. Several tests were carried out to determine the impact of C829 circuit breaker on operation of the landing gear extension system.

Fig. 2. Test of landing gear extension, C829 (A1) in OFF setting

Note 1

The tests of the alternate landing gear extension system on SP-LPB airplane in the absence of pressure in "C" hydraulic system were carried out in two settings of C829 BAT BUS DISTR circuit breaker:

- *When C829 circuit breaker was in ON setting (pushed) – moving ALT GEAR EXTEND switch into DN position caused extension of the landing gear;*
- *When C829 circuit breaker was in OFF setting (pulled out) – moving ALT GEAR EXTEND switch into DN position did not cause extension of the landing gear.*

After functional tests the visibility of P-6 panel was verified while seated normally in the FO seat. The first observation was made without a briefcase in the cockpit, the second one with a briefcase placed close to P6-1 panel.

Fig. 3. View from FO seat on P6 panel (no briefcase)

Fig. 4. View from FO seat on P6 panel (briefcase present)

Note 2

It was found that while seated normally in the FO seat, the observation of C829 (A1) circuit breaker was very difficult if any briefcase was placed close to P-6 panel.

On November 16, 2011, in accordance with the SCAAI guidelines, measurements and testing according to LOTAMS NON-ROUTINE/COMPLAINT CARD (NRC) No. C00143359 (Appendix 2) were carried out on SP-LPC airplane.

1. During the test of alternate landing gear extension TASK CARD B767 32-021-01 (Boeing) the current of electric motor driving the system was recorded (NRC step 1). The recorded current waveform is shown in Figure 5.

2. The value of the operating current was within limits and was 2A, and the value of the starting current was 14A. According to CMM EATON S257T400-1 (-3) 32-35-01 at a normal load the operating current should not exceed 5A, and the starting current should not exceed 10 x operating current i.e. 20A for the investigated case.

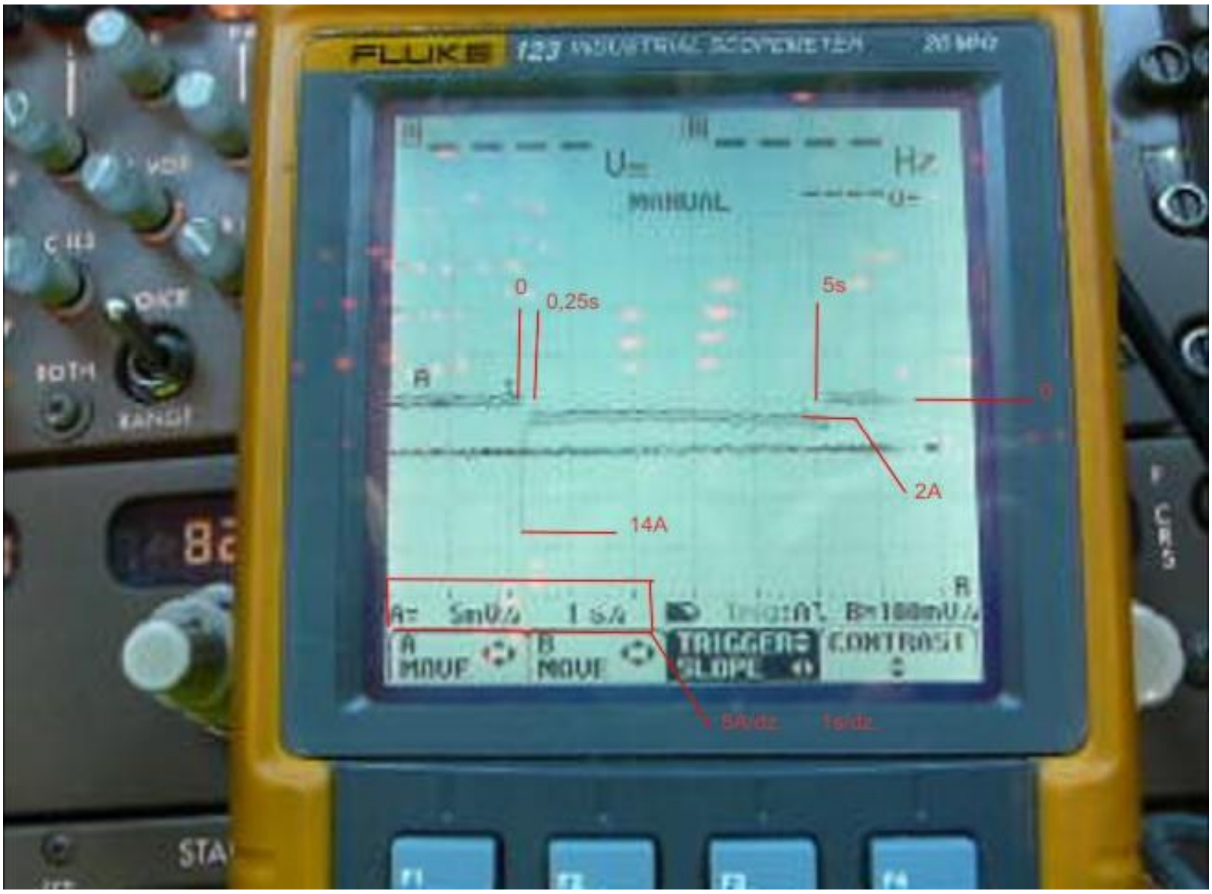


Fig. 5. Recorded waveform of the current of the alternate landing gear extension motor

Fig. 6. Connecting of a clamp ammeter probe to the circuit of the C4248 circuit breaker

3. Examination of inside of P6-1 panel was carried out, in particular the area of the wiring harness connected with the above circuit breakers: W1040-009, -010, -044, -047 (NRC step 2). No irregularities or foreign objects were found.

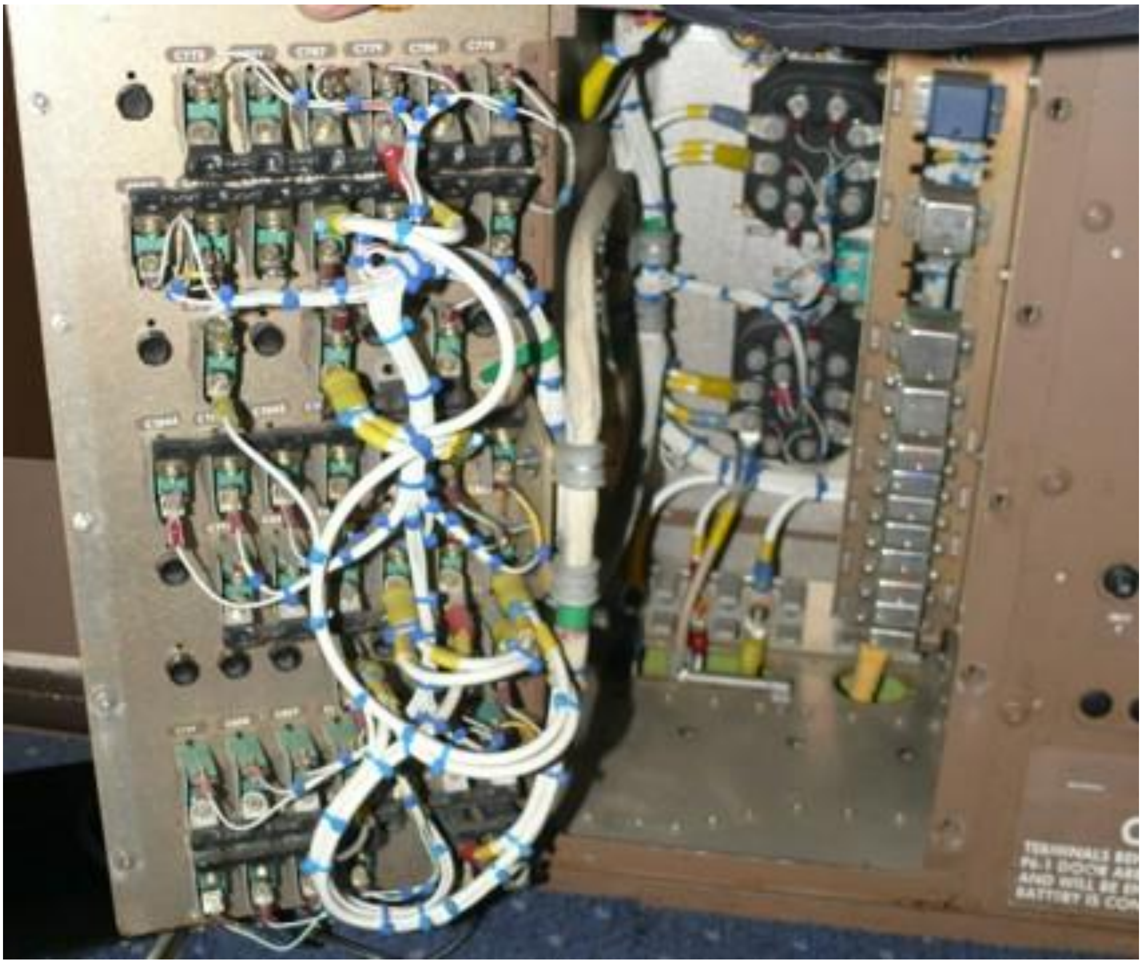


Fig. 7. View of the inner side of P6-1 panel

4. Resistance of the power supply circuit (positive) of M1104 electric motor from C4248 circuit breaker to D10228 connector was measured (NRC step 3/1-4). The measured resistance value was 0,24Ω and was correct.

5. Resistance of the power supply circuit (negative) of the electric motor (NRC step 3/6 - D10228 connector, contacts 1 and 7 was measured. The measured resistance values were less than 0,01Ω and were correct.

6. Resistance of insulation of the power supply circuit (positive) of M1104 electric motor (to the airplane ground) was measured, (NRC step 3/6). The measured value was 7,56GΩ and was correct.

7. Resistance of insulation of : C829, C749, C804, C805, C807, C808, C809, C828, C879, C906, C1100, C4097, C4248 circuit breakers circuit was measured, (NRC step 3/7-9). The measured value of the resistance was 6,4 GΩ and was correct.

8. It was checked whether OFF setting of C829 circuit breaker gives any noticeable symptoms when switching off electrical power. It was found that when C829 circuit breaker is in OFF setting, disconnecting of STBY buses (normal procedure when switching off the power) does not cause the STBY BUS OFF light to illuminate.

9. C829 (p/n BACC18X25) and C4248 (p/n BACC18Z7R) circuit breakers were removed from the airplane for workshop measurements in LOTAMS.

In accordance with SCAAI recommendations LOTAMS carried out the following workshop tests of C829 and C4248 circuit breakers (on November 16, 2011):

a) X-ray examination of C829 and C4248 circuit breakers removed from the aircraft "Technical Opinion No. 1353/TTWN/RT/11" (Appendix 3);
b) Tests of C829 circuit breaker, WO No. TWPA/767/0963/11/R00, (Appendix 4);
c) Tests of C4248 circuit breaker, WO No. TWPA/767/0964/R00, (Appendix 5).

Workshop tests were carried out to check whether:

- it was possible that the increase in current, in the case of overload in the system of alternate landing gear extension, caused OFF setting of C829 (25A) circuit breaker and at the same time did not caused OFF setting of C4248 (7,5A) circuit breaker;
- it was possible automatic turn off of C829 circuit breaker.

For this purpose X-ray examination of the circuit breaker was done and its pull-out force was measured. X-ray picture (Fig. 8) showed no internal damage to the circuit breaker, and in particular to the latch holding the breaker in ON position.

Average pull-out force (OFF setting force) was 1,5 kG and was within the specified limits (according to the applicable documentation: 0,61-5,44 kG). The current of 28,5A during 1 hour did not cause OFF setting of the breaker, while with the current of 50A (200% of the rated current) the trip time was 25 seconds (according to the documentation 15-55s). These and others parameters were within the limits specified in the applicable documentation (BOEING BPS BACC18X, BPS-C-144) and C829 circuit breaker should be regarded as operational.

Average pull-out force (OFF setting force) of C4248 circuit breaker was 2,6 kG and was within the specified limits (according to the applicable documentation: 0,61-5,44 kG). The current of 8,63A during 1 hour did not cause OFF setting of the breaker, while with the current of 15A (200% of the rated current) the trip time was 14,5 seconds (according to the documentation 15-55s). These and other parameters were within the limits specified in the applicable documentation and the C4248 circuit breaker should be regarded as operational.

It should be noted that the button of C829 circuit breaker showed many traces of scratches and abrasions (Fig. 9 and Fig. 10).

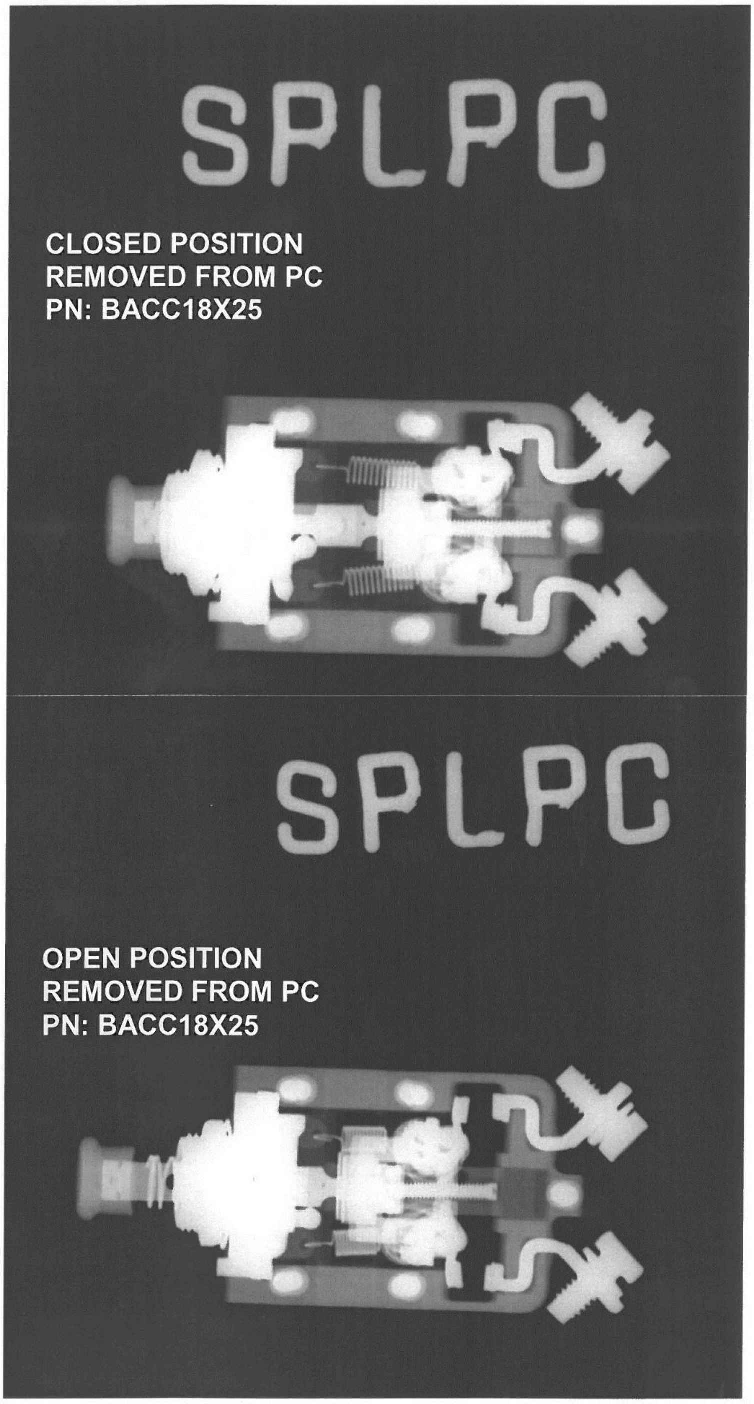


Fig. 8. X-ray picture of C829 circuit breaker

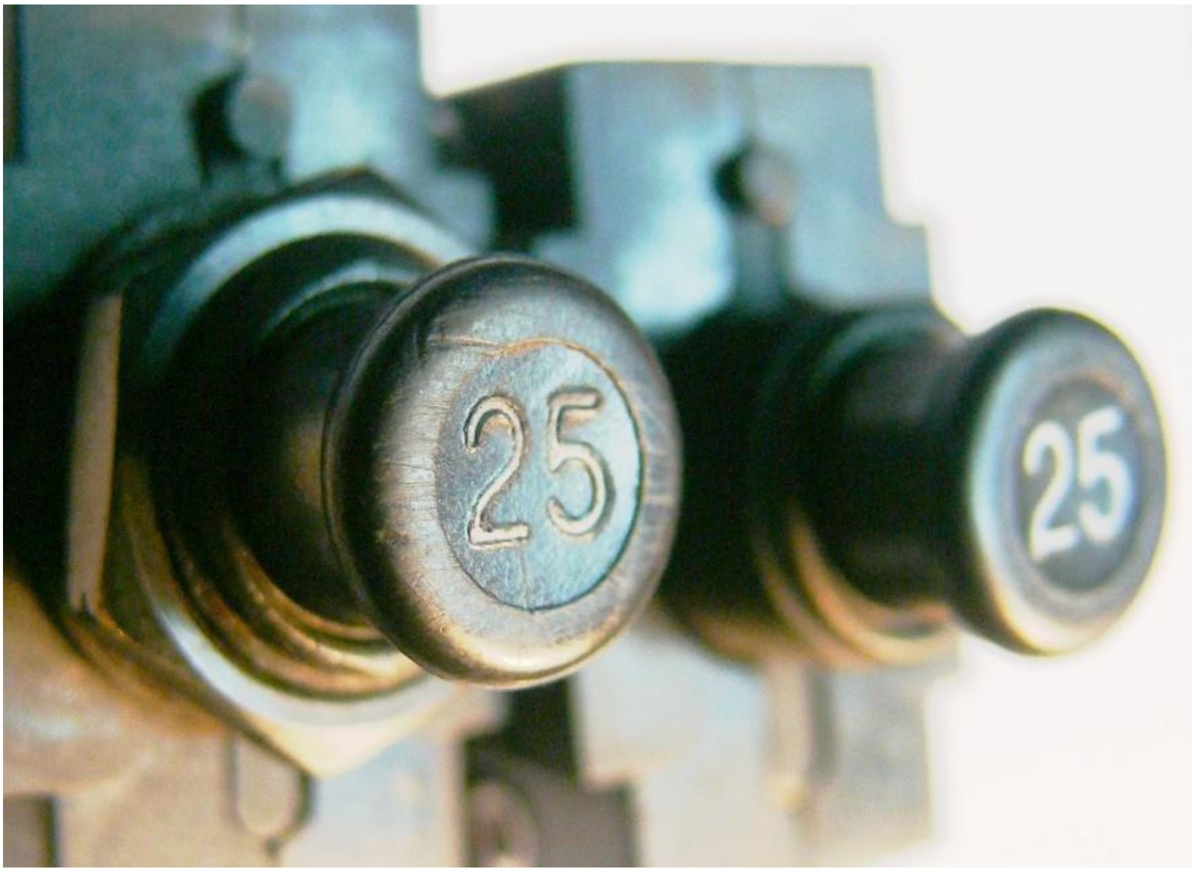


Fig. 9. Buttons of C829 circuit breakers (left – from SP-LPC, right – a new one)

Fig. 10. Button of C829 circuit breaker from SP-LPC airplane

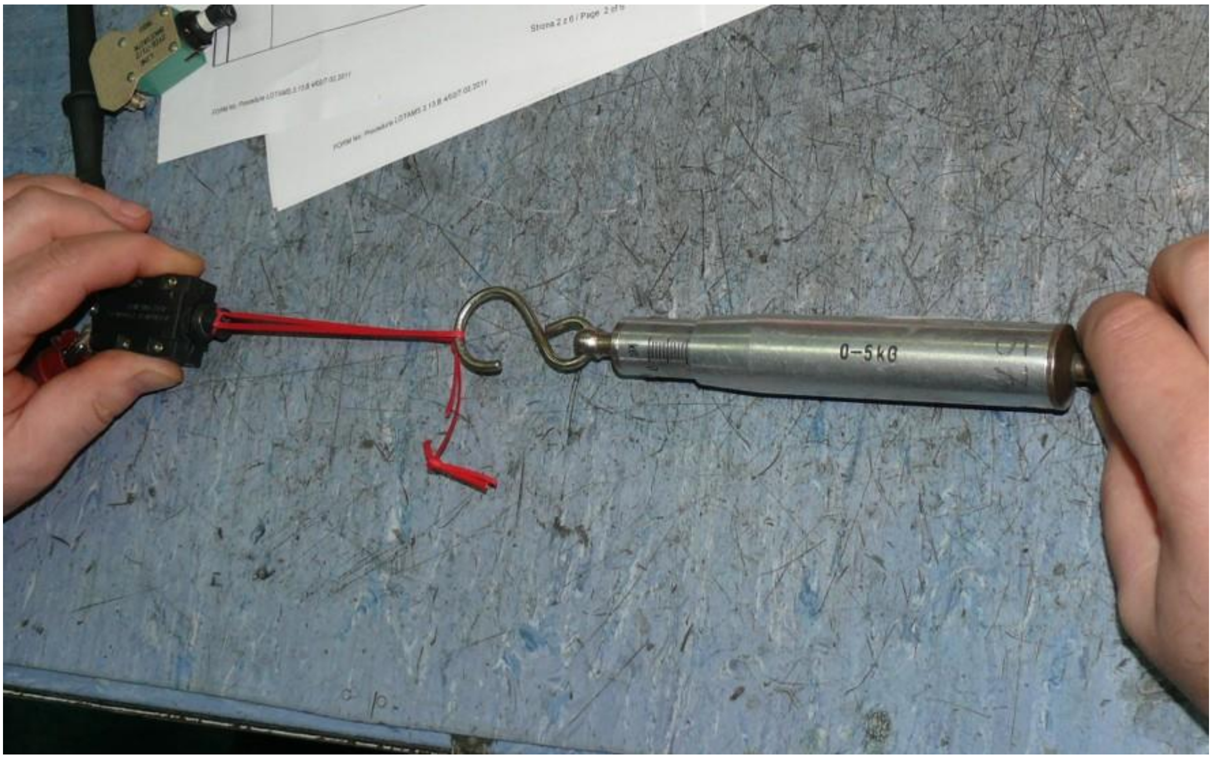


Fig. 11. Measurement of pull-out force (OFF setting force) of C829 circuit breaker

Fig. 12. Measurement of insulation resistance of C829 circuit breaker

Fig. 13. Measurements of currents of C829 circuit breaker

Fig. 14. Measurement of dielectric leakage current of C829 circuit breaker

3. Analysis of operation of the systems protected by BATTERY BUS-SECONDARY (C829) during landing phase and related research

State of the 13 systems (circuits) protected by BATTERY BUS-SECONDARY (C829) was inactive or did not change during the flight, touchdown and landing roll, so the systems did not cause overloading of the power supply circuits. As the airplane landed with the landing gear up, its configuration AIR/GND remained as AIR. In such a configuration, conditions for activation of RAM AIR TURBO-AUTO and HMG systems could possibly exist.

3.1. RAT operation

RAT activates automatically in the AIR configuration if the RPMs of both engines are below 50% and the aircraft speed is above 80 kts. At 13:38:42 hrs (Fig. 15) the engine fuel cut-off valves (LEFCUT, REFCUT) were activated and one second later (the FDR recording ended at 13:38:43) the engines speeds were: L_ENG 67.8%, R_ENG 72% and the aircraft speed was 88 kts.

It should be noted that the aircraft was in the AIR configuration and flaps at the position 30, which means that the idle speed of the engines (FLT IDLE) was approximately 10% higher than GND IDL. The decrease in the engine speed is approximately 0,6-5,0 %/s depending on the engine, aerodynamic conditions and time. During the examined period decrease in the aircraft speed was about 3 kts/s, so the time needed to reach the airspeed of 80 kts was 2,7 s. Assuming that the decrease in the engines speed in the initial phase was approximately 5,0%/s (more adverse), then after 2,7 s, speeds of the engines would have been respectively: L_ENG 54,3%, R_ENG 58,5% (a decrease of 13,5%), which was still more than 50% when the aircraft speed was 80 kts.

It means that the conditions for automatic activation of RAT and loading of circuit of C1100 circuit breaker did not occur.

3.2. HMG operation

HMG activates automatically in the AIR configuration when loss of power 115V (in the left and the right network) occurs. Such a situation occurred at 13:38:43 hrs, i.e. after shutdown of the engines and the generators (IDG). It may be assumed that after shutdown of the generators the main battery was active for at least 2s, so there were conditions for opening the HMG VALVE and loading of C906 supply circuit.

(However, HMG was not activated because C HYD SYS was out of order).

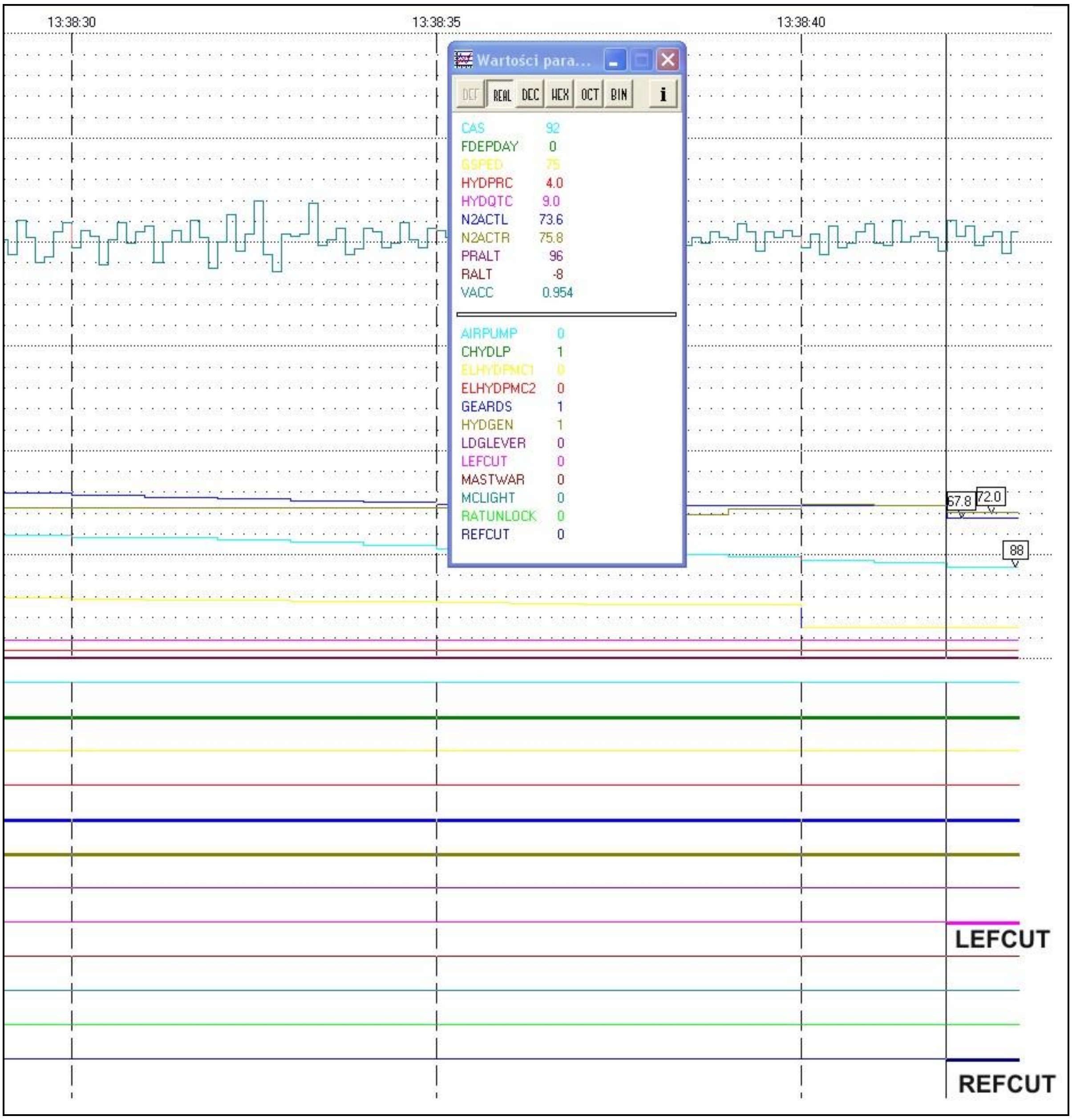


Fig. 15. Image of the end of FDR recording

3.3. HMG VALVE check

On December 13, 2011 a functional check of the HMG VALVE and measurements of the valve current were carried out on SP-LPC airplane. The tests were carried out with the use of the test function (TEST HMG switch on P61). After setting the switch in the TEST position the valve opened and communicated that fact by EICAS message HYD GEN VAL (Fig. 16). The valve motor current was 0,63 A, which was much lower than the rated current of C906 individual circuit breaker (2,5 A). After releasing the test switch the valve started to close and the current was also 0,63 A.

Fig. 16. HYD GEN VAL message on EICAS

3.4. Circuit breakers check

Additionally, a functional test of the other 12 individual circuit breakers protected by C829 was carried out. (C4248 (F6) circuit breaker LANDING GEAR-ALTN EXT MOTOR was checked in a workshop earlier).

The test consisted in measurement of the trip time of the circuit breakers after application of the loading current equal to 200% of the rated current. The results are given below:

1. C749 2,5A (B7) CHILLER SHUTDOWN CONT - 12s
2. C804 7,5A (B1) L GEN CONT UNIT - 13s
3. C805 7,5A (B2) R GEN CONT UNIT - 12s
4. C806 7,5A (B3) APU CONT UNIT - 12s
5. C807 7,5A (B5) L GEN DRIVE DISC - 13s
6. C808 7,5A (B6) R GEN DRIVE DISC - 13s
7. C809 7,5A (B4) BUS PWR CONT UNIT - 14s
8. C828 2,5A (A5) STBY PWR CONT - 11s
9. C879 2,5A (A6) DC BUS TIE CONT - 13s
10. C906 5A (A7) HYD GEN CONT PWR - 14s
11. C1100 2,5A (C2) RAM AIR TURB-AUTO - 19s
12. C4097 2,5A (A4) BAT CUR MON PWR - 13s

The measurements results were consistent with the requirements from BPS BACC18X, BPC-C-144 (taking into account permissible errors). NRC LOTAMS task card No. C0014359 agreed with SCAAI (Appendix 1).


Fig. 17. Test set for measurement of the trip time of the circuit breakers

3.5. BPCU/GCU read out

BPCU/GCU memories were read out. The recording of flight No 00 (the flight that followed the takeoff from EWR) except messages that were irrelevant to the investigated occurrence, contained the messages "SERIAL DATA LINK FAILED" related to the left and right GCU (GENERATOR CONTROL UNIT). Such a message indicates malfunction of the BPCU/GCU interface during operation of a generator (FIM B767 24-20-00 page 180L, 142, 143, 148 and 149). APU GCU recording contained the message "SYSTEM OK".
In the previous flights (01-03, 01 is the flight WAW-EWR on 31 October 2011) for all three power systems (L, R IDG, GEN APU the displayed status was "SYSTEM OK" (Fig. 18).

Fig. 18. BPCU display images

Time and circumstances of “R/L SERIAL DATA LINK FAILED” message generation

Each GCU is equipped with an internal power supply, which is a stand-alone device powered from a generator exciter (PMG). During normal operation of L, R, ENG/APU no additional power from BATTERY BUS -SECONDARY (C804/C805-C829) is required. This power supply is able to maintain the required power also in case of decrease in generator revolution, after engine shutdown and during a large range of its rundown.

BPCU is powered by 28V DC via R-BUS (C803) or BATTERY BUS - SECONDARY (C809-C829). In normal configuration of the aircraft, after engines shutdown, BPCU and GCU are powered at least from BATTERY BUS-SECONDARY and „SERIAL DATA LINK" preserves correctness of operation.

In the investigated case C829 circuit breaker was switched off, which discontinued power supply from BATTERY BUS-SECONDARY to BPCU and GCU. As long as the engines were working AC generators powered their networks (from TRU, 28V DC R-BUS) and there were no abnormalities in GCU-BPCU communication. GCU was powered from the internal power supply and BPCU from 28V DC R BUS. Upon shutdown of the engines the networks were disconnected from the generators and BPCU completely lost power supply which caused the loss of „SERIAL DATA LINK". At this time GCU was still powered by the internal power supply and still operated, but lost „SERIAL DATA LINK" with BPCU because BPCU had not been powered. As a result, GCU generated the message "SERIAL DATA LINK FAILED".

Based on the above analysis, it may be concluded that at the time of engines shutdown C829 circuit breaker was already OFF.

4. Conclusions

The analysis, tests and measurements on the airplane, workshop tests and measurements (on November 13, 2011 and December 13, 2011) did not reveal any indications that C829 circuit breaker was switched off due to any malfunction of the examined systems and components. Numerous signs of damage to the button of C829 circuit breaker and its location may prove that the luggage (bags, suitcases, etc.) placed in the cockpit or cleaning services actions repeatedly affected the circuit breaker in the past.

At the time of engines shutdown C829 circuit breaker had already been in OFF setting.

767 Operations Manual

Do the remaining actions after a crew change or maintenance action.

Maintenance documents .... Check

FLIGHT DECK ACCESS SYSTEM switch .... Guard closed

FLIGHT RECORDER switch .... NORM

SERVICE INTERPHONE switch .... OFF

RESERVE BRAKES and STEERING
RESET/DISABLE switch .... Guard closed

Verify that the ISLN light is extinguished.

Circuit breakers .... Check

Emergency equipment .... Check

Fig. 19. Part of Boeing 767 Operation Manual related to the check of the circuit breakers.

5. Appendices

Appendix 1

LOT AMS

WP identification No :	C0014359

Item :		A/C type :	A/C registration
F40	NON-ROUTINE / COMPLAINT CARD	767	SP-LPC

Non Routine List No:	Discrepancy No :
02	053230

Step	Work Description	Ordered by (sign, ID, date)	Performed by (sign, ID, date)
7	. MEASURE THE HYD MTR GEN SHUTOFF VALVE CURRENT (1) Make sure that BAT. BUS DISTR CB C829 is installed (see Item 4 (1)). (2) Open the P6-1 CB panel and connect clamp ammeter probe to the W070-02F-22 wire (CB C906). WDM 24-25-11. (3) Push the HYD GEN test switch at the P61 panel. (4) Measure and record the W070-02F-22 current value. *Write down result:* 0,63 *(A)*	12 Dec. 11 LOT AMS PL.145.003	LOT AMS PL.145.003 13DEC11
8.	(1) Install BPCU P/N 734285E S/N **1895** AMM 24-41-03 p 401. (2) Perform BPCU BITE AMM 24-20-00.	12 Dec. 11 LOT AMS PL.145.003	LOT AMS PL.145.003 13DEC11
9.	MEASURE THE TRIP TIME OF CIRCUITS BREAKERS CONNECTED TO THE CB C829 AT P6-1 PANEL (1) Remove electrical power AMM 24-22-00/201. (2) Open the BAT. BUS DISTR CB C829. (3) Disconnect the output wires from CBs listed in Table 1. WDM 24-54-71 (4) Adjust the power supply to 200 % current value set in Table 1. (5) Connect power supply to each CB, measure and record the trip time. (6) Connect wires disconnected in item (2). (7) Close the BAT. BUS DISTR CB C829.	12 Dec. 11 LOT AMS PL.145.003	LOT AMS PL.145.003 13DEC11

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Form No: MOE LOTAMS 2.13A/12/08.08.2002

LOT AMS	WP identification No : C0014359		
Item : F40	NON-ROUTINE / COMPLAINT CARD	A/C type : 767	A/C registration SP-LPC

Table 1

CB description	Diagram No.	Position	BREAKER RATING (AMPS)	200 % RATED CURRENT (AMPS)	TRIP TIME (SEC)
HYD GEN CONT PWR	C906	A7	5	10	14
DC BUS TIE CONT	C879	A6	2,5	5	13
STBY PWR CONT	C828	A5	2,5	5	11
BAT. CUR. MON PWR	C4097	A4	2,5	5	13
LEFT GEN CONT UNIT	C804	B1	7,5	15	13
RIGHT GEN CONT UNIT	C805	B2	7,5	15	12
APU GEN CONT UNIT	C806	B3	7,5	15	12
BUS POWER CONT UNIT	C809	B4	7,5	15	14
L GEN DRIVE DISC.	C807	B5	7,5	15	13
R GEN DRIVE DISC.	C808	B6	7,5	15	13
CHILLER SHT DN CONT	C749	B7	2	4	12
RAM AIR TURBINE AUTOMATIC CONTROL	C1100	C2	2,5	5	19

List of used calibrated tools	
Tool description	S/N
MULTIMETER FLUKE 87	0430-09-8441/001
STOP WATCH	E230
CLAMP AMMETER PROBE H256	0430-09-3441/001

TEST PERFORMED IN OAT = 5°C

LOTAMS PL.145.0002 Leszek Malinowski ID 800229 Licence PL.66.1341

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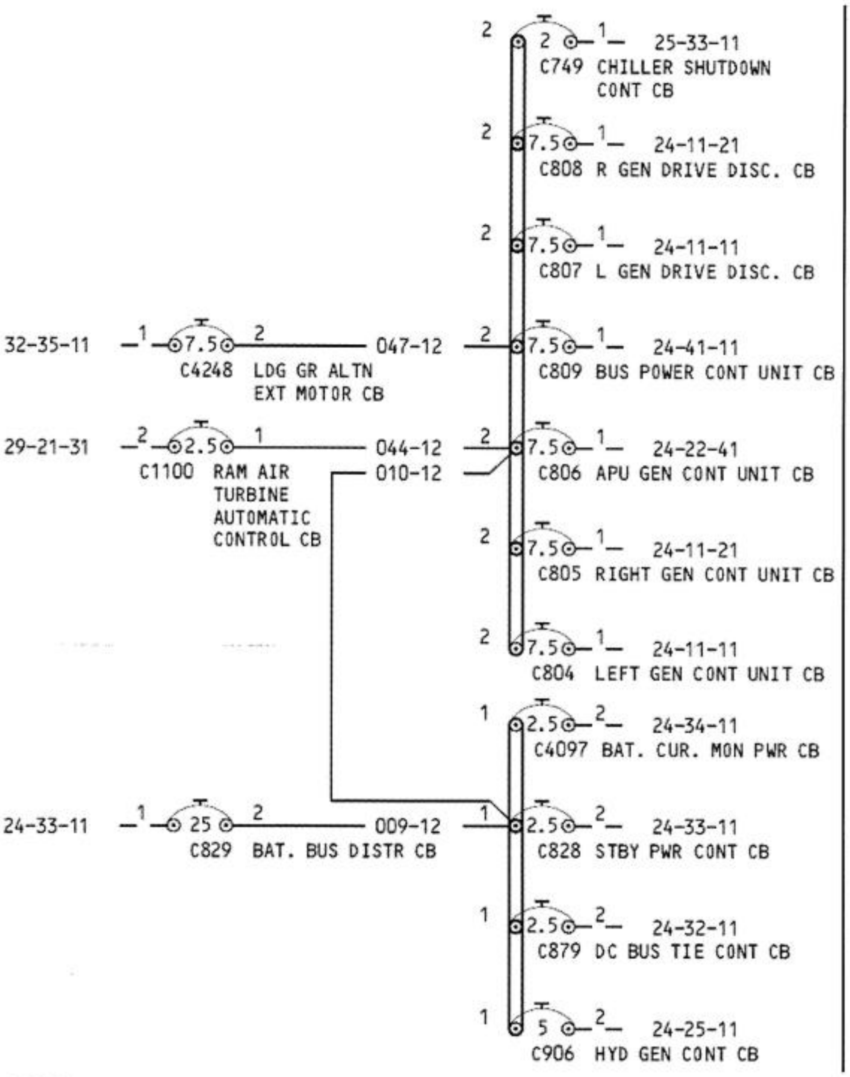
Form No: MOE LOTAMS 2.13A/12/08.08.2002



24-54-71
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Jul 01/2005

Appendix 2

LOT AMS		WP identification No : C00114359	
Item : F40	NON-ROUTINE / COMPLAINT CARD	A/C type : 767	A/C registration SP-LPC

Non Routine List No:	Discrepancy No :
02	0053230

Action details

Step	Work Description	Ordered by (sign, ID, date)	Performed by (sign, ID, date)
1.	Perform MAIN/NOSE ALTERNATE EXTEND SYSTEM TEST Task Card B 767 32-021-01 Note: Before the test: (1) Open the P6-1 CB panel and connect clamp ammeter probe to the W028-013 wire (CB C4248) During the test: (1) Measure and record the W028-013 current value.	LOT AMS PL.145.003 Mirosław Sadowski ID 60840565 Lic.No PL66.4253 16.11.11	LOT AMS PL.145.003 ID 60830864 Lic.No PL66.8250 16.11.2011
2.	**P6-1 panel wiring inspection.** References: WDM 24-54-71 page 3 (1) Remove electrical power (AMM 24-22-00/201). (2) Open the P6-1 CB panel. (3) Perform detail visual inspection for any damage to wiring or behind any of the breakers. Particular interest are the in yellow (specifically ones labelled W1040-009, -010, -044, and –047).	LOT AMS PL.145.003 Mirosław Sadowski ID 60840565 Lic.No PL66.4253 16.11.11	LOT AMS PL.145.003 ID 60830270 Lic.No PL66.1341 16.11.2011

Form No: MOE LOTAMS 2.13A/12/08.08.2002 page 1 Of 15

LOT AMS	WP identification No : C00014 359		
Item : F40	**NON-ROUTINE / COMPLAINT CARD**	A/C type : 767	A/C registration SP-LPC

3.	**Landing gear alternate extend actuator wiring check.** References: WDM 32-35-11 page 1. (1) Disconnect W028-013 wire terminal from the C4248 CB. (2) Disconnect connector D10228 from the alternate extend actuator. (3) Move the ALT N GEAR EXTENSION switch, on the panel P3, to the DN position. (4) Check the W028-013 wire continuity from CB terminal to connector D10228 pin 5. *Write down result:* 0,24 Ω (5) Perform W028-013 wire insulation test. *Write down result:* 7,56 GΩ (6) Check the connector D10228 pins 1 and 7 resistance to GND *Write down result, pin 1:* 0,01 <Ω *pin 7:* 0,01 <Ω (7) Open following CBs: 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), C 829 (A1) (8) Perform wire 010 (connected to the C829 CB output) insulation test. *Write down result:* 6,4 GΩ (9) Close CBs opened in item (7). (10) Connect W028-013 wire terminal to the C4248 CB. (11) Connect connector D10228 to the alternate extend actuator. (12) Move the ALT N GEAR EXTENSION switch, on the panel P3, to the OFF position	LOT AMS PL.145.003 Mirosław Sadowski ID. 80640565 Lic. No. PL.66.4253 16.11.11	LOT AMS PL.145.003 Mirosław Sadowski ID. 80640565 Lic. No. PL.66.4253 16.11.11

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LOT AMS

		WP identification No :	C0014359
Item : F40	NON-ROUTINE / COMPLAINT CARD	A/C type : 767	A/C registration SP-LPC

4.	(1) Replace the BAT. BUS DISTR CB C829 (SWPM 20-30-00 page 22) (2) Replace the LDG GR ALT EXT MOTOR CB C4248 (SWPM 20-30-00 page 22 (3) Close the P6-1 CB panel. **Note: The removed CBs have to be transfer for further examination.**	LOT AMS PL.145.003 Mirosław Sadowski ID. 60840565 Lic.no.PL66.4253 16.11.11	CB C829 & C4248 REMOVED LOT AMS PL.145.003 Mirosław Sadowski ID. 60840565 Lic.no.PL66.4253 16.11.11
5.	Remove the LANDING GEAR ALTERNATE EXTEND ACTUATOR (AMM 32-35-12 p.401) **Note: The removed ACTUATOR have to be transfer for further examination**	LOT AMS PL.145.003 Mirosław Sadowski ID. 60840565 Lic.no.PL66.4253 16.11.11	
6.	Install the LANDING GEAR ALTERNATE EXTEND ACTUATOR (AMM 32-35-12 p.401)	LOT AMS PL.145.003 Mirosław Sadowski ID. 60840565 Lic.no.PL66.4253 16.11.11	

Form No: MOE LOTAMS 2.13A/12/08.08.2002

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LOT AIRCRAFT MAINTENANCE SERVICES SP. z o.o.
Służba Obsługi Warsztatowej
Sekcja Pomiarów i NDT
00-906 Warszawa ul. 17 stycznia 45c

POLISH AIRLINES NDT LAB.
PART-145 APPROVAL CERTIFICATE

Orzeczenie Techniczne Nr – Inspection Report No: 1353 / TTWN/RT/11

Appendix 3

I. Data Wykonania Badania(dd-mm-rr) – Date of inspection: 16-11-2011

II. Rodzaj Przeglądu – Check No: Spec

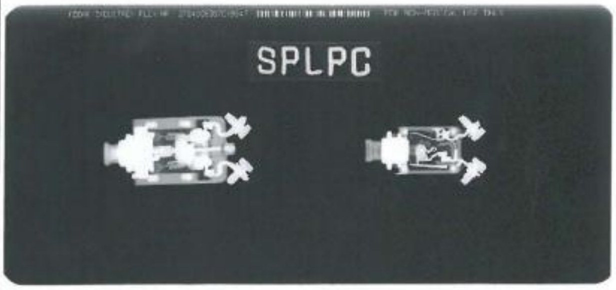
III. Podstawa Badań - Ref. Documentation: WO No. C0014359

IV. Dane Samolotu – Aircraft Data:		**V. Dane Silnika – Engine Data:**	
1. Samolot – Aircraft:	**SP-LPC**	1. Typ s-ka – Engine type:	------------------------------
2. Nr fabryczny – S/N:	28656	2. Pozycja – Position:	------------------------------
3. Nalot – Flt. hrs.:	65379 h	3. Nr fabryczny – S/N:	------------------------------
		4. Nalot – Flt. hrs:	---------- h

VI. Badany Rejon – Inspected Area:
25A fuse P/N: BACC18X25 and 7A fuse P/N: BACC18Z7R Removed from SP-LPC

VII. Metoda i Aparatura – Method and equipment:
Metoda: X – RAY INSPECTION.
Aparatura: Balteau SN: 4801812 calibrated on 25.05.2011, Scaner CR VMI 5100MS SN: 1091-3383
Badanie zgodne z – Carried out on: Part 2 - B767 NDT Manual No. D6347301 Aug 15/2011 Rev.99

VIII. Wyniki Badań – Results of inspection:



IX. Badanie Wykonali – Inspected by:	**Nr Lic. – Lic. No**	**Podpis – Signature**
1. Adam Talaga	LK – 12	NDT STAFF Adam Talaga ID 60730321 Lic. TK LK-12
2. Andrzej Szewc	LK – 26	NDT STAFF Andrzej Szewc ID 60030091 Lic. TK/LK-26

Zatwierdził - Approved by:
Główny Specjalista
Kierujący Jednostką Organizacyjną
Piotr Gajowiak
Data/Podpis - Date/Signature 18.11.2011

Rozdzielnik – Distribute:
TTWN, TZQ, TTC, TZQR,
PKBWL

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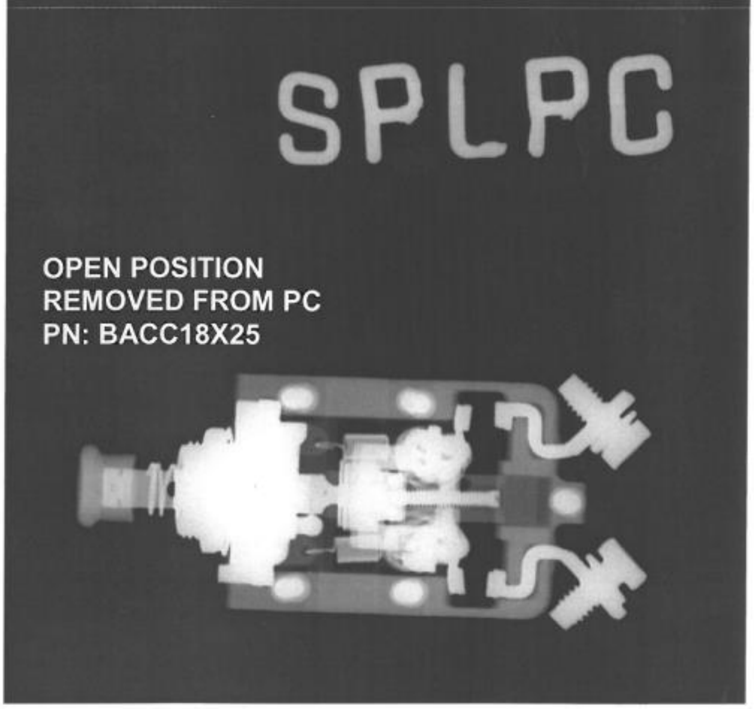

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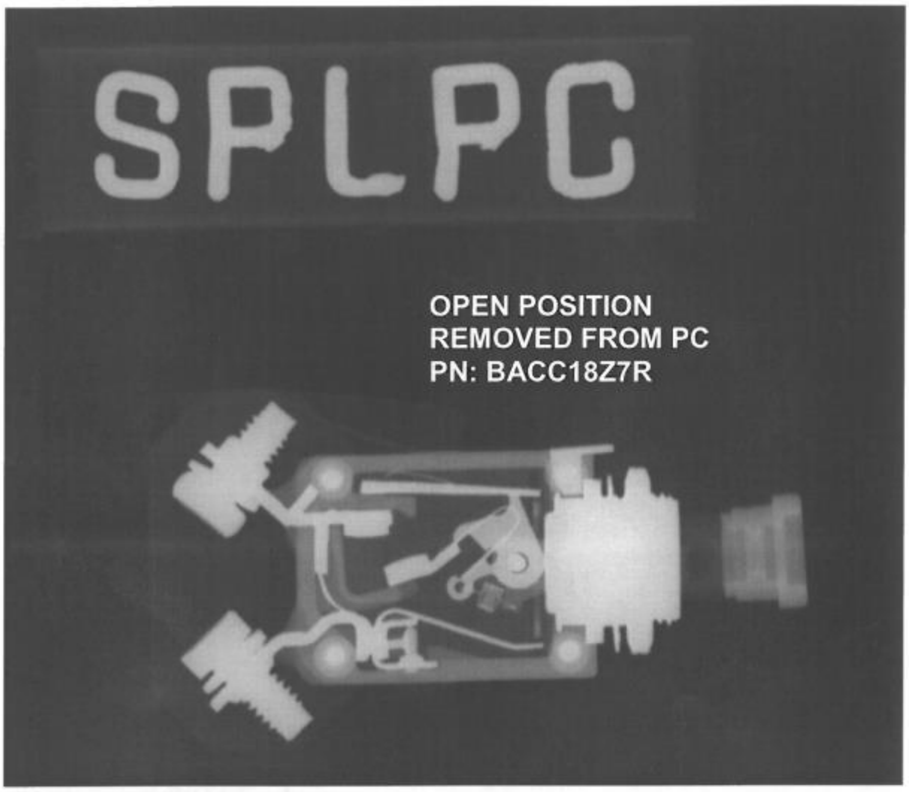

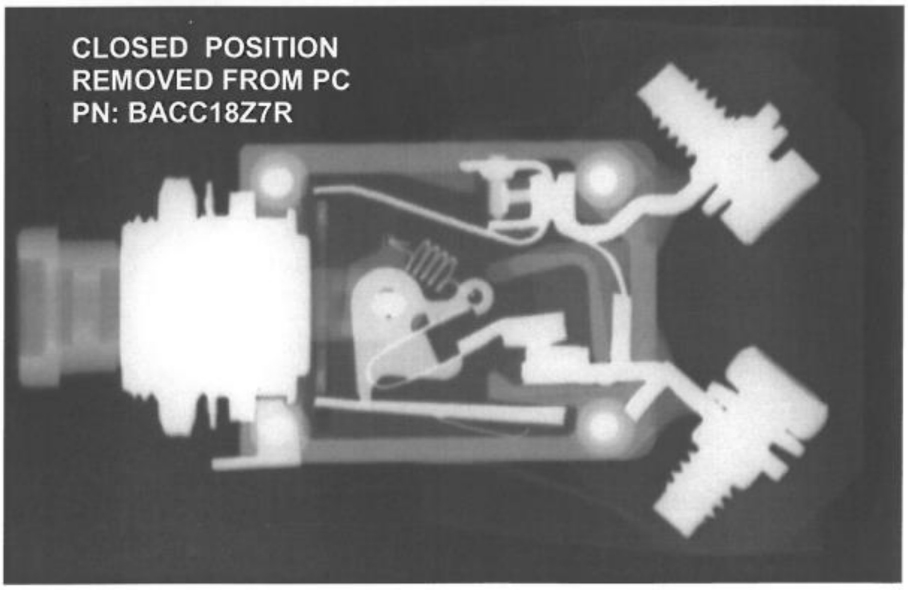

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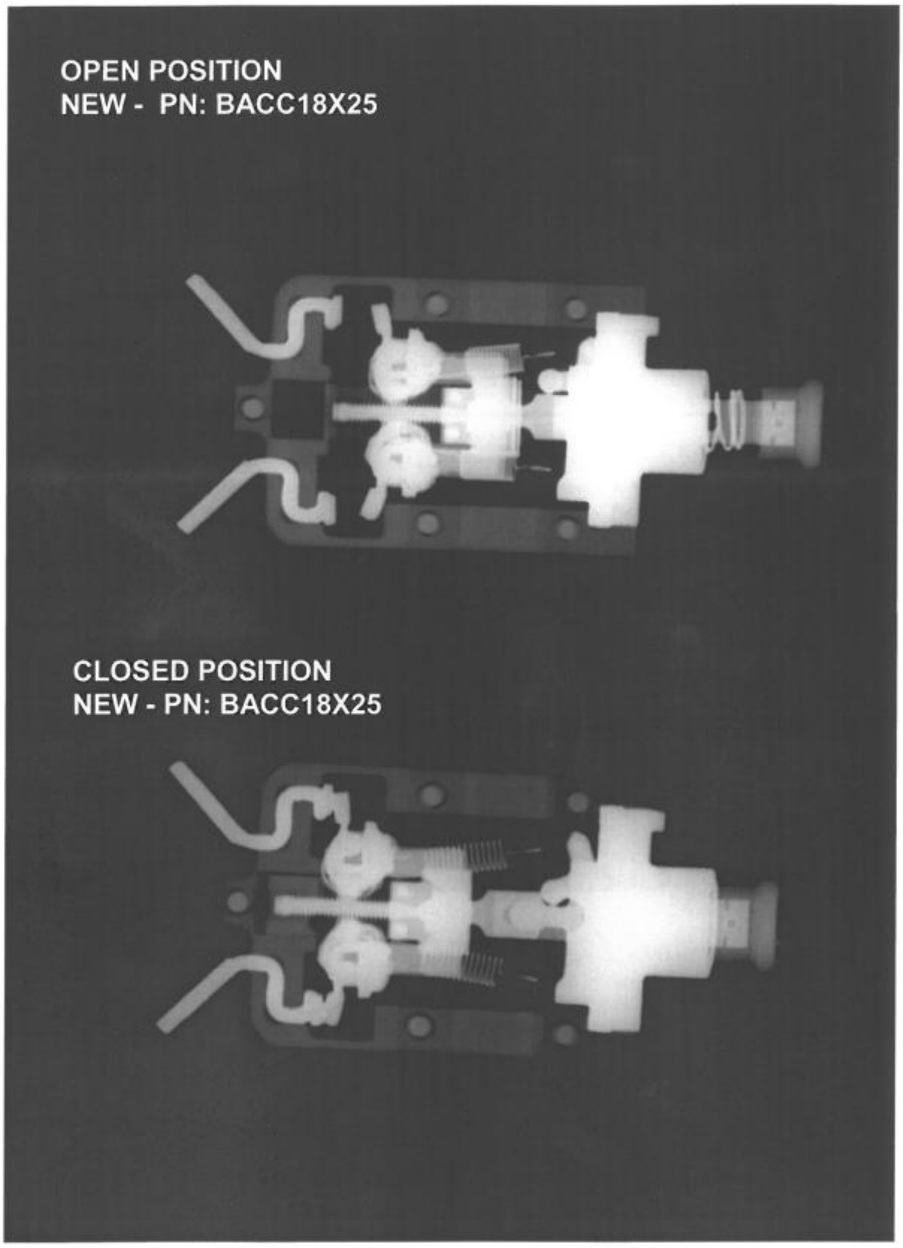

Strona/ Page 4

LOT AMS **WARSZTATOWE POLECENIE TECHNICZNE**
(WORKSHOP ENGINEERING ORDER)

WEO – numer *(number)*: **TWPA/767/0963/11/R00**

Stowarzyszone EO Nr *(Associated with WEO number)*: N/a	Stowarzyszone WEO Nr *(Associated with WEO number)*: N/a	Numer zlecenia (SWP *number)*: T31000009668

Rodzaj *(Type of)* WEO	Grupa ATA*/coordination)*	Data wydania *(Issue date)*	Data zmiany *(Revision date)*	Kopie przesłać do *(Copy send to)*
CHK	24	16.11.2011	N/a	N/a

Opracował (Prepared by)	Sprawdził (Checked by)	Zaakceptował *(Approved by)*	Zatwierdzenie Nadzoru Lotniczego (tak/nie) *(CAA Approval (Y/No))*
Grzegorz Grzybowski	Krzysztof Majos	Jacek Nowicki	No

TEMAT *(Subject)*: **Sprawdzenie Bezpiecznika** (Circuit Breaker Test)

Appendix 4

Wykonać na *(Performed on)*

Samolot *(Aircraft)*	P/N komponentu *(Component P/N)*	S/N komponentu *(Component S/N)*	Nazwisko, podpis, data *(Name, signature , date)*
SP-LPC	700-038-25, or BACC18X25	brak	N/a

Warunki wykonania *(Compliance)*:	N/A
Dotyczy *(Effectivity)*:	Bezpiecznik z samolotu SP-LPC z pozycji C829 *Circuit breaker from position C829*
Dokumentacja związana *(References)*:	Boeing Part Specification BPS-C-144 rev B Mar 17/1993 Boeing Part Standard BACC18X rev U Jun 23/2003
Przyczyna *(Reason)*:	Do sprawdzenia (Check)
Dodatkowe środki ostrożności *(Special precautions)*:	N/A
Zmiany oznaczeń po modyfikacji/naprawie *(Modification / Repair markings)*:	N/A
Zmiany dotyczące dokumentacji *(Publication affected)*:	N/A
Współzamienność *(Interchangeability)*:	N/A
Części i materiały *(Parts and materials)*:	Bezpiecznik *(circuit breaker)* p/n 700-038-25
Pracochłonność / wymagany czas *(Expected manhours /Elapsed time)*:	
Narzędzia specjalne *(Special tooling)*:	Zasilacz *(power supply)* 28 DC, obciążenie *(load)* E120, miernik uniwersalny *(digital multimeter)*, miernik do pomiaru oporności izolacji (*Isolation meter)* E90, stoper *(stopwatch)*, amperomierz *(ammeter)*, dynamometr *(dynamometer)*
Rysunki / Załączniki *(Drawings /Appendixes)*:	N/A
Zmiana masy i położenia środka masy *(Weight / MAC change / STA)*:	N/A
Zmiany w bilansie elektrycznym *(Electrical load data)*:	N/A

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LOT AMS WARSZTATOWE POLECENIE TECHNICZNE *(WORKSHOP ENGINEERING ORDER)*	WEO – numer *(number)* TWPA/767/0963/11/R00

Technologia wykonania prac – dla obsługi jednowarsztatowej
(Accomplishment instruction – for single shop maintenance):

Lp	Warsztat *(Work shop)*	Operacje *(Instructions)*	Nazwisko, podpis i data *(Name, sign & date)* Wykonał *(Worked by)*	Sprawdził *(Checked by)*
1.	TTWA Electrical	**Sprawdzenie** (Check) Sprawdzić wizualnie, czy bezpiecznik nie posiada śladów uszkodzeń mechanicznych. Sprawdzić stan terminali połączeniowych, czy nie noszą śladów przegrzania, czy są prawidłowo zabudowane w obudowie(nie występują luzy). *Visually inspect the fuse does not have signs of damage. Check the condition of the connecting terminals, and no signs of overheating, whether they are properly integrated in the housing (there are no clearances).* Uwagi *(Note)*: No remarks	Dariusz Olewiński 17 LIS. 2011	**N/a**
2.	TTWA Electrical	**Test** (Test) a)Sprawdzenie siły wyciągnięcia główki bezpiecznika. Podłączyć dynamometr i wykonać pięciokrotnie pomiar siły potrzebnej do wyciągnięcia bezpiecznika. Wymagany wynik: 1.35 do 12 lbs (0.61 do 5.44 kg) Zanotować poniżej wyniki pomiarów: *(Checking the force to draw the head of the fuse. Connect the dynamometer and measurement performed five times the force required to pull the fuse. Required result: 1.35 to 12 lbs (0.61 to 5.44 kg). Record the following measurements)* 1 - 1,5, 2 - 1,4, 3 - 1,6, 4 - 1,5, 5 - 1,6 Dla porównania wykonać identyczny test dla nowego bezpiecznika pobranego z magazynu. Zanotować poniżej wyniki pomiarów: *(For comparison, perform the same test for the new fuse downloaded from the store. Record the following measurements)* 1 - 2,7, 2 - 2,8, 3 - 2,9, 4 - 2,8, 5 - 2,8 Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	Dariusz Olewiński 17 LIS. 2011	**N/a**

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LOT AMS WARSZTATOWE POLECENIE TECHNICZNE (WORKSHOP ENGINEERING ORDER)	WEO – numer *(number)* TWPA/767/0963/11/R00

Technologia wykonania prac – dla obsługi jednowarsztatowej
(Accomplishment instruction – for single shop maintenance):

Lp	Warsztat *(Work shop)*	Operacje *(Instructions)*	Wykonał *(Worked by)*	Sprawdził *(Checked by)*
cd 2.	TTWA Electrical	Sprawdzenie siły wciśnięcia główki bezpiecznika. Podłączyć dynamometr i wykonać pięciokrotnie pomiar siły potrzebnej do wciśnięcia główki bezpiecznika. Wymagany wynik: 2 do 16 lbs (0.91 do 7.26 kg) Zanotować poniżej wyniki pomiarów: *(Checking the force to reset the fuse.* *Connect the dynamometer and measurement performed five times the force required to reset the fuse. Required result: 2 to 16 lbs (0.91 to 7.26 kg) Record the following measurements)* 1 - 6,2, 2 - 6,2, 3 - 6,3, 4 - 6,2, 5 - 6,3 Dla porównania wykonać identyczny test dla nowego bezpiecznika pobranego z magazynu. Zanotować poniżej wyniki pomiarów: *(For comparison, perform the same test for the new fuse downloaded from the store. Record the following measurements)* 1 - 3,2, 2 - 3,4, 3 - 3,3, 4 - 3,1, 5 - 3,4 Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	17 LIS. 2011 Dariusz Olewiński	N/a
		b) Test przy maksymalnym obciążeniu nominalnym. Zwiększać powoli obciążenie przy napięciu 28VDC do osiągnięcia wartości 28.75A. Pozostawić bezpiecznik z takim obciążeniem na czas 1 godziny, w tym czasie bezpiecznik nie powinien zadziałać. <u>Uwaga:</u> w przypadku zadziałania bezpiecznika przed osiągnięciem wartości prądu 28.75A, bądź wcześniej niż zakładany czas testu należy zanotować te dane w uwagach. *(Test at the maximum rated load.* *Slowly increase the load* to 28.75A, voltage 28VDC. Leave the fuse with this load for 1 hour, at the time fuse should not work. <u>Note:</u> If the fuse knock out before reaching the current value of 28.75A, *or earlier than expected test time, record the data in the comments.)* Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	17 LIS. 2011 Dariusz Olewiński	

AIRCRAFT MAINTENANCE SERVICES LOT AMS WARSZTATOWE POLECENIE TECHNICZNE (WORKSHOP ENGINEERING ORDER)	WEO – numer *(number)* TWPA/767/0963/11/R00

Technologia wykonania prac – dla obsługi jednowarsztatowej
(Accomplishment instruction – for single shop maintenance):

Lp	Warsztat *(Work shop)*	Operacje *(Instructions)*	Nazwisko, podpis i data *(Name, sign & date)* Wykonał *(Worked by)*	Sprawdził *(Checked by)*
cd 2.	TTWA Electrical	c) Test spadków napięcia na stykach. Wykonać prądem 25 A, napięciem 28 VDC. Spadek napięcia powinien być mniejszy od 150 mV. Podłączać obciążenie po zwarciu styków. Próbę powtórzyć pięć razy. Zanotować poniżej wyniki pomiarów: *(Test voltage drop in the contacts.* *Carry current 25 A, voltage of 28 VDC. The voltage drop should be less than 150 mV. Connect the load after shorting the contacts.* *Repeat test five times. Record the following measurements)* 1 - 122mV, 2 - 123mV, 3 - 124mV, 4 - 121mV, 5 - 122mV W trakcie testu należy sprawdzić, czy przy wyciągniętej główce bezpiecznika następuje rozłączenie obwodu(R> 100 Ω) *(During the test, check the fuse with outstretched head is disconnected the circuit (R> 100 Ω).)* Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	17 LIS. 2011 Dariusz Olewiński	N/a
		d) Sprawdzenie działania bezpiecznika przy przekroczonym nominalnym obciążeniu. Przy wciśniętej główce bezpiecznika podać obciążenie 50A, 28VDC. Sprawdzić czas zadziałania bezpiecznika. Czas powinien wynieść od 12,5 do 55 sekund. *(Checking the fuse when exceeded their rated load.* *When pressed the head of state load fuse 50A, 28VDC. Check the fuse time. Time should range from 12,5 to 55 seconds.)* Wynik pomiaru *(The result)*: ...25 s.... Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	Dariusz Olewiński 17 LIS. 2011	

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LOT AMS **WARSZTATOWE POLECENIE TECHNICZNE** (WORKSHOP ENGINEERING ORDER)	WEO – numer *(number)* **TWPA/767/0963/11/R00**

Technologia wykonania prac – dla obsługi jednowarsztatowej
(Accomplishment instruction – for single shop maintenance):

Lp	Warsztat *(Work shop)*	Operacje *(Instructions)*	Nazwisko, podpis i data *(Name, sign & date)* Wykonał *(Worked by)*	Sprawdził *(Checked by)*
cd 2.	TTWA Electrical	e) Test upływności izolacji. Wykonać test upływności izolacji napięciem 1500 VAC, 50Hz pomiędzy połączonymi terminalami połączeniowymi a metalowymi elementami obudowy i pomiędzy terminalami przy otwartym bezpieczniku. Przyrost wartości napięcia w trakcie testu nie powinien być większy od 250 V na sekundę. W trakcie testu nie powinny nastąpić iskrzenia, lub inne czynniki świadczące o usterce urządzenia. Upływność nie powinna przekroczyć 1 mA. *(Dielectric Test of insulation.* *Test voltage 1500 VAC , 50Hz between connected terminals and a metal elements the housing and terminals with an open fuse. Increase the voltage during the test should not be greater than 250 V per second.* *During the test no evidence of breakdown, flashover.* *Leakage should not exceed 1 mA)* Wynik pomiaru *(The result)*: 0 mA /brak upływności/ Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	17 LIS 2011 Dariusz Olewiński	N/a
		f) Test rezystancji izolacji. Wykonać test rezystancji izolacji napięciem 500 VDC pomiędzy połączonymi terminalami a metalowymi elementami obudowy i pomiędzy terminalami przy otwartym bezpieczniku. Rezystancja powinna wynosić ≥ 100MΩ. *(Test insulation resistance.* *Perform insulation resistance test voltage of 500 VDC between connected terminals and a metal elements the housing and terminals with an open fuse. Resistance should be ≥ 100MΩ.)* Wynik pomiaru *(The result)*: 50 GΩ Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	Dariusz Olewiński 17 LIS 2011	

AIRCRAFT MAINTENANCE SERVICES
LOT AMS **WARSZTATOWE POLECENIE TECHNICZNE**
(WORKSHOP ENGINEERING ORDER)

WEO – numer *(number)*
TWPA/767/0963/11/R00

Technologia wykonania prac – dla obsługi jednowarsztatowej
(Accomplishment instruction – for single shop maintenance):

Lp	Warsztat *(Work shop)*	Operacje *(Instructions)*	Nazwisko, podpis i data *(Name, sign & date)* Wykonał *(Worked by)*	Sprawdził *(Checked by)*
cd 2.	TTWA Electrical	Po wykonanych testach, należy uznać urządzenie za sprawne: *(After the tests performed, the device should be considered serviceable)* TAK*(Yes)* / NIE*(No)* ** ** zaznaczyć prawidłową odpowiedź *(select the correct answer)*	17 LIS. 2011 Dariusz Olewiński	N/a

Nazwisko, pieczęć, podpis i data *(Name, Sign & date)*	* Poświadczył *(Certify by)*	Dariusz Olewiński 8918 17 LIS. 2011

* Certifies that the work specified except as otherwise specified was carried out in accordance with Part-145 and in respect to that work the aircraft/aircraft component is considered for release to service.

Lista użytych narzędzi podlegających obsłudze metrologicznej *(List of the used calibration tools)*:

Lp	Warsztat *(Work shop)*	Nazwa narzędzia *(Tool description)*	S/N	Lub (or) workshop S/N	Nazwisko, podpis i data *(Name, sign & date)*
1	TTWA Electrical	Zasilacz 28VDC	1101089		Dariusz Olewiński 17 LIS. 2011
2	TTWA Electrical	Obciążenie		E120	Dariusz Olewiński 17 LIS. 2011
3	TTWA Electrical	Miernik uniwersalny		0430-09-8441/002	Dariusz Olewiński 17 LIS. 2011
4	TTWA Electrical	Miernik rezystancji izolacji		0430-09-6341	Dariusz Olewiński 17 LIS. 2011
5	TTWA Electrical	Stoper		E233	Dariusz Olewiński 17 LIS. 2011
6	TTWA Electrical	Miernik upływności izolacji		E113	Dariusz Olewiński 17 LIS. 2011
7	TTWA Electrical	Amperomierz		E100	Dariusz Olewiński 17 LIS. 2011
8	TTWA Electrical	Dynamometr	57		Dariusz Olewiński 17 LIS. 2011
9	TTWA Electrical	Dynamometr		P3	Dariusz Olewiński 17 LIS. 2011
		END OF LIST			

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AIRCRAFT MAINTENANCE SERVICES LOTAMS **WARSZTATOWE POLECENIE TECHNICZNE** *(WORKSHOP ENGINEERING ORDER)*

WEO – numer *(number)*	TWPA/767/0964/11/R00			
Stowarzyszone EO Nr *(Associated with WEO number)*: N/a	Stowarzyszone WEO Nr *(Associated with WEO number)*: N/a	Numer zlecenia (SWP *number*): T31000009668		
Rodzaj *(Type of)* WEO: CHK	Grupa ATA *(coordination)*: 24	Data wydania *(Issue date)*: 16.11.2011	Data zmiany *(Revision date)*: N/a	Kopie przesłać do *(Copy send to)*: N/a
Opracował (Prepared by): Grzegorz Grzybowski	Sprawdził *(Checked by)*: Krzysztof Majos	Zaakceptował *(Approved by)*: Jacek Nowicki	Zatwierdzenie Nadzoru Lotniczego (tak/nie) *(CAA Approval (Y/No))*: No	

TEMAT *(Subject)*: **Sprawdzenie Bezpiecznika** (Circuit Breaker Tes

Appendix 5

Wykonać na *(Performed on)*

Samolot *(Aircraft)*	P/N komponentu *(Component P/N)*	S/N komponentu *(Component S/N)*	Nazwisko, podpis, data *(Name, signature, data)*
SP-LPC	BACC18Z7R or 2TC6-71/2	brak	N/a

Warunki wykonania *(Compliance)*:	N/A
Dotyczy *(Effectivity)*:	Bezpiecznik z samolotu SP-LPC z pozycji C4248 *Circuit breaker from position C4248*
Dokumentacja związana *(References)*:	Boeing Part Specification BPS-C-144 rev B Mar 17/1993 Boeing Part Standard BACC18X rev U Jun 23/2003
Przyczyna *(Reason)*:	Do sprawdzenia (Check)
Dodatkowe środki ostrożności *(Special precautions)*:	N/A
Zmiany oznaczeń po modyfikacji/naprawie *(Modification / Repair markings)*:	N/A
Zmiany dotyczące dokumentacji *(Publication affected)*:	N/A
Współzamienność *(Interchangeability)*:	N/A
Części i materiały *(Parts and materials)*:	Bezpiecznik *(circuit breaker)* p/n BACC18Z7R
Pracochłonność / wymagany czas *(Expected manhours /Elapsed time)*:	
Narzędzia specjalne *(Special tooling)*:	Zasilacz *(power supply)* DC nr E105, obciążenie *(load)* E120, miernik uniwersalny *(digital multimeter)*, miernik do pomiaru oporności izolacji (*Isolation meter)* E90, stoper *(stopwatch)*, amperomierz *(ammeter)*, dynamometr *(dynamometer)*
Rysunki / Załączniki *(Drawings /Appendixes)*:	N/A
Zmiana masy i położenia środka masy *(Weight / MAC change / STA)*:	N/A
Zmiany w bilansie elektrycznym *(Electrical load data)*:	N/A

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AIRCRAFT MAINTENANCE SERVICES

LOT AMS **WARSZTATOWE POLECENIE TECHNICZNE**
(WORKSHOP ENGINEERING ORDER)

WEO – numer *(number)*
TWPA/767/0964/11/R00

Technologia wykonania prac – dla obsługi jednowarsztatowej
(Accomplishment instruction – for single shop maintenance):

L p	Warsztat *(Work shop)*	Operacje *(Instructions)*	Nazwisko, podpis i data *(Name, sign & date)* Wykonał *(Worked by)*	Sprawdził *(Checked by)*
1.	TTWA Electrical	**Sprawdzenie** (Check) Sprawdzić wizualnie, czy bezpiecznik nie posiada śladów uszkodzeń mechanicznych. Sprawdzić stan terminali połączeniowych, czy nie noszą śladów przegrzania, czy są prawidłowo zabudowane w obudowie(nie występują luzy). *Visually inspect the fuse does not have signs of damage. Check the condition of the connecting terminals, and no signs of overheating, whether they are properly integrated in the housing (there are no clearances).* Uwagi *(Note)*: No remarks	17 LIS. 2011 Dariusz Olewiński	N/a
2.	TTWA Electrical	**Test** (Test) a)Sprawdzenie siły wyciągnięcia główki bezpiecznika. Podłączyć dynamometr i wykonać pięciokrotnie pomiar siły potrzebnej do wyciągnięcia bezpiecznika. Wymagany wynik: 1.35 do 12 lbs (0.61 do 5.44 kg) Zanotować poniżej wyniki pomiarów: *(Checking the force to draw the head of the fuse. Connect the dynamometer and measurement performed five times the force required to pull the fuse. Required result: 1.35 to 12 lbs (0.61 to 5.44 kg). Record the following measurements)* 1 - 2,6, 2 - 2,9, 3 - 2,7, 4 - 2,6, 5 - 2,7 Dla porównania wykonać identyczny test dla nowego bezpiecznika pobranego z magazynu. Zanotować poniżej wyniki pomiarów: *(For comparison, perform the same test for the new fuse downloaded from the store. Record the following measurements)* 1 - 2,2, 2 - 1,9, 3 - 2,1, 4 - 2,0, 5 - 1,8 Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	17 LIS. 2011 Dariusz Olewiński	N/a

LOT AMS (AIRCRAFT MAINTENANCE SERVICES) **WARSZTATOWE POLECENIE TECHNICZNE** *(WORKSHOP ENGINEERING ORDER)*	WEO – numer *(number)* TWPA/767/0964/11/R00

Technologia wykonania prac – dla obsługi jednowarsztatowej
(Accomplishment instruction – for single shop maintenance):

Lp	Warsztat *(Work shop)*	Operacje *(Instructions)*	Nazwisko, podpis i data *(Name, sign & date)* Wykonał *(Worked by)*	Sprawdził *(Checked by)*
cd 2.	TTWA Electrical	Sprawdzenie siły wciśnięcia główki bezpiecznika. Podłączyć dynamometr i wykonać pięciokrotnie pomiar siły potrzebnej do wciśnięcia główki bezpiecznika. Wymagany wynik: 2 do 16 lbs (0.91 do 7.26 kg) Zanotować poniżej wyniki pomiarów: *(Checking the force to reset the fuse. Connect the dynamometer and measurement performed five times the force required to reset the fuse. Required result: 2 to 16 lbs (0.91 to 7.26 kg) Record the following measurements)* 1 - 1,0, 2 - 1,4, 3 - 0,95, 4 - 0,85, 5 - 1,2 Dla porównania wykonać identyczny test dla nowego bezpiecznika pobranego z magazynu. Zanotować poniżej wyniki pomiarów: *(For comparison, perform the same test for the new fuse downloaded from the store. Record the following measurements)* 1 - 1,0, 2 - 1,0, 3 - 1,2, 4 - 1,3, 5 - 1,0 Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*:	Dariusz Olewiński 17 LIS. 2011	N/a
		b) Test przy maksymalnym obciążeniu nominalnym. Zwiększać powoli obciążenie przy napięciu 28VDC do osiągnięcia wartości 8.63A. Pozostawić bezpiecznik z takim obciążeniem na czas 1 godziny, w tym czasie bezpiecznik nie powinien zadziałać. Uwaga: w przypadku zadziałania bezpiecznika przed osiągnięciem wartości prądu 8.63A, bądź wcześniej niż zakładany czas testu należy zanotować te dane w uwagach. *(Test at the maximum rated load. Slowly increase the load* to 8.63A, voltage 28VDC. Leave the fuse with this load for 1 hour, at the time fuse should not work. Note: If the fuse knock out before reaching the current value of 8.63A, *or earlier than expected test time, record the data in the comments.)* Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*:	Dariusz Olewiński 17 LIS. 2011	

AIRCRAFT MAINTENANCE SERVICES LOT AMS WARSZTATOWE POLECENIE TECHNICZNE (WORKSHOP ENGINEERING ORDER)	WEO – numer (number) TWPA/767/0964/11/R00

Technologia wykonania prac – dla obsługi jednowarsztatowej
(Accomplishment instruction – for single shop maintenance):

Lp	Warsztat *(Work shop)*	Operacje *(Instructions)*	Nazwisko, podpis i data *(Name, sign & date)* Wykonał *(Worked by)*	Sprawdził *(Checked by)*
cd 2.	TTWA Electrical	c) Test spadków napięcia na stykach. Wykonać prądem 7.5 A, napięciem 28 VDC. Spadek napięcia powinien być mniejszy od 150 mV. Podłączać obciążenie po zwarciu styków. Próbę powtórzyć pięć razy. Zanotować poniżej wyniki pomiarów: *(Test voltage drop in the contacts. Carry current 7.5 A, voltage of 28 VDC. The voltage drop should be less than 150 mV. Connect the load after shorting the contacts. Repeat test five times. Record the following measurements)* 1 - 148mV 2 - 146mV 3 - 145mV 4 - 147mV 5 - 144mV W trakcie testu należy sprawdzić, czy przy wyciągniętej główce bezpiecznika następuje rozłączenie obwodu(R> 100 Ω) *(During the test, check the fuse with outstretched head is disconnected the circuit (R> 100 Ω).)* Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	Dariusz Olewiński 17 LIS. 2011	N/a
		d) Sprawdzenie działania bezpiecznika przy przekroczonym nominalnym obciążeniu. Przy wciśniętej główce bezpiecznika podać obciążenie 15A, 28VDC. Sprawdzić czas zadziałania bezpiecznika. Czas powinien wynieść od 12,5 do 55 sekund. *(Checking the fuse when exceeded their rated load. When pressed the head of state load fuse 15A, 28VDC. Check the fuse time. Time should range from 12,5 to 55 seconds.)* Wynik pomiaru *(The result)*: 14,55 Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	17 LIS. 2011 Dariusz Olewiński	

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AIRCRAFT MAINTENANCE SERVICES LOT AMS **WARSZTATOWE POLECENIE TECHNICZNE** *(WORKSHOP ENGINEERING ORDER)*			WEO – numer *(number)* TWPA/767/0964/11/R00	
Technologia wykonania prac – dla obsługi jednowarsztatowej ***(Accomplishment instruction – for single shop maintenance):***				
Lp	Warsztat *(Work shop)*	Operacje *(Instructions)*	Nazwisko, podpis i data *(Name, sign & date)* Wykonał *(Worked by)*	Sprawdził *(Checked by)*
cd 2.	TTWA Electrical	e) Test upływności izolacji. Wykonać test upływności izolacji napięciem 1500 VAC, 50Hz pomiędzy połączonymi terminalami połączeniowymi a metalowymi elementami obudowy i pomiędzy terminalami przy otwartym bezpieczniku. Przyrost wartości napięcia w trakcie testu nie powinien być większy od 250 V na sekundę. W trakcie testu nie powinny nastąpić iskrzenia, lub inne czynniki świadczące o usterce urządzenia. Upływność nie powinna przekroczyć 1 mA. *(Dielectric Test of insulation. Test voltage 1500 VAC , 50Hz between connected terminals and a metal elements the housing and terminals with an open fuse. Increase the voltage during the test should not be greater than 250 V per second. During the test no evidence of breakdown, flashover. Leakage should not exceed 1 mA)* Wynik pomiaru *(The result)*: 0 mA / brak upływności / Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	Dariusz Olewiński 17 LIS. 2011	N/a
		f) Test rezystancji izolacji. Wykonać test rezystancji izolacji napięciem 500 VDC pomiędzy połączonymi terminalami a metalowymi elementami obudowy i pomiędzy terminalami przy otwartym bezpieczniku. Rezystancja powinna wynosić ≥ 100MΩ. *(Test insulation resistance. Perform insulation resistance test voltage of 500 VDC between connected terminals and a metal elements the housing and terminals with an open fuse. Resistance should be ≥ 100MΩ.)* Wynik pomiaru *(The result)*: >50GΩ Parametry zgodne z dokumentacją (Parameters in accordance with the documentation) : TAK*(Yes)* / NIE*(No)* ** Uwagi*(Note)*: No remarks	17 LIS. 2011 Dariusz Olewiński	

AIRCRAFT MAINTENANCE SERVICES

LOT AMS WARSZTATOWE POLECENIE TECHNICZNE
(WORKSHOP ENGINEERING ORDER)

WEO – numer (number)
TWPA/767/0964/11/R00

Technologia wykonania prac – dla obsługi jednowarsztatowej
(Accomplishment instruction – for single shop maintenance):

Lp	Warsztat (Work shop)	Operacje (Instructions)	Nazwisko, podpis i data (Name, sign & date) Wykonał (Worked by)	Sprawdził (Checked by)
cd 2.	TTWA Electrical	Po wykonanych testach, należy uznać urządzenie za sprawne: *(After the tests performed, the device should be considered serviceable)* TAK*(Yes)* / NIE*(No)* ** ** zaznaczyć prawidłową odpowiedź *(select the correct answer)*	Dariusz Olewiński 17 LIS. 2011	N/a

Nazwisko, pieczęć, podpis i data *(Name, Sign & date)* | * Poświadczył *(Certify by)* Dariusz Olewiński UC-8918 17 LIS. 2011

* Certifies that the work specified except as otherwise specified was carried out in accordance with Part-145 and in respect to that work the aircraft/aircraft component is considered for release to service.

Lista użytych narzędzi podlegających obsłudze metrologicznej *(List of the used calibration tools)*:

Lp	Warsztat (Work shop)	Nazwa narzędzia (Tool description)	S/N	Lub (or) workshop S/N	Nazwisko, podpis i data (Name, sign & date)
1	TTWA Electrical	Zasilacz 28VDC	1101089		Dariusz Olewiński 17 LIS. 2011
2	TTWA Electrical	Obciążenie		E120	Dariusz Olewiński 17 LIS. 2011
3	TTWA Electrical	Miernik uniwersalny		0430-09-8441/002	Dariusz Olewiński 17 LIS. 2011
4	TTWA Electrical	Miernik rezystancji izolacji		0430-09-6341	Dariusz Olewiński 17 LIS. 2011
5	TTWA Electrical	Stoper		E233	Dariusz Olewiński 17 LIS. 2011
6	TTWA Electrical	Miernik upływności izolacji		E113	Dariusz Olewiński 17 LIS. 2011
7	TTWA Electrical	Amperomierz		E100	Dariusz Olewiński 17 LIS. 2011
8	TTWA Electrical	Dynamometr		P3	Dariusz Olewiński 17 LIS. 2011
9	TTWA Electrical	Dynamometr ELEKTRONICZNY	0430-09-6881/002 S1/122		Dariusz Olewiński 17 LIS. 2011
10	TTWA Electrical	DYNAMOMETR	57		Dariusz Olewiński 17 LIS. 2011

END OF LIST

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FORM No: Procedura LOTAMS 2.13.B.4/02/7.02.2011

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ANNEX 5

to Final Report on accident to B-767-300, SP-LPC

PSYCHOLOGICAL OPINION ON
OPERATIONS OF THE FLIGHT CREW OF BOEING B-767-300, SP–LPC

TABLE OF CONTENTS

Elżbieta Stolarek, MA

Aviation Psychologist

Psychological opinion
on operations of the flight crew of Boeing 767-300, SP-LPC

SCAAI reference number: 1400/11

Introduction

On November 1, 2011 Boeing B-767-300, SP-LPC airplane had an accident on Warsaw Chopin Airport (EPWA aerodrome). Due to negative results of successive attempts to extend the landing gear and low fuel quantity the crew decided to carry out an emergency gear up landing. The airplane landed on EPWA RWY 33 at 13:39 hrs LMT. After the airplane came to rest the flight crew carried out evacuation of passengers. None of the 221 passengers, 8 cabin crew members and 2 flight crew members suffered injuries in the occurrence.

Members of the State Commission on Aircraft Accident Investigation arrived at the aerodrome and carried out the initial inspection of the aircraft. They found that in the cockpit, on P6 panel, C829 BAT BUS DISTR circuit breaker (on A1 position) was in OFF setting, while C4248 LANDING GEAR - ALTN EXT MOTOR circuit breaker (on F6 position) was in ON setting. 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 a Ground Power Unit, setting C829 BAT BUS DISTR circuit breaker in ON position and activation of the alternate landing gear extension system, the landing gear was extended.

Functional tests of the entire electrical system of the alternate landing gear extension system were carried out. Analysis of tests and measurements on the airplane and in a workshop (on November 16, 2011 and December 13, 2011) did not show any signs that C829 circuit breaker was opened due to any irregularity in operation of the examined systems and components. At the time of the engines shutdown C829 circuit breaker was already in OFF setting. It may be assumed that the circuit breaker was opened mechanically by objects that were moved in the cockpit during the flight. Location of C829 circuit breaker and numerous signs of damage to its head (button) may indicate that the luggage (bags, suitcases, etc.) placed in the cockpit repeatedly touched the circuit breaker in the past. Assuming that the flight crew carried out all the prescribed pre-departure actions (BOEING OPERATION MANUAL N.P.21.2) at KEWR, it may be supposed that the circuit breaker was opened during the KEWR-EPWA flight on November 1, 2011. The OFF setting of the circuit breaker is not recorded or indicated by the airplane systems (FDR - Flight Data Recorder or EICAS - Engine Indications and Crew Alerting System).

Based on the above information it may be concluded that the direct cause of inability to extend the landing gear using the alternate landing gear extension system was the fact that C829 (BAT BUS DISTR) circuit breaker was in OFF setting - which could have remained outside attention, knowledge and control of the pilots.

A detailed psychological analysis of performance and cooperation of the flight crew members was carried out in order to explain and understand the course of the occurrence. The data source for this expert opinion was: the author's personal interviews with Captain and FO, visual inspection of B767-300 cockpit, accident documentation, analysis of the flight crew conversations (recordings from the Cockpit Voice Recorder), communication with the Operations Center on EPWA, post-accident interviews conducted with the pilots by SCAAI members and consultations with SCAAI experts.

1. Boeing B-767-300 crew

The flight crew and the cabin crew had appropriate authorizations and ratings to perform the flight.

Captain - employed in PLL LOT SA since 1981, flight time on B-767 as a Commander: 12432 hrs 51 min, he had been Captain for 22 years, prior to the accident he had never coped with emergency situations caused by a technical failure. In the interview he cited three emergency situations associated with other circumstances such as: fainting a passenger and twice – deterioration in weather conditions. The general feeling of mental and physical health - good. He excluded any current life problems which could affect his mental condition. He successfully passed periodic aero-medical examinations with no limitations, including recently completed specific post-accident examinations.

FO - employed in PLL LOT since 1996, flight time on B-767: 1981hrs 09 min. Experience with emergency situations: on October 24, 2008 during his flight from New York to Warsaw a landing with the use of alternate landing gear extension system was carried out; the course of landing was in accordance with the applicable procedures. The general feeling of mental and physical health - good. He excluded any current life problems which could affect his mental condition. He successfully passed periodic aero-medical examinations with no limitations, including recently completed specific post-accident examinations.

Chief Flight Attendant - employed in PLL LOT since 1972.

Prior to the accident the pilots had performed together four flights without any problems. During interviews conducted individually they declared peaceful, harmonious cooperation, positive attitudes towards each other, high estimation of professional skills and high mutual trust. They commenced their flight duty rested, refreshed, in good psychophysical condition. They did not report recent overload by air operations.

2. Course of occurrences during flight LO 16

Pre-eparture Check of the aircraft was conducted in accordance with the applicable requirements. The airplane was inspected by a mechanic of the USA service organization. Exterior Walk-Around and external inspection of the airplane was done by Captain. FO checked on-board equipment and the cockpit arrangement for the flight. No failures or irregularities were found.

In the framework of the Crew Resources Management it was determined that Captain was a pilot flying (PF) and FO was a pilot monitoring (PM).

The airplane took off from Newark aerodrome in the USA. Approximately 15 minutes after the take-off the hydraulic fluid from the central hydraulic system leaked out. The crew was warned about the failure by the warning beeps and lights of EICAS system.

After a detailed analysis of the problem and consultation with Operations Center according to the Quick Reference Handbook, the crew decided to continue the flight to Warsaw.

Both Captain and FO, when asked for their subjective assessment of importance of the occurring problems in relation to the sense of negative emotional pressure did not assess the occurrences at this stage of the flight as excessively stressful. The occurrence had a nature of a difficult but controllable situation in the context of detailed actions and procedures pre-planned for such circumstances. This situation was well known to pilots due to numerous exercises carried out in a flight simulator.

The landing in Warsaw was to be carried out with the alternate landing gear extension system. The flight proceeded without significant irregularities. Taking advantage of the available time, Captain and FO were developing the landing plan in accordance with the procedure laid down in QRH, discussed an anticipated sequence of events resulting from their vision of the foreseeable circumstances. The important fact was that three years earlier the PM was a FO in the flight, which ended in landing with the use of the alternate landing gear extension system. Therefore, PM shared with Captain his experience about nuances of nonstandard characteristics of this type of landing (e.g. longer time required for the proper flaps setting and landing gear extension as well as specific sounds).

In the course of information processing by pilots its importance has a relative value. Experience and familiarity with various situations in the air cause that a pilot needs less time for orientation in functioning of the controlled object, has a greater margin of psychological comfort and a sense of self-confidence. Both pilots were well prepared for the proper execution of a landing with the alternate landing gear extension system.

During approach to landing at EPWA aerodrome the flight crew carried out the procedure of the landing gear extension. After the expected time, about two minutes, for reasons unknown to the crew the landing gear was not extended.

At this moment the critical phase of the flight began, it was assessed by the pilots as having features of a precarious situation. In the psychology of stress it is a situation of absence of data that would allow to control stressors - loss of belief that one has ability to influence the course or consequences of an occurrence. Stress is an integral part of a private life and work in aviation. The aviation psychology emphasizes the enormous influence of the emotional strain associated with stress on cognitive functions of pilots. Action of the team was taken in accordance with the characteristic personal profile of aviators style of coping with stress: in a way focused on the task [6]. Reasonable steps were taken to seek additional information necessary to solve the problem.

The correctness of successive steps of the procedure was checked, as described in QRH. Due to failure of the second attempt the approach to landing was abandoned. The flight crew reported to an air traffic controller inability to extend the landing gear and requested an assistance from Operations Center. Approximately at 12:25 hrs the pilots declared EMERGENCY situation. The aircraft was directed to a holding zone. Experts were contacted via Operations Center and after consultations the recommended actions were carried out - but without the desired result. The landing gear was not extended. In the meantime two F-16 on duty checked Boeing visually from the air and confirmed that the landing gear was still in the retracted position. The crew carried out the last attempt to extend the landing gear in a gravitational way, which also ended in failure. Due to time pressure associated with a limited fuel quantity and unsuccessful attempts to extend the landing gear, the crew decided to execute an emergency landing with landing gear retracted.

Airport services prepared the runway for landing. The emergency gear up landing was successful, then the crew carried out evacuation of the passengers.

3. Detailed psychological analysis of a critical situation during the flight

Situational awareness of the flight crew changed dynamically when unexpected and dangerous malfunction of the alternate landing gear extension system occurred. The pilots were forced to act quickly, analyze the situation and seek missing information necessary to solve the problem. QRH did not contain instructions or information related to the difficult situation on board the aircraft.

The pilots lost confidence in the basic source of information. The fundamental factors in the air operations and decision-making process [5] are:

- skills and actions resulting from the professional experience based on automation of routinely trained reactions;
- actions based on rules (principles, regulations): the procedures coded in permanent memory and details contained in QRH checklist which are helpful in difficult situations;
- actions based on knowledge: there is analysis of the situation, thinking, decision-making in untypical situations, not covered by instructions which a pilot faces for the first time. In these situations a pilot analyses situation and chooses a course of action according to his best knowledge.

The pilots' attention resources were overloaded. There was a need for increased, very intense selection of information and extreme maximization of the cognitive effort in the context of multitasking divisibility of mental concentration, which is always needed and also present during performing routine air operations. A need to undertake the tasks and decisions in a complex probabilistic situation with insufficient amount of information and a very high level of estimated risk was an additional psychological load experienced by the flight crew.

Captain acted as Pilot Flying (PF). Pilot Flying carefully analyzes all information needed to control an airplane, monitors autopilot operation, enters data into on-board computer and in case of irregularities, malfunctions or substantial deviations from the planned route disengage autopilot and takes over control of an airplane. On landing PF receives and analyzes information from altimeter, flight director, ILS, autopilot (if used) and in the final phase of landing he observes the airspace outside airplane [5].

Additional workload and burden on the Captain field of concentration included: flight control in contact with F-16 pilots, a detailed analysis of the flight parameters due to rate of the fuel consumption, participation in communication with Operations Center and the assisting expert, supervising attempts to extend the landing gear (according to QRH and in the gravitational way), preparation and discussion with the crew a safe evacuation and execution of the landing procedure with retracted landing gear taking into account the time required for optimal performance of the foam applied on the runway.

Captain emphasized in an interview that he was highly focused on the flight control. He did not monitor personally FO actions. He expressed the opinion that as a Pilot Flying and Captain of the aircraft he could not abandon the flight control. According to Captain's explanation FO had more comfortable conditions for checking the circuit breakers and location of P-6 panel prevented Captain from visual inspection.

In addition to the standard duties, in the situation of a dangerous failure a huge load on attention resources and thought processes of pilots and a high and escalating emotional stimulation appeared, associated with the threat to the flight safety.

Analysis of voice recordings from the cockpit allowed to find the wider spectrum of the flight crew actions and the scale of their emotional experience. The pilots were able to remain calm and self-controlled, the form of speech was clear, maintaining discipline of procedural phraseology, the content was relevant to the course of events. Parallel to the ongoing adverse developments it was obvious that a palpable strain, impatience and nervousness were increasing, which was associated with a long wait for expert assistance from Operations Center, successive attempts to reset the circuit breakers and checking other parameters as indicated by a ground engineer (without the expected extension of the landing gear) and during preparations for an emergency landing - but all in compliance with the principles of a good verbal communication. In his statements Captain repeatedly expressed concern for the passengers.

FO acted as a pilot monitoring (PM). The duties of PM include navigation, communications, operation of on-board equipment and installations as well as monitoring of Pilot Flying work. During landing approach PM receives and analyzes information from air traffic controller, the weather conditions, monitors engines and other aircraft system indicators [5].

Additional workload and burden on FO field of concentration included: repeated reading and analysis of recommendations from Quick Reference Handbook, intensive cooperation with Captain, maintaining additional communication with F-16 pilots and the Operations Center, execution of the recommended actions according to the instructions of experts from Operations Center, preparation of the cockpit for an emergency landing and cooperation with Chief Flight Attendant.

In implementing expert recommendations received from Operations Center FO checked the switch of alternate landing gear extension, circuit breaker on P-11 panel and twice left his seat to inspect the circuit breakers located on P-6 panel. He reset the recommended circuit breakers. However, the recommendation did not relate to C829 BAT BUS DISTR circuit breaker located at A1 position (in the first bottom row at the first position on the left). They related to ALT EXT MOTOR circuit breaker at F6 position (located in the sixth row of the sixth column). If the pilot wanted to see the entire P6-1 panel he had to leave his seat and push it again to the previous position to bare the panel. According to witnesses he did so twice: he left his seat, moved the seat to see the entire panel and performed checking on his knees, because it was the only way to see it in detail. He reported to the Operations Center and to Captain that the circuit breakers were checked.

FO assured that he inspected P6-1 panel carefully „from top to bottom” and did not notice any of the circuit breakers to be stretched out („blown”). These circuit breakers have a visible white part of the base and if they are not specifically marked by mechanics they should be checked.

During the second visual inspection of the panel the pilot requested Chief Flight Attendant (present in the cockpit) to look at the panel. Chief Flight Attendant was busy with preparation of passengers evacuation. In my opinion he was not a competent person for this kind of assessment. The pilot was aware of that. Captain also remembered the situation. This episode is an evidence proving lack of self-confidence and mental strain of FO.

The space on the right side of the aircraft cockpit is occupied by a number of panels with numerous circuit breakers. Five panels with circuit breakers, each 20 cm wide and 42 cm high, marked with numbers from the left P6-1 to the right P6-5 are arranged next to each other from the floor level. Each panel contains 56 circuit breakers arranged in 7 columns (marked with numbers from 1 to 7) and 8 rows (marked from „A" to „H"). C829 BAT BUS DISTR circuit breaker, which caused malfunction of the alternate landing gear extension system is situated on P6-1 panel in close proximity to the right side of the co-pilot's seat, at A-1 position, which is in the bottom left corner just above the floor. This position of the circuit breaker was in extremely peripheral portion of the pilot's attention field.

During visual inspection of the aircraft after the accident SCAAI members found this circuit breaker in OFF setting. According to an expert opinion that setting of the circuit breaker prevented the landing gear extension.

After tests and drafting expert opinions by aviation engineers a detailed analysis of the situation was made. Based on the analysis, SCAAI Investigation Team formulated a hypothesis that it was likely that OFF setting of the circuit breaker could have been unnoticed or unconsciously ignored.

Arrangement of the board instruments in an airplane cockpit is designed according to their functions. This system complies with the principle of importance and therefore the instruments are grouped in specific sets. This provides optimal conditions for reception of information by a pilot. In the course of training and gaining the flight experience pilot develops and consolidates specific functional stereotypes called „route of pilot perception". The aviation psychology knows a phenomenon that a pilot excessively focuses on indications of instruments essential for him - a reduction, narrowing the field of visual perception is observed in these cases. Experimental studies of pilot behavior during simulator flights show that during landing approach pilots notice FIRE signal with a delay of several seconds. Focus on a particular section of the sensory field of work causes that the stimuli occurring in the peripheral field of vision are not noticed [1]. Probably a similar situation might have occurred in the presented event. OFF setting of C829 BAT BUS DISTR circuit breaker could have not been noticed due to its extremely peripheral location, lack of pilots knowledge on its function and because of the multi-level commitment of the pilots' cognitive processes involved in other important activities essential in the critical situation.

In the presented dangerous situation the center of the pilots' attention was focused on a number of objects and tasks. Emotional strain could perturb the processes of perception and could also reduce vigilance. Vigilance is a state in which an individual for a long period is able to detect specific stimuli out of many possible stimuli occurring in an environment. Even in a state of optimal stimulation the critical stimuli, requiring some action, may not be detected, for example, because other monotonous stimuli were acting for long periods, or because an individual in a particular situation produced a negative expectation, which assumed that the critical stimulus would not appear. Studies show that a long-term performance of repetitive detection tasks reduces vigilance and individuals ignore stimuli to which they should respond [8]. This phenomenon is well known in aviation in the context of limitations in functioning the pilots' cognitive processes especially in a difficult situation. Further explanation and justification of probability of this hypothesis is given below.

Psychology of cognitive processes deals with acquisition, processing and use of information by men. Elementary cognitive process is perception. The primary objective of perception is to obtain an accurate, stable image of the world. This is not only a simple, automated process initiated by reception of sensory data and finished by analysis on the level of brain centers ("bottom-up process"), in which the incoming stimulus information from the sensory data are transmitted to the brain in order to analyze the information. The dominant and important form of human perception is "top down processing", in which information from experience, knowledge and education, thus human attitudes and expectations affect the way of interpretation and classification of incoming characteristics of a perceived object. The memory processes control search and interpretation of sensory data [8]. Perception is always directly linked to many other cognitive processes, and - what is worth emphasizing – also significantly with the human emotional processes.

Sight is the most important and most complex human perceptual system. Studies show that pupil size reflects the state of the nervous system, the pupil hole size changes with changes of emotional states during thinking and problem solving. The mechanism of eye accommodation is not automatic and involuntary, it is dependent on the higher nerve centers [7]. Human perceptual system does not simply record information about external world but actively organizes and interprets it. In the visual perception determination of the distal stimulus (characteristics of the external world objects) is done on the basis of information contained in the proximal stimulus (sensory - the retinal image). Perception is a three-phase process consisting of sensory phase, perceptual organization phase and identification phase (recognition of content of the stimulus).

The processes of identification, recognition and perceptual organization are very complicated and dependent on many cognitive, motivational - emotional and situational aspects, which shape the final effect of perceptual processing. The signal estimation threshold is a result of the decision making process, not the sensory one [6]. Perceptual processes are computational processes of the mind which integrate our knowledge with current evidence of the senses and stimulus context. Perceptual synthesis is always subject to modification. Perception delusions are a function of distortion of information received from the sensory pattern. They may occur in the absence of the known patterns, when the stimulus situation is ambiguous and the key information is missing. In terms of data organization and interpretation the dominant role is played by processes which have their origin in the mind and affect the interpretation, selection, and organization of data. They are called conceptually-driven or top-down processes. Aspects of higher mental processes: abstract concepts, knowledge, beliefs, value system is a filter for the incoming information.

Activation function of emotions in relation to cognitive processes indicates that the influence of the positive and negative emotions are different. Perception is not simply the result of perceptual analysis, it is also the result of emotional significance of the situation. In the case of a very strong negative emotions the field of attention is narrowing and a strong focus is placed on threatening stimuli, the critical details of an occurrence. Emotional stimulation is a key internal distractor, it limits field of attention - a man can not pick up information potentially available and focuses on the most threatening elements of the situation. Such changes in the field of attention are called tunnel memory. All attention resources of an individual are committed to a difficult situation to such extent that there is not enough of them to deal with parallel challenges and to solve additional problems. The human ability to perform several tasks at once is very limited. This problem is the subject of Kahneman theory of attentional resources (1973) [8].

Investigations of air accidents can never be reduced to the identification and elimination of a direct cause. The term "human error" is not synonymous with the term "pilot error". This way of thinking is considered as a significant and unfair simplification. Air accidents always result from accumulated errors of the whole, widely understood system of air operations protection and safety on different levels. James Reason presented a very accurate concept of description of air accident problems, dividing their causes into “active factors” and "hidden factors" [3]. In the aviation psychology it is known and appreciated concept of understanding of air accidents. It is widely used in civil aviation. It forces us to investigate and answer in detail to questions about circumstances that enabled or facilitated the occurrence of the pilot error.

In the presented air accident attention should be drawn to the presence of the following stress factors recognized in aviation as a high level stressors: a long flight with awareness of the failure and during landing approach totally surprising and unexpected emergency circumstances appeared, associated with a risk to the pilots and passengers lives.

The event took place on 1 November - All Souls' Day. This is an accidental situational context psychologically meaningful, significant, noticed by the pilots, significantly increasing the burden of dramatic events.

Psychological stress, which is an emergency situation associated with the risk to life is extremely complex neuro-hormonal and psychophysiological reaction with a maximum intensity. When the intensity of stress is high – the response is a complex psychophysiological reaction, resulting from an individual temperament and personality traits. This type of stress may change the ability to assess situation, interfere with the thinking processes, decision making and attention concentration.

Aviation psychology knows and describes the potential catastrophic consequences of pilots cognitive decline in stressful situations. Pilots particularly closely track the information enabling achievement of the intended goal and safety of a flight. They do many things at the same time: receive and process information from the control instruments, acoustic information (communication within the crew, acoustic signals from equipment), perform control activities acting on levers, buttons and switches. They take the thought processes developing strategies for solving problems arising in the course of a flight. With an increase in the burden on pilots the amount of missed information also increases and a variety of disruptions in orientation processes occur [2]. An analysis of perceptual and decision-making processes indicates that a pilot under influence of negative emotions of a high intensity and always under the influence of time pressure may not be able to focus attention on instruments indications. He ceases to trust them and loses the ability to assess the situation. Acting in the time deficit he can forget the order of the necessary flight operations, make improper decisions, inadequate to the situation and may be subject to illusions and delusions resulting from disorder of sensory perception [4]. A phenomenon of limitation of visual field, so called tunnel vision and other errors in the process of information perception and processing may occur, such as: confusing colors, confusing the right and left sides, omitting important information, inaccurate perception of equipment malfunctions and inadequate responses to these malfunctions [5].

The results of experimental studies show that excessive simultaneous load of information on sensory organs and operational memory of a pilot results in: decrease in effectiveness of the visual tracking process, losses in information reception, delay or interruption in the transmission of the received information, delay or lack of psychomotor reactions. In experimental, non-standard conditions, with high additional load of information transmitted by radio a pilot ceased to receive information from control instruments and properly perform corrective actions related to airplane control. Activities related to the visual tracking of the control instruments indications interfere with the reception of verbal information, its memorizing and transferring. In the course of reception of the radio information in a test situation pilot's eye movements were defined as minimal and not having a searching nature [2]. Pilot abilities to receive information of different modalities are limited. Excessive load causes that he makes errors in his operations.

Anxiety experienced in a difficult situation additionally reduces the level of human performance due to the phenomenon of narrowing the field of awareness, which hampers analysis and objective assessment of the situation. Mental strain and strong anxiety focus attention on difficulties and causes a tendency to withdrawal and self-defense. Emotional charge of anxiety experienced in a life-threatening situation is very strong, because it is deeply embedded in the evolutionarily oldest psychological mechanisms related to the struggle for survival. It may disturb mental functions which are phylogenetically younger, related to mindful management of attention resources, analytical thinking and decision-making.

4. Summary

Opinion of James Reason, that the most important role in the diagnosis of air accidents is played by so called "hidden factors" may be confirmed. The pilots can make errors, but the most important is consideration of the situational context, which contributed and could lead to decrease in the quality of an air operation execution without directly observed gross error in pilots' operations. How could an efficient flight operation support system contribute to the occurrence of the described air accident?

1. Pilots looking for information did not find in the Quick Reference Handbook any reference to their situation.

2. Pilots with many years of flight experience, who had numerous trainings including regular trainings in a flight simulator related to emergency situations, did not have a detailed knowledge on construction of the alternate landing gear extension system and knowledge necessary for solving problems that might arise in the situation of inability to extend landing gear with the alternate system.

3. Operations Center did not have a prompt and professional structure of predefined actions to be implemented in a crisis situation and had no ability to assist pilots reporting problems (regardless of days off, holidays, etc.).

4. Operation under the influence of stress and time pressure could have resulted in:

    4.1. Possible dysfunction of the processes of receiving and processing information by FO, which could contribute to inability to notice setting of the circuit breaker and proper diagnosis of this failure. It is worth noting an important fact, that if the pilots had had in their permanent memory a detailed knowledge on operation of the alternate landing gear extension system, they could have used it in their operational memory and avoid a hazard. Memory and intellect are more resistant to stress than perceptual functions [2].

4.2. Narrowing PF field of activity only to a perfect, careful fulfillment of his primary duties without any attempt to monitor FO actions.

Proper operation of a flight crew require detailed division of responsibilities, organization of work in the most efficient way, open and smooth communication within the crew, harmonious cooperation and understanding. Very important is the principle of mutual monitoring of actions essential for the flight ("cross-checking"). This is the optimal way to control an emergency symptoms, allowing verification of input data.

During the flight, PF in addition to his standard duties (i.e. controlling an aircraft) should control and monitor the whole process aimed at failure removal. All important changes should be checked on an ongoing basis, regardless of whether the change is made by PF, PM or autopilot [5]. A monitoring error consists in negligence of mutual check by pilots. The check process is determined by the conditions resulting from the principles of maintaining safety of flight - including the amount of time which is available to pilots in an emergency situation. If there is no urgent need for a very quick decision and reaction, the principle of mutual monitoring by pilots is recommended. In this way a loop of additional correction is achieved, which increases reliability of the whole system.

The role of mutual monitoring by the pilots during air operations, regardless of the automated monitoring systems, is important because errors in monitoring many times caused serious accidents [5].

It should be emphasized that in the framework of principles of flight safety, primary principle of limited trust must be applied.

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5. Tomasz Smolicz „Psychologia lotnicza dla pilotów” Polskie Linie Lotnicze „LOT”
6. Philip G. Zimbardo „Psychologia i życie”
7. Peter H. Lindsay, Donald A. Norman “Procesy przetwarzania informacji u człowieka”
8. Tomasz Maruszewski „Psychologia poznania”

ANNEX 6
to Final Report on accident to B-767-300, SP-LPC

This document was developed by LOT Polish Airlines internal Commission on Air Occurrences Investigation.

Evacuation of passengers from SP-LPC airplane after gear up landing

(Cabin crew actions)

Warsaw 2012

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1. Introduction

List of cabin crew is compiled by Crew Control department according to crew members ratings in four categories: Instructor, Supervisor, Purser, Steward. In the framework of these categories the crew members are listed according to the seniority.

During a pre-flight briefing instructor or supervisor arranges his team according to the needs of: training, checking, service and others (e.g. language). Prior to flight LO 16 CC1, who was also an instructor, arranged the team according to his needs (Figure 1).

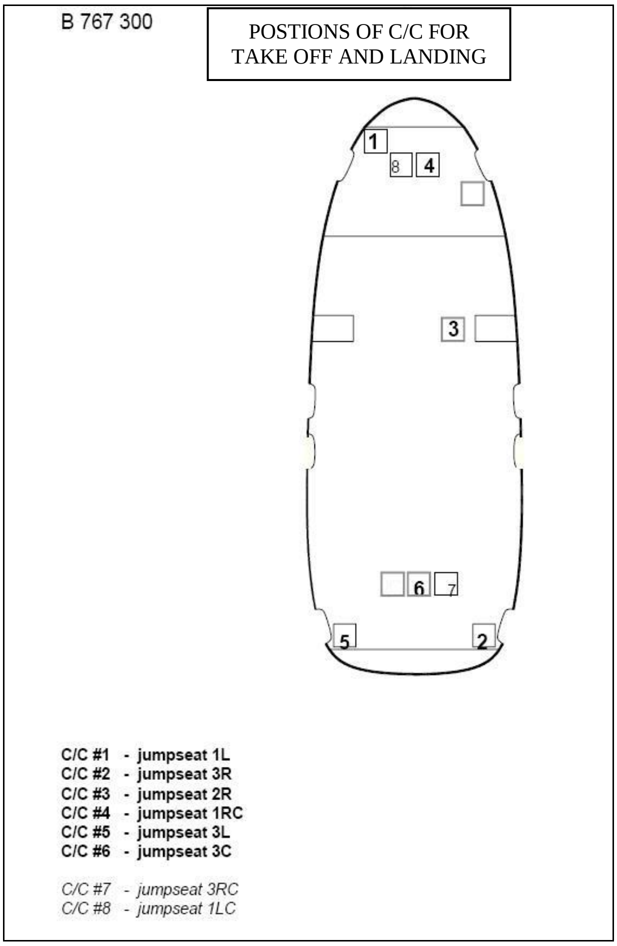


Figure 1. Arrangement of the cabin crew for flight LO 16.

2. Flight LO 16 Newark – Warsaw, November 1, 2011, B767 300ER, SP-LPC

2.1 Prior to take-off

Prior to the take-off the cabin crew carried out all procedural actions in accordance with their duties contained in the Cabin Crew Manual. During inspection of emergency equipment CC5 found that the headphone at CC2 position (jumpseat 3R) was inoperative and marked with INOP sticker.

2.2 After take-off

The airplane take-off was normal. About 20-25 minutes after the take-off the „Fasten Seat Belts" signal was still on. As the passengers began to get up from their seats, CC3 called CC1 asking about a cause of the signal still active. The call was answered by CC4 who informed CC3 that CC1 was in the cockpit. Soon after, the signal was turned off.

After starting their standard duties CCs working in the front and center galleys noticed problems with power supply. It was reported to the cockpit. After a while the problem was fixed. The pilots switched off and again switched on the galleys power supply.

CC1 was called to the cockpit (by INT) and informed about the hydraulic system failure (fluid leakage). In his statement, he wrote: *„I did not inform the rest of the cabin crew about the failure as well as about the fact that in the case of the next failure we would be forced to land at the nearest aerodrome".*

After consultation with the Operations Center in Warsaw Captain decided to continue the flight. The rest of the flight, until the attempt to extend the landing gear, was uneventful.

2.3 Prior to landing

Preparation of the cabin and passengers to landing in Warsaw proceeded in a standard way. About 20 minutes before the scheduled landing on EPWA CC1 was called to the cockpit and informed about problems with the landing gear extension.

After some time CC1 was instructed by Captain to prepare the cabin and passengers to a planned emergency landing, because repeated attempts to extend the landing gear had failed. Then CC1 returned to his workstation and using ALERT push button tried to call the heads of all sections to provide them with details of emergency landing. However, it turned out that the ALERT system was inoperative. Therefore, CC1 conveyed relevant information to CC4 and CC8, appointed CC4 to read the emergency announcement and instructed CC8 to train AP for door 1L.

On Captain order CC1 was spending most of the time in the cockpit, where he was kept informed about the situation development and an expected performance of the aircraft during gear up landing, took part in arrangements for evacuation, participated in checking circuit breakers, removed all loose objects from the cockpit and secured them. Therefore, part of the crew (CC3, CC6, CC2, CC5, CC7) was not informed directly by CC1 about the situation. CC2 went to the front galley, where she obtained the relevant information from CC4 and then, returning to the rear galley passed it to CC3, CC6, CC5 and CC7. At the same time CC4 commenced reading the emergency announcement.

During the cabin preparation (approximately 1,5 hour prior to landing) the passengers were calm, they carried out the crew commands, there was no active/passive panic. Emergency positions in the seats were demonstrated, all loose luggage was secured, the emergency exits were shown.

Mostly Polish-speaking passengers were chosen as APs to exits, except for APs to over-wing exits, where half of the APs were English speakers. 16 APs were trained for all aircraft exits and as assistants for traffic control in Section C.

Some cabin crew members had difficulties in finding the right pages in „AP Briefing & Evacuation Commands Booklet"; others, seeing that the selected assistants had problems with concentration of attention and they were able to understand only simple commands/words, abandoned using the text from the booklet and used their own simple words.

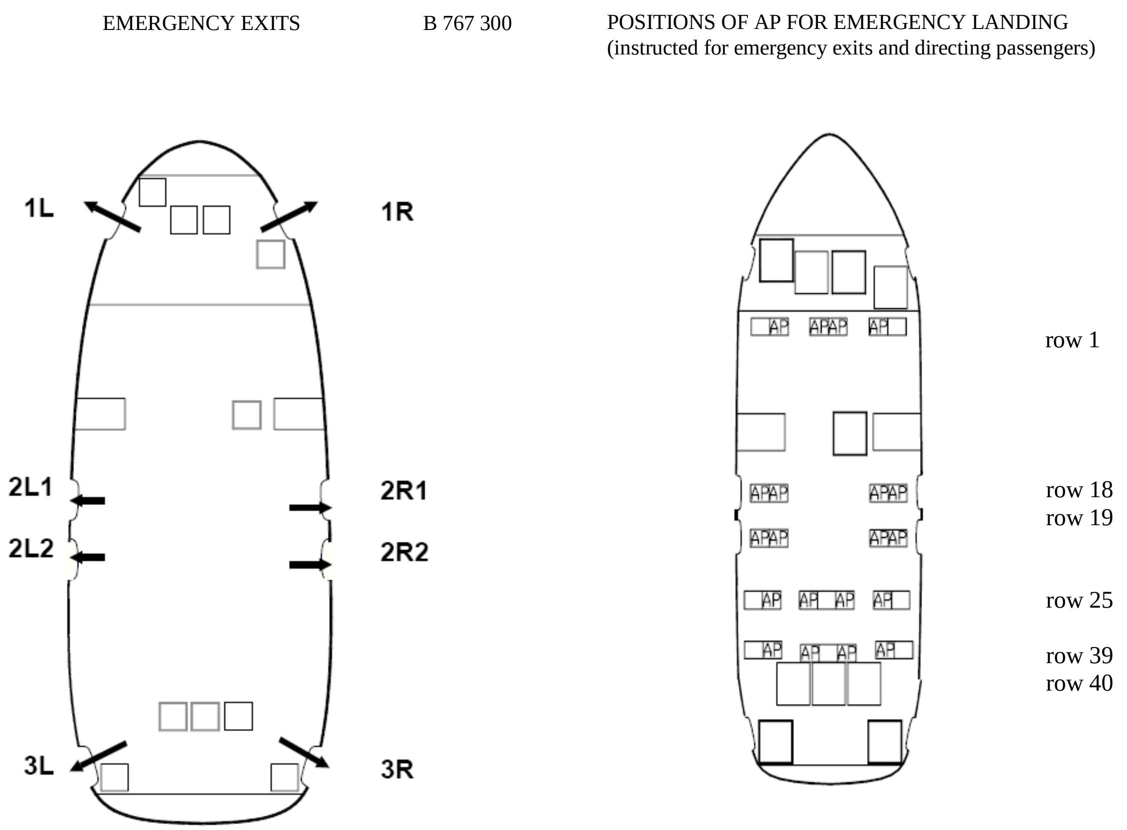


Figure 2. Designation of emergency exits and location of APs.

In the meantime, an additional attempt was carried out to extend the landing gear by producing the vertical g-load. The attempt ended in failure.

During preparation of the passengers for emergency landing CC1 was instructed by Captain that when the airplane would come to rest the cabin crew should begin evacuation of passengers immediately without waiting for an order from the cockpit.

A few minutes before the touchdown CC1 passed the airplane and informed all members of the cabin crew that when the airplane would come to rest they were to assess situation and start evacuation without waiting for an order (according to the arrangement with Captain).

CC1 also agreed with Captain that the command to adopt brace position would be issued by CC1, which actually happened. However, it should be noted that the cabin crew had problems with assessment of the airplane height which impeded estimation of the touchdown time.

Such a change in standard procedures, practiced in training, resulted in substantial disorder of the start of the evacuation by the cabin crew. As a result of the lack of a standard call-out "Crew at Stations" and "Evacuate" or use of EVAC button by Captain, the crew of the aft galley (CC5, CC2 and CC7) according to their own assessment of the airplane height began to shout "Brace position". CC1 issued the command „Brace position"(via PA) after issuing this command by the aft galley crew.

2.4 After landing

When the airplane came to rest 3L and 3R exits were opened; evacuation of the passengers began. 1L and 1R exits were opened later, about 12 seconds after the opening of the aft exits. This was due to CC1 illusion of normal landing (as with the landing gear extended). Because of that impression CC1 (despite earlier arrangements) wanted to make sure whether evacuation was necessary. It is worth emphasizing that the impressions of passengers and crew associated with gear up landing were different in the front and the aft parts of the aircraft.

CC1 entered the cockpit, received confirmation of the need for evacuation and then opened door 1L and began evacuation of passengers. CC4 opened door 1R at the same time.

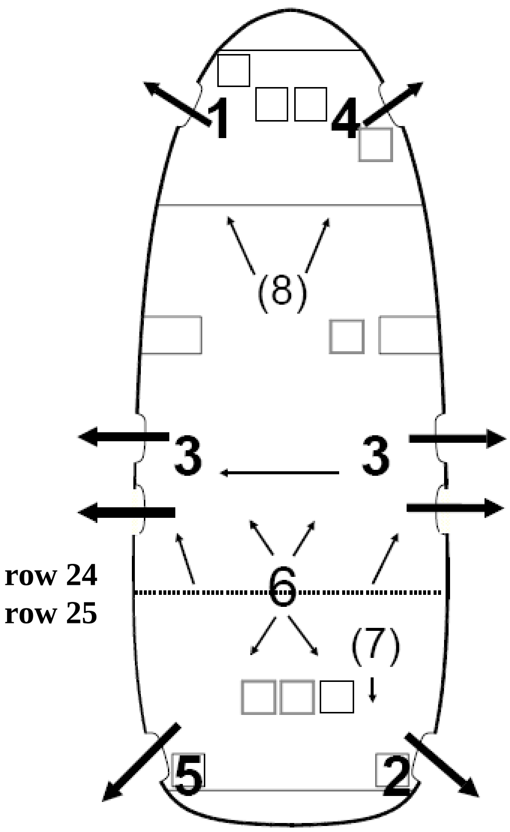
All main door exits were opened, escape slides were inflated.

Aft slides at doors 3L and 3R were set at small angle, which resulted in their flat position during the evacuation.

This setting of the slides slowed evacuation of the passengers. In the initial phase of the evacuation there was nobody who could assist passengers at the aft right slide (3R) - assistants failed, they ran away. Therefore, at some point CC2 had to slow down the evacuation significantly, so that the successive passengers did not fall on the heads of the ones sitting on the slide.

B 767 300

EMERGENCY LANDING
(planned and unplanned)
Action zones assigned to each CC



CC1 – door 1L
CC2 – door 3R
CC3 – emergency over-wing exits 2R1/2R2, 2L1/2L2
CC4 – door 1R
CC5 – door 3L
CC6 – directs pax from section C to exits 3R/3L and over-wing exits
CC7 – directs pax from the first seven rows, section C to over-wing exits, the rest of pax to exits 3R and 3L
CC8 - directs pax from sections A and B to exits 1L and 1R

Figure 3. Action zones of the cabin crew during emergency landing.

Figure 4. Position of the aft slides of SP-LPC airplane after gear up landing.

Over-wing emergency exits on the right side of the airplane (2R1 and 2R2) were not opened because after assessing the situation outside the airplane CC3 stated smoke hazard. After the touchdown engine No. 2 rubbed against dry surface of the runway leaving a plume of fire. The over-wing emergency exits on the left side of the airplane (2L1, 2L2) were opened, but nobody was evacuated this way. That was due to the fact that all passengers, directed by CC7 and CC6, very quickly moved towards the aft exits. Door 2L1 was thrown out of the airplane while door 2L2 remained inside. The wing slide was inflated, but the drop step under over-wing exit 2L2 did not open.

Figure 5. Evacuation slide on the let wing and locked drop step.

The cabin crew used evacuation commands adequate to the situation. EVAC system was activated at 3L door by CC5, who pressed the button.

Figure 6. Evacuation signaling system over CC5 seat.

During the evacuation, the crew tried to stop the passengers from taking their luggage, but they were not always effective.

The evacuation proceeded very efficiently.

Three members of the crew: CC8, CC6 and CC7 directed passengers to the active exits:

- CC8 to exits 1L and 1R;
- CC6 and CC7 to exits 3L and 3R;
- the rest of the crew carried out the evacuation at the main exits: CC1 - 1L, CC4 - 1R, CC2 - 3R, CC5 - 3L.

When all passengers left the airplane the crew checked the cabin and reported in the standard way „BOARD CLEAR", then they began to leave the airplane.

- CC4 and CC8 left the airplane via exit 1R;
- CC2, CC5, CC6, CC7, CC3, CC1, FO and CPT left the airplane via exit 3L.

Figure 7. Escape slide at door 1R

Figure 8. Escape slide at door 3L.

CC1 and CPT left the airplane as the last ones, after several re-checks to make sure that all persons left the board. They stayed on the board more than 5 minutes after the evacuation.

About 12-15 minutes after the end of the evacuation on the police request CC1 entered the airplane twice via slide 3L. During the second visit he saw in the cockpit third parties. Two other members of the cabin crew: CC3 and CC7 also entered the airplane via door 3L to take their personal belongings.

For quite a long time, about 15 minutes, the airplane cabin crew members were waiting by the airplane (some without shoes) for further decisions. Lack of proper coordination by the ground rescue services caused splitting of the crew: CC4 and CC8 were taken by bus with the passengers, the rest of the crew were waiting on the bus by the airplane for about 1,5 hours, with no information about CC4 and CC8.

3. Timing in UTC

Timing was determined on the basis of information from the Polish Air Navigation Services Agency.

Time: 13:38:40 hrs – touchdown;

Time: 13:39:25 hrs – airplane came to rest;

Time: 13:39:26 hrs – exit 3L opened;

Time: 13:39:27 hrs – exit 3R opened;

Time: 13:39:31 hrs – first passengers on escape slide 3L;

Time: 13:39:33 hrs – first passengers on escape slide 3R;

Time: 13:39:38 hrs – exit 1R opened;

Time: 13:39:40 hrs – exit 1L opened;

Time: 13:39:46 hrs – first passengers on escape slide 1L;

Time: 13:39:47 hrs – first passengers on escape slide 1R;

Time: 13:40:18 hrs – last passengers on escape slide 1R;

Time: 13:40:20 hrs – last passengers on escape slide 1L;

Time: 13:40:38 hrs – CC3 and CC6 left the airplane via exit 3L;

Time: 13:40:39 hrs – CC2 and CC7 left the airplane via exit 3L;

Time: 13:40:42 hrs – CC5 left the airplane via exit 3L;

Time: 13:40:45 hrs – last passenger (wearing a light shirt) left the airplane via exit 3L;

Time: 13:40:51 hrs – all passengers moved away from the airplane;

Time: 13:41:28 hrs – FO left the airplane via exit 3L;

Time: 13:44:38 hrs – CPT and CC1 are still on the board.

4. Zones of the crew actions after complete stop of the airplane

Zones of the crew actions are given at the end of this Chapter.

According to the Cabin Crew Manual in case of an emergency landing in unprepared terrain CCs take emergency equipment from the plane.

5. Conclusions from the evacuation of SP-LPC airplane:

1. The evacuation was successful. During the evacuation none of the passengers and the crew suffered any injuries. It was possible due to professional actions of the cabin crew, who not only demonstrated knowledge of the applicable procedures but also flexibility in particular situations. In addition, self-control of the crew should be assessed very highly because it prevented panic on the board. *In this context it seems that CC1 made the right decision in the initial phase of the occurrence and not informed the rest of the cabin crew about failure of the hydraulic system.*

2. During flight LO 16 an atmosphere of trust and excellent cooperation among the cabin crew prevailed, which was largely due to CC1 ability to build the team spirit. *It resulted in a very good cooperation of the cabin crew in the emergency situation under very strong pressure of the psychological factors.*

3. *The Commission from LOT Polish Airlines assessed communication and cooperation between the flight crew and the cabin crews as correct.*

4. During the preparation of the cabin and passengers for the planned emergency landing, some members of the cabin crew had problems in finding the right pages in the “AP Briefing & Evacuation Commands Briefing Booklet”. *Thus, the Commission from LOT Polish Airlines recommended that foiled, stiff paper sheets with the text of AP briefing should be permanently placed in the airplane near the emergency exits.*

5. During AP briefing the cabin crew noticed that the chosen assistants had problems with concentration of attention and they could understand only simple commands/words. Some members of the cabin crew abandoned using the text from the Booklet and used their own simple words. *It is necessary to simplify and shorten the text of AP briefing.*

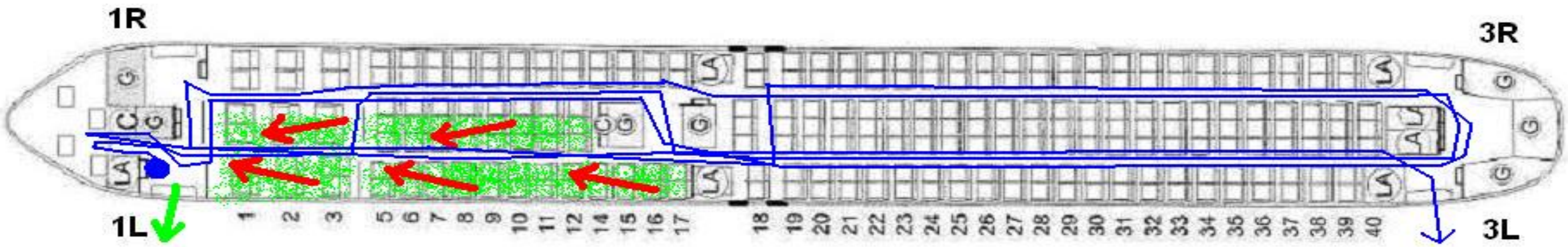
6. In accordance with Captain order CC1 issued the command to adopt the emergency position. However, the cabin crew had problems with assessment of the airplane height which hindered estimation of the touchdown time. As a result, the crew of the aft galley (CC5, CC2 and CC7) according to their own assessment of the airplane height began to shout „Brace position”. CC1 issued the command „Brace position” only0 after issuing this command by the aft galley crew. *LOT Polish Airlines Commission recommends that during crews training it should be emphasized that if possible, the command to adopt brace position should be issued by a flight crew.*

7. The commands “Brace position” shouted by CCs were completely inaudible in the cabin parts distant from the galleys. *A change in the applicable procedure should be considered, so that these commands were issued first by PA, and the shouting of commands was an alternative method applicable only in case of failure of the PA system.*

8. Captain ordered that when the airplane would come to rest the cabin crew were to begin evacuation of passengers immediately, without waiting for an order from the cockpit. CC1 ensuring whether the evacuation was actually required, delayed the evacuation via exits 1R and 1L for about 12 seconds in relation to the aft exits.

9. Based on assessment of observations made by the cabin crew members during the emergency landing, the LOT Commission recommends to put emphasis on practical elements during trainings in emergencies. In a real emergency particularly useful seem these elements which are not only mastered theoretically, but also repeated many times in practice.

CC1 action zone



<table>
<tr><th>Duties and responsibilities, description from CCM</th><th>Actual actions</th></tr>
<tr><td>
Receives information from the Captain about:
⇒ remaining time – type of preparation (full or shortened)
⇒ place – airport/random area, landing/ditching
⇒ type of failure - concerning sides of the aircraft or specific exits
⇒ signal - to adopt emergency position
⇒ signal - to start or cancel passengers evacuation and
⇒ special instructions - who and how informs the passengers

(C/C#1 refers to QRC - pre-planned emergency situation)

√ Communicates the Captain's information to the rest of CCs
√ Orders preparation of cabin and passengers for emergency landing or ditching
√ Switches lighting in section A on full
√ Reads emergency announcement – front galley
√ Checks doors 1L and 1R armed
√ Designates and instructs 2APs for door 1L
AP seats - 1B and 1C
√ Checks preparation of cabin, passengers and galleys for emergency landing or ditching, receives reports from other C/Cs
√ Switches off the lights in the front galley
√ Reports to the Captain completion of preparation for emergency landing or ditching
√ Reduces the lighting in section A to overwindow lights
√ Takes emergency landing or ditching seat – jumpseat 1L
√ Switches off the overwindow lights
√ On command switches on emergency lights, adopts emergency position and keeps it until the aircraft has come to a complete rest
√ After emergency landing and ditching evacuates passengers via door 1L
√ Takes flashlight, ELT, megaphone and first aid kit type A
√ Evacuates via door 1L
</td><td>
1. Received all necessary information from CPT
2. Communicated the information to CC4 and CC8
3. Switched lighting in section A on full
4. Did not read emergency announcement, ordered CC4 to read the emergency announcement
5. Did not designate or instruct APs for door 1L, ordered CC8 to designate and instruct APs
6. Removed the galley and aisle curtains
7. Checked door 1L and 1R armed
8. On CPT order took part in the arrangements for evacuation, participated in checking circuit breakers, removed from the cockpit and secured all loose objects
9. Received report from the rest of the CC members
10. Reported to CPT preparations completion
11. Reduced the cabin lighting
12. Took jumpseat 1L
13. Issued the command „ BRACE POSITION" via PA
14. Switched on the emergency lights
15. Evacuated passengers via door 1L
16. Received reports „ THE BOARD CLEAR"
17. Reported to CPT that all left the airplane
18. Checked the cabin several times along with CPT
19. After the evacuation stayed in the airplane for a long time
20. Left the airplane via exit 3L - time unknown
21. Entered the airplane twice via slide 3L
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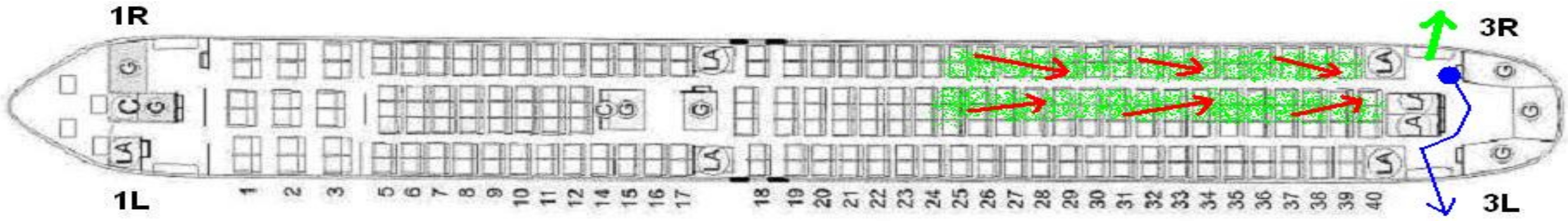
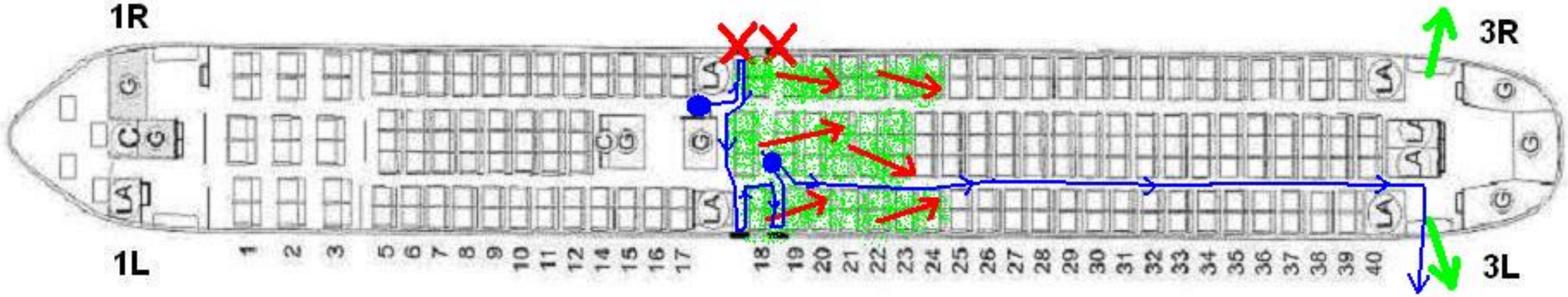
CC2 action zone



Duties and responsibilities, description from CCM	Actual actions
√ Receives information from C/C#1 √ Switches lighting in sections B and C on full √ During emergency announcement adopts position: **B 767 300 – row 29 section C, right aisle** √ Prepares passengers for emergency landing or ditching: **B 767 300 – rows 25-40** (emergency landing), **22-40** (ditching) **– right aisle** √ Designates and instructs two APs to assist by the door 3R **AP seats:** **B 767 300 – 39 F , 40 E** √ Checks and prepares rear galley, switches off the electrical devices of the galley √ Checks doors 3R and 3L armed √ Reports readiness to C/C#1 √ Reduces lighting in sections B and C to overwindow lights, switches off the light in the rear galley √ Takes emergency landing or ditching seat – **jumpseat 3R** √ Switches off the overwindow lights √ On command adopts emergency position and keeps it until aircraft has come to a complete rest √ **After emergency landing and ditching** evacuates passengers via door **3R** √ Takes **flashlight, megaphone, ELT and first aid kit type A** √ Evacuates via door 3R	1. Received all necessary information from C/C#4 and C/C#8 2. Switched lighting in section B an C on full 3. During the emergency announcement took the seat according to the applicable procedure 4. Prepared passengers in the assigned sections 5. Designated and instructed APs for exit 3R 6. Removed the galley and aisle curtains 7. Checked doors 3R and 3L armed 8. Switched off the galley power supply 9. Reported cabin readiness to C/C#1 10. Reduced lighting in sections B and C 11. Took jumpseat 3R 12. Without „BRACE POSITION" command started shouting out own commands 13. Evacuated passengers via door 3R 14. Received report „THE BOARD CLEAR" from C/C #7 15. Left the airplane via door 3L **at 13:40:39 hrs UTC** 16. After evacuation entered the airplane via slide 3L

CC3 action zone



Duties and responsibilities, description from CCM

- √ Receives information from C/C#1
- √ During emergency announcement adopts position:

  B 767 300 – row 5, right aisle

- √ Prepares passengers for emergency landing or ditching:

  B 767 300 – rows 5-24 (emergency landing), **5-21** (ditching) **–right aisle**

- √ Designates and instructs 2 or 8 APs to help:

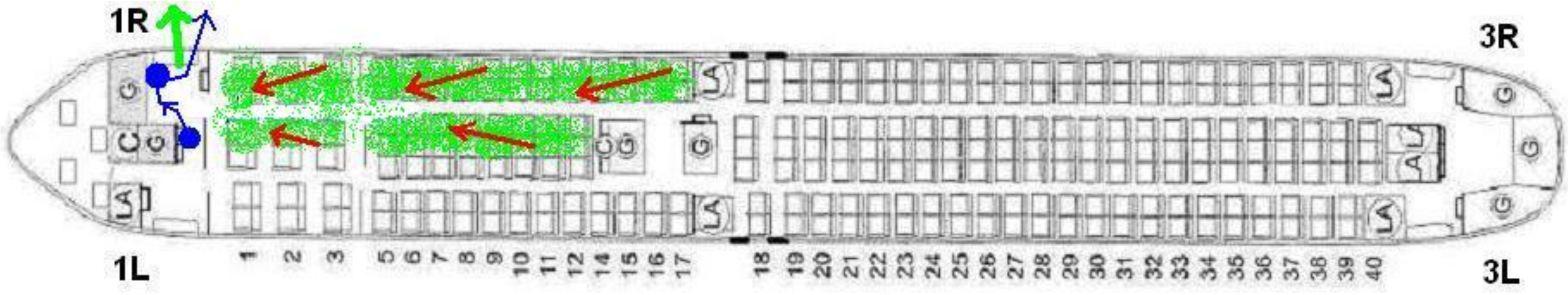
  B 767 300 – emergency over-wing exits **2R1, 2R2, 2L1, 2L2**
  APs seats (respectively) **18FG, 19FG, 18AB, 19AB**

- √ Prepares middle galley, switches off electrical devices and the lighting of the galley
- √ **For ditching :** (along with 2 APs or one AP and C/C#6 and C/C#7) checks the additional raft
- √ Removes handles protection in emergency over-wing exits
- √ Reports readiness to C/C#1
- √ Takes emergency landing or ditching seat
  B 767 300 - jumpseat 2R
- √ On command adopts emergency position and keeps it until aircraft has come to complete stop
- √ After emergency landing evacuates passengers via :
  B 767 300 – over-wing exit 2R1, 2R2, 2L1, 2L2 (passengers from **seven** rows 18-24)
- √ After ditching directs passengers to:
  B 767 300 - front exits **1R and 1L** (passengers from **four** rows 18-21) and
  rear exits **3R and 3L** (remaining passengers from section C)
- √ Takes **flashlight and first aid kit type E**
- √ Checks section **C**
- √ Evacuates via the closest exit

Actual actions

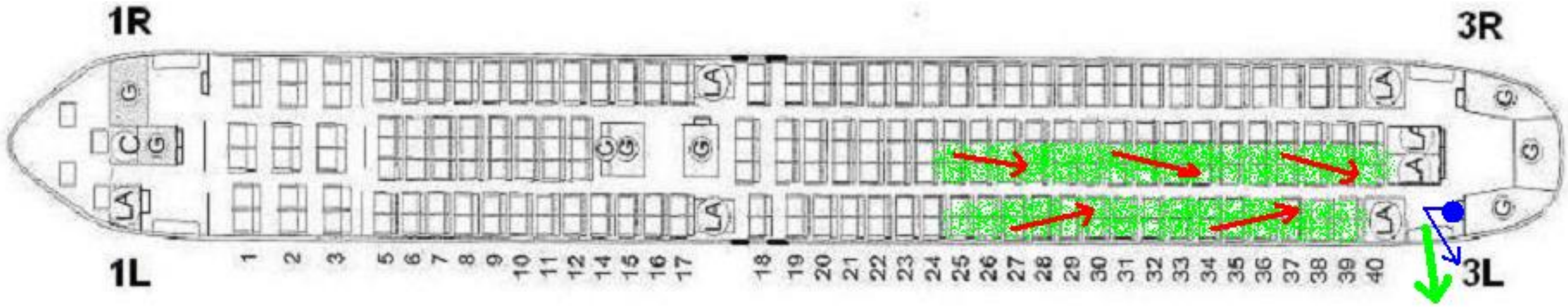
1. Received the information from C/C#2
2. Learned about the emergency landing from the emergency announcement
3. During the emergency announcement took the position according to the applicable procedure
4. Prepared passengers in the assigned sections
5. Designated and instructed APs for over-wing exits 2R1, 2R2, 2L1 and 2L2
6. Designated 2 APs
7. Removed the galley and aisle curtains
8. Switched off the galley power supply
9. Reported cabin readiness to C/C#1
10. Took jumpseat 2R
11. After „BRACE POSITION" command issued by C/C#1 via PA started shouting out own commands
12. Did not open exits on the right side - hazard
13. Opened over-wing exits from the left side
14. Did not evacuate anybody via emergency over-wing exit
15. Directed passengers to doors 3R and 3L
16. Checked section C and reported „THE BOARD CLEAR"
17. Left the airplane via door 3L **at 13:40:38 hrs UTC**
18. After evacuation entered the airplane via slide 3L

CC4 action zone



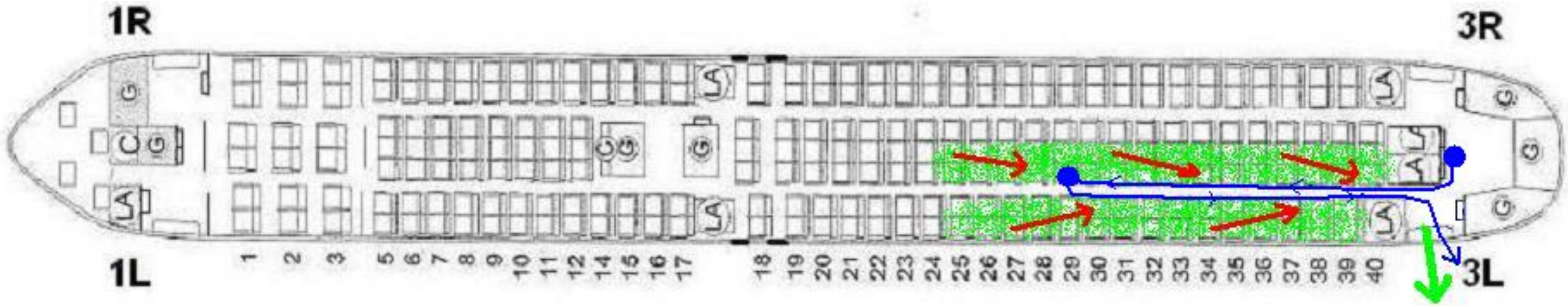
Duties and responsibilities, description from CCM	Actual actions
√ Receives information from C/C#1 √ During emergency announcement adopts position: **row 1, right aisle** √ Prepares passengers for emergency landing or ditching **B 767 300 – rows 1-3 ABCDEF** (section A) √ Designates and instructs 2 APs to assist by door 1R **AP seats - 1 DE** √ Prepares front galley, switches off electrical devices of the galley √ Checks doors 1R and 1L armed √ Reports readiness to C/C#1 √ Takes emergency landing or ditching seat – **jumpseat 1RC** √ On command adopts emergency position and keeps it until aircraft has come to complete stop √ **After emergency landing and ditching** evacuates passengers via door **1R** √ Takes **flashlight and first aid kit type A** √ Checks sections **A and B** √ Evacuates via the closest exit	1. Received information about the emergency landing from C/C#1 2. During the emergency announcement did not take the position according to the applicable procedure 3. On C/C#1 order read the emergency announcement 4. Prepared passengers in the assigned section 5. Designated and instructed APs for exit 1R 6. Switched off the galley power supply 7. Checked doors 1R and 1L armed 8. Reported cabin readiness to C/C#1 9. Took jumpseat 1RC 10. After „BRACE POSITION" command issued by C/C#1 via PA started shouting out own commands 11. Evacuated passengers via door 1R 12. Did not check sections A and B 13. Received from C/C#8 „THE BOARD CLEAR" report 14. Reported to C/C#1 „THE BOARD CLEAR" 15. Left the airplane via door 3R - **time unknown**

CC5 action zone



Duties and responsibilities, description from CCM	Actual actions
√ Receives information from C/C#1 √ During emergency announcement adopts position: **B 767 300 - row 18, section C, left aisle** √ Prepares passengers for emergency landing or ditching: **B 767 300 – rows 25-40** (emergency landing) **22-40** (ditching) **– left aisle** √ Designates and instructs 2 APs to assist by door 3R **AP seats:** **B 767 300 - 39B, 40C** √ Checks doors 3L and 3R armed √ Reports readiness to C/C#1 √ Takes emergency landing or ditching seat – **jumpseat 3L** √ On command adopts emergency position and keeps it until aircraft has come to a complete stop √ **After emergency landing and ditching** evacuates passengers via door **3L** √ Takes **flashlight** √ Evacuates via door 3L	1. Received information about the emergency landing from C/C#2 2. During the emergency announcement took the position according to the applicable procedure 3. Prepared passengers in the assigned section 4. Designated and instructed APs for exit 3L 5. Checked doors 3L and 3R armed 6. Reported cabin readiness to C/C#1 and C/C#2 7. Took jumpseat 3L 8. Without „BRACE POSITION” command started shouting out own commands 9. Evacuated passengers via door 3L 10. Checked section C 11. Received reports and reported „THE BOARD CLEAR” to C/C#2 12. Left the airplane via exit 3L at **13:40:42 hrs UTC** 13. After evacuation gathered and directed the passengers running on the runway

CC6 action zone



<table>
<tr><th>Duties and responsibilities, description from CCM</th><th>Actual actions</th></tr>
<tr><td>

√ Receives information from C/C#1
√ During emergency announcement adopts position :
B 767 300 – row 5, left aisle

√ Prepares passengers for emergency landing or ditching
B 767 300 – rows 5-24 (emergency landing), **5-21** (ditching) – **right aisle**

√ Designates and instructs 4 APs to direct the passengers:
B 767 300 landing, AP seats : 25 BC, 25 EF
B 767 300 ditching, AP seats: 22 BC, 22 EF

√ Reports readiness to C/C#1
√ Takes emergency landing or ditching seat
B 767 300 jumpseat 3C

√ On command adopts emergency position and keeps it until aircraft has come to a complete rest
√ After emergency landing evacuates passengers via exits:
B 767 300 - directs to exits **3R and 3L and over-wing**

√ **Takes flashlight**
√ Evacuates via the closest exit

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1. Received information about the emergency landing from C/C#2
2. During the emergency announcement took the position according to the applicable procedure
3. Prepared passengers in the assigned section
4. Designated and instructed APs directing passengers
5. Reported cabin readiness to C/C#2
6. Took jumpseat 3C
7. Without „BRACE POSITION” command started shouting out own commands
8. Did not direct passengers to the emergency over-wing exits
9. Directed passengers to door 3L
10. Checked section C, left aisle
11. Left the airplane via exit 3L at **13:40:38 hrs UTC**

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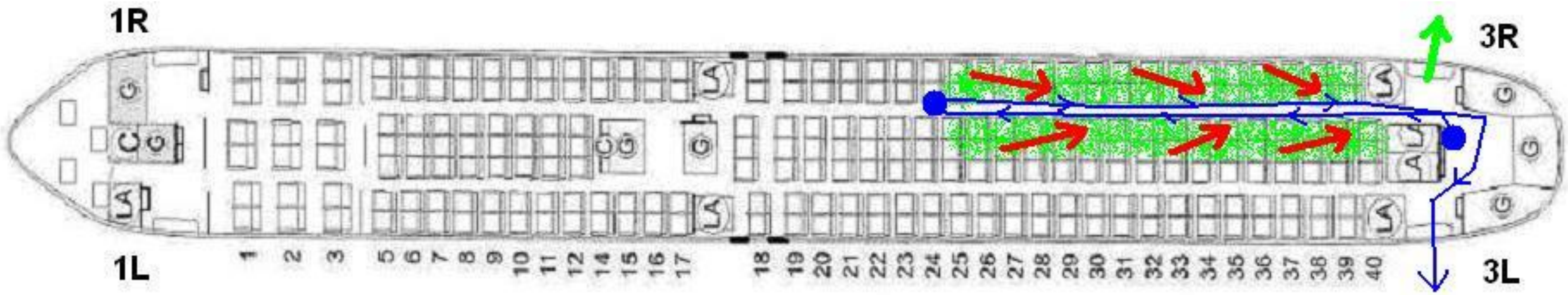
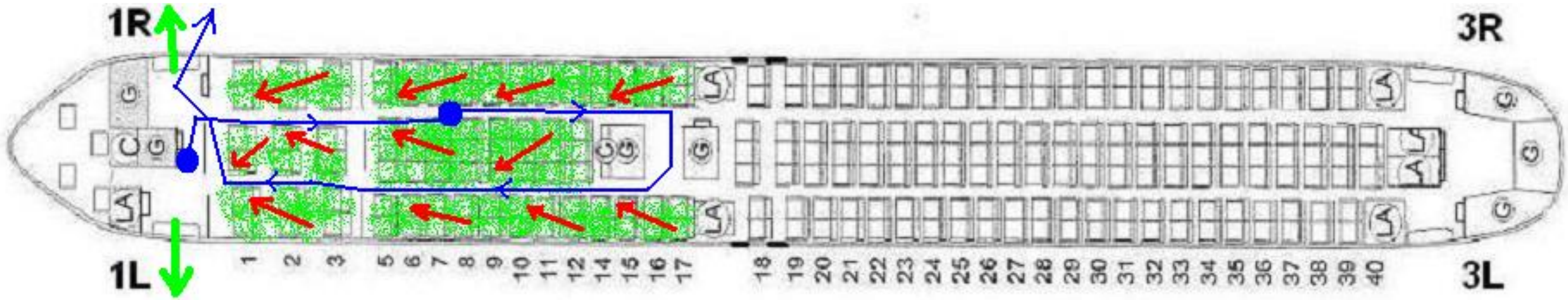
CC7 action zone



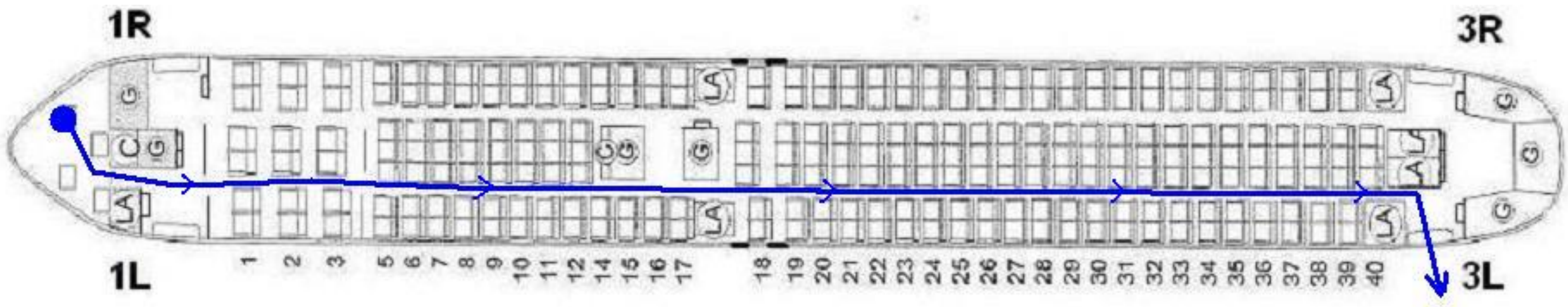
<table>
<tr><th>Duties and responsibilities, description from CCM</th><th>Actual actions</th></tr>
<tr><td>
√ Receives information from C/C#1
√ During emergency announcement remains at C/C#1's disposal
In case of full set of passengers on board his suggested position is:
B 767 300 – row 18 section C, right aisle
√ For emergency landing or ditching:
B 767 300 – remains at C/C#1 disposal and follows his commands
√ If necessary helps C/C#3 to check and prepare the additional raft
√ Reports readiness to C/C#1
√ Takes emergency landing or ditching seat – jumpseat 3RC
√ On command adopts emergency position and keeps it until aircraft has come to a complete stop
√ After emergency landing follows C/C#1 commands
√ In case of full set of passengers on board C/C#7 is suggested to direct the passengers to:
B767300 – over-wing exits (passengers from first seven rows, section C)
exits 3R and 3L (remaining passengers from section C)
√ Takes flashlight
√ Evacuates via the closest exit
</td><td>
1. Received information about the emergency landing from C/C#4
2. During the emergency announcement took the position according to the applicable procedure
3. Prepared passengers in section C
4. Helped to instruct APs directing passengers
5. Reported cabin readiness to C/C#2
6. Took jumpseat 3RC
7. Without „BRACE POSITION" command started shouting out own commands
8. Did not direct passengers to the over-wing exits
9. Directed passengers to door 3R
10. Checked section C, right aisle
11. Reported to C/C#2 „THE BOARD CLEAR"
12. Left the airplane via exit 3L at 13:40:44 hrs UTC
</td></tr>
</table>

CC8 action zone



Duties and responsibilities, description from CCM	Actual actions
√ Receives information from C/C#1 √ During emergency announcement remains at C/C#1's disposal In case of full set of passengers on board the suggested position is: **B 767 300 – row 29 section c, left aisle** √ Prepares passengers for emergency landing or ditching: **B 767 300 –** remains at C/C#1 disposal and follows his commands √ Reports readiness to C/C#1 √ Takes emergency landing or ditching seat – **jumpseat 1LC** √ On command adopts emergency position and keeps it until aircraft has come to a complete rest √ **After emergency landing** follows C/C#1 commands √ In case of full set of passengers on board C/C#7 is suggested to direct the passengers to: **B767300 – exits 1L and 1R** (passengers from sections A and B) √ Takes **flashlight** √ Evacuates via the closest exit	1. Received information about the emergency landing from C/C#1 2. During the emergency announcement took C/C#4 position (first row, right side) 3. Prepared passengers in section A 4. Designated and instructed APs for exit 1L 5. Reported cabin readiness to C/C#1 and C/C#4 6. Took jumpseat 1LC 7. After „BRACE POSITION" command issued by C/C#1 via PA started shouting out own commands 8. Directed passengers to door 1L and 1R 9. Checked sections A and B 10. Reported to C/C#4 „THE BOARD CLEAR" 11. Left the airplane via exit 1R at **13:40:.... hrs UTC**

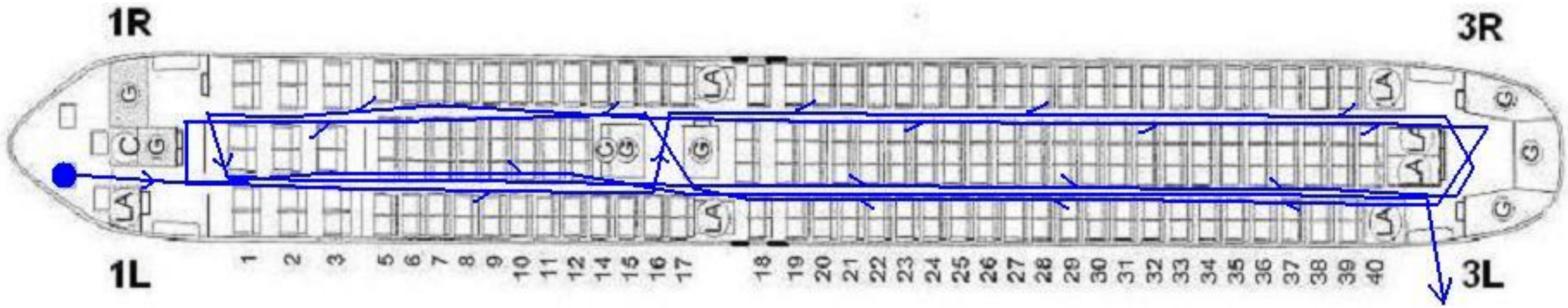
FO action zone



On Captain order FO checked the cabin to make sure that nobody remained on board the airplane.

He left the airplane at 13:41:28 hrs UTC.

CPT action zone



CPT and CC1 were in the cabin for more than 5 minutes checking the cabin several times.

It was not determined when they left the airplane.

ANNEX 7

to Final Report on accident to B-767-300, SP-LPC

This document was developed by management of Warsaw Chopin Airport.

RESCUE AND FIREFIGHTING ACTION AFTER EMERGENCY LANDING OF SP-LPC AIRPLANE
November 1, 2011

TABLE OF CONTENTS

ABBREVIATIONS

AFB	- Airport Fire Brigade
EAP	- Emergency Action Plan
KZ DOP	- Shift Manager of Airport Duty Officers
PA LSP	- Alarm Point of the Airport Fire Brigade
PSP	- State Fire Service
RK	- Concentration Area
RWY	- Runway
TWR	- Tower
TWY	- Taxiway
WSPR	- Provincial Station of Ambulance Service
WSPR&TM	- Provincial Station of Ambulance Service and Medical Transport
ZMR	- Medical Rescue Team
THR	- Threshold
DOP	- Airport Duty Officer

RESCUE AND FIRE FIGHTING ACTION AFTER EMERGENCY LANDING OF SP-LPC AIRPLANE

Introduction

The basis of the action was Emergency Action Plan (EAP) for Warsaw Chopin Airport.

On the day of the accident the users of EAP were:

- Airport Services
- Crisis Management Center of the capital city of Warsaw
- Provincial Command of the State Fire Service
- Provincial Station of Ambulance Service and Medical Transport "Meditrans"
- Police Station of Warsaw Chopin Airport
- Border Guard station of Warsaw Chopin Airport
- Customs Office "Airport" in Warsaw

1. AFB forces and resources planned for action in accordance with EAP

No	Rescue-firefighting vehicle	Rescue equipment	Extinguishing medium	Access time to RWY threshold
1.	1 x GCBAPr-12/5,5/250 BARRACUDA	steel and concrete cutter, apparatus for respiratory tract protection, hydraulic rescue kit, portable flashlights, big poleaxe, knives for cutting belts, medical equipment	water – 1x12000 dm^3 frothing agent - 1x1450 dm^3 powder – 1 x250 kg productivity – 1x5500 dm^3/min	THR 33 - up to 3 min THR 29 - up to 2,5 min THR 15 - up to 2 min THR 11 - up to 1,5 min
2.	3 x GCBAPr-12/5,5/250 EAGLE	steel and concrete cutter, apparatus for respiratory tract protection, hydraulic rescue kit, portable flashlights, big poleaxe, knives for cutting belts, medical equipment	water – 3x12000 dm^3 frothing agent - 3x1500 dm^3 powder – 3 x250 kg productivity - 3x5500 dm^3/min	THR 33 - up to 3 min THR 29 - up to 2,5 min THR 15 - up to 2 min THR 11 - up to 1,5 min
3.	1 x GCBAPr-5/5,5/150 EAGLE	steel and concrete cutter, apparatus for respiratory tract protection, hydraulic rescue kit, portable flashlights, big poleaxe, knives for cutting belts, medical equipment	water - 1x5000 dm^3 frothing agent - 1x600 dm^3 powder - 1x 2x75 kg productivity - 5500 dm^3/min	THR 33 - up to 3 min THR 29 - up to 2,5 min THR 15 - up to 2 min THR 11 - up to 1,5 min
4.	2 x GCBAPr-9/6,5/250 TIGER	apparatus for respiratory tract protection, fire arm, water - foam equipment and fittings	water – 2x9000 dm^3 frothing agent - 2x1080 dm^3 powder – 2 x250 kg productivity – 2x6500 dm^3/min	THR 33 - up to 3 min TKR 29 - up to 2,5 min THR15 - up to 2 min THR 11 - up to 1,5 min

No	Rescue-firefighting vehicle	Rescue equipment	Extinguishing medium	Access time to RWY threshold
5.	SRT MERCEDES	radiation equipment, acid and lye proof clothing, steel and concrete cutter, chain saw, hydraulic rescue kit, air-bags, respiratory systems, smoke removing aggregate, chemical pump, not-sparking tools, dielectric equipment, lighting equipment	water - 1 x 2000 dm^3 frothing agent - 1 x 240 dm^3 powder - 135 kg productivity - 2700 dm^3/min	THR 33 - up to 3 min THR 29 - up to 2,5 min THR15 - up to 2 min THR 11 - up to 1,5 min
6.	GBMPrSn Mercedes	not applicable	water - 600 dm^3, frothing agent -80 dm^3 powder - 250 kg, CO_2 - 2 x 30 kg	not applicable

Notification: KZ DOP
Tasking: PA LSP

2. Chronology

Time: 07:00 hrs

Duty services did not report any comments to the course of duty.
Airport equipment and systems operational.

Meteorological conditions:
- visibility: 10 km;
- cloud base: first layer - 500 m, second layer -1300 m;
- temperature: 12° C;
- wind: 3m/s, direction: south-east.

Time: 12:23 hrs

TWR controller declared a state of uncertainty for flight LO 16 and informed KZ-DOP accordingly. The crew reported technical problems with the flaps and then with the landing gear.

Time: 12:24 hrs

KZ-DOP informed ZMR and AFB about declaration of state of uncertainty for flight LO 16.

Time: 12:25 hrs

TWR controller forwarded a detailed information on SP-LPC position (holding in „Linin” area), number of persons on the board (231) and fuel quantity (7,7 t).

Time: 12:26 hrs

TWR controller forwarded to KZ-DOP information that flight crew of LO 16 declared EMERGENCY. Landing with flaps and landing gear up. KZ-DOP declared alert for the airport services.

Time: 12:27 hrs

TWR controller declared alert for AFB, DOP and ZMR.
AFB vehicles took pre-planned positions along RWY 33.
KZ-DOP informed WSPR&TM dispatcher about declaration of alert for an aircraft with 231 persons on board.

Time: 12:28 hrs.

Vehicles of airport services arrived at Concentration Area No. 1.

Time: 12:55 hrs

Firefighter No. 1, commanding the rescue operation, decided to distribute foam on both sides of RWY 33 centre line on the section: 100 m from RWY 33 THR to TWY „D" (approximately 3000 m long).

Time: 12:59 hrs.

Arrival of the external forces (PSP, WSPRiTS ambulances) at RK 2.

Time: 13:05 hrs.

Firefighter No. 1 informed all services that the airplane would land with the landing gear up.

Time: 13:15 hrs.

Completion of arrangement of the State Fire Service and the city medical services vehicles in RK 2.

Time: 13:16 hrs.

Airplane at a distance of 12 miles from the runway. Rescue services in full readiness.

Time: 13:32 hrs.

The airplane commenced the final approach.

Time: 13:37 hrs.

The airplane in sight of the airport services. The landing gear up confirmed.

Time: 13:38 hrs.

Airplane touched down and was moving on the surface of RWY 33, along its centre line. Visible sparks from the right engine being suppressed by the applied foam.

Time: 13:39 hrs.

The airplane came to rest approximately 42 m behind RWY 29 centre line . Visible fire of the right engine. The crew activated the rescue traps. Evacuation of passengers commenced.
AFB units arrived. Extinguishing of the right engine fire and securing the airplane structure against outbreak of fire commenced.
Closing the airport for air traffic

Time: 13:41 hrs.

Completion of the passengers evacuation. The engines are being cooled down.

Time: 13:47 hrs.

Transport of the passengers to the VIP lounge in the terminal. Care offered to the passengers.

Time: 13:53 hrs.

Completion of the airplane searching. No passengers on the board. Nobody injured.

Time: 13:56 hrs.

City ambulances left the airport area.

Time: 14:06 hrs.

Completion of the rescue and firefighting operation.

Time: 14:16 hrs.

The State Fire Service units left the airport.

Time: 14:48 hrs.

Cancellation of alert for the airport services. Sending the report to SCAAI.

3. Forces and resources involved in the rescue and firefighting operation

- 10 rescue-fire fighting units and 18 firefighters of the Airport Fire Brigade;
- 21 teams (81 firefighters) of the State Fire Service;
- 2 Airport Medical Rescue Teams (7 persons), additionally six off duty persons and two resuscitation ambulances;
- 33 ambulances of the Provincial Station of Ambulance Service and Medical Transport "MediTrans" (about 110 persons);
- Police - initially 10 cars with 30 policemen, and later additionally 15 vehicles and 140 persons securing the accident site;
- Border Guard - 3 vehicles and 12 persons;
- Vehicular Traffic Supervision - 1 vehicle and 2 airport employees;
- Airport Security Service - 5 cars and 21 airport employees;
- Airport Duty Operational Officers – 4 persons.

In total, about 420 persons took part in the operation.

4. Organization of psychological assistance for the passengers and their families/friends

- Organization of assistance for families and passengers was carried out in constant and close cooperation among: Medical Service (Head of the Service, Psychologist and Rescue Medical Team), Passenger Service, Airport Chaplain and LOT Victim Assistance Team.
- According to „Procedure of Services Notification and Launching Activities in Dedicated Facilities in Emergency Situations at Warsaw Chopin Airport" - (Edition 1) CENTRE FOR PASSENGERS (VIP Lounge) and additionally CENTRE FOR FAMILIES/FRIENDS were established (Conference Center in terminal).
- Passengers were provided with the opportunity of telephone contact with their families/friends, access to information (including the Internet and TV), hot and cold drinks, snacks, blankets, personal care products, etc.
- Passengers were provided with psychological care by Psychologist from Chopin Airport and LOT Victim Assistance Team (Operator).
- A psychologist was present at the airport from 14:45 hrs to 24:00 hrs to assist the passengers.

- Passengers received booklets containing basic information about typical reactions experienced in case of participation in a potentially traumatic event, and the basic methods of dealing with the stress. The fact that passengers could take the materials with them was very important because the psychological effects of such events often arise a few days or months after the occurrence.
- Chopin Airport developed Local Emergency Response Action Plan (LERAP). LERAP of Chopin Airport is a source material for cooperating organizations. After analysis of the operations carried out on 1 November 2011 the provisions of LERAP were extended to cover the procedures of dealing with passengers by representatives of the state services (Police, Border Guard).

5. Photographic documentation

5.1. Concentration of forces and resources, runway preparation

Photo 1. Concentration area of airport services.

Photo 2. Airport personnel in the concentration area.

Photo 3. Concentration area of external services.

Photo 4. Vehicles of Airport Fire Brigade .

5.2. Landing and landing roll of the airplane

Photo 5. Vehicle of Airport Fire Brigade in the area of RWY 33 threshold.

Photo 6. Touchdown of SP-LPC airplane.

Photo 7. Landing roll of SP-LPC airplane and fire of the right engine.

Photo 8. Stop of SP-LPC airplane.

5.3. Evacuation and the rescue - firefighting operation

Photo 9. Deployment of the rear right emergency escape slide .

Photo 10. Deployed escape slides of SP-LPC airplane.

Photo 11. Evacuated passengers of SP-LPC airplane.

Photo 12. Firefighting action carried out from a vehicle of Airport Fire Brigade

5.4. Accident site

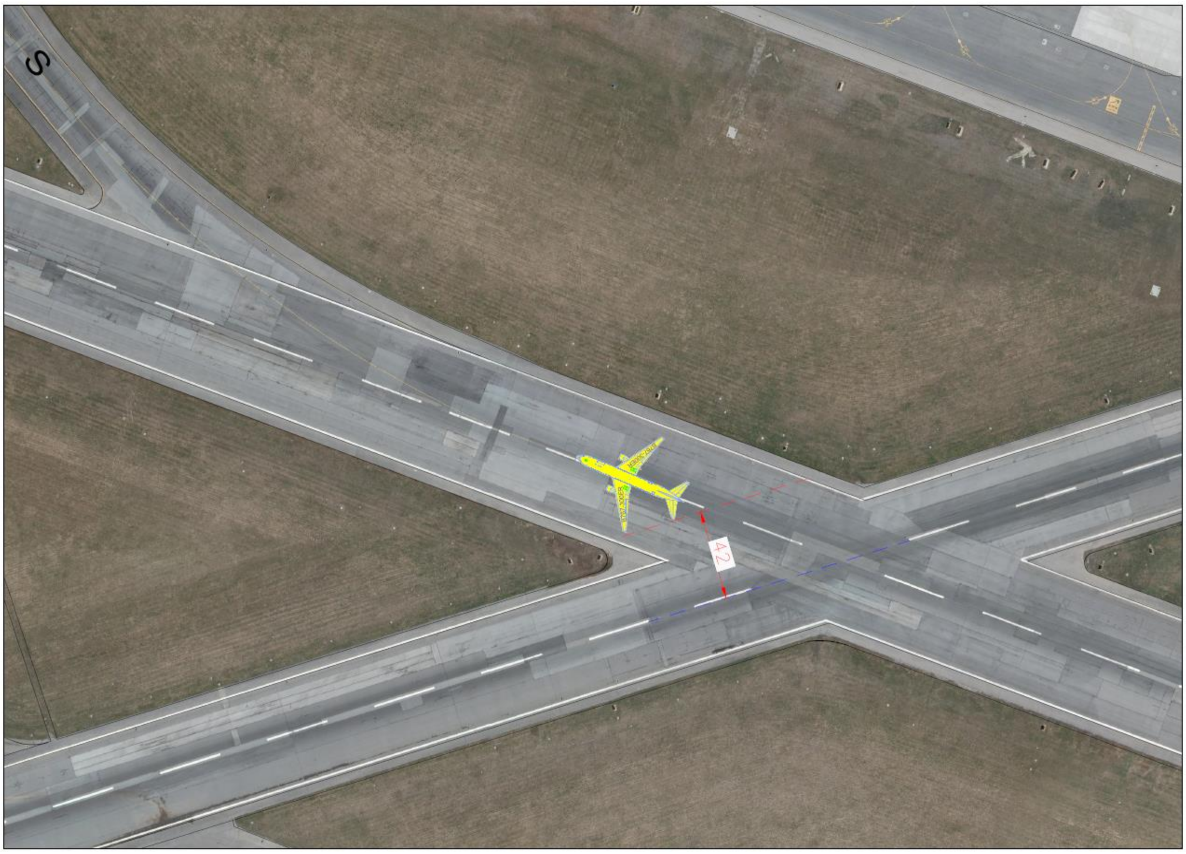


Photo 13. Stop place of SP-LPC airplane.