

## **FINAL REPORT of Civil Aviation Investigation**

OCCURRENCE TYPE	<b>Incident</b>
DATE AND TIME	11.12.2015 / 19:28 UTC; 22:28 LT
LOCATION	Kyiv/Zhulyany Airport (UKKK)
AIRCRAFT	Challenger 850 CL (CL-600-2B19)
REGISTRATION	OY-VGA
OPERATOR	ExecuJet Europe A/S

The Investigation Board (hereinafter – the Board), which was appointed by the Order No.118 dated 14.12.2015, issued by the Director of the National Bureau of Air Accidents and Incidents Investigation with Civil Aircraft (NBAAI), conducted during the period of 14.12.15 to 23.09.16 the investigation into an incident with Challenger 850 CL OY-VGA of “ExecuJet Europe A/S” (Denmark), which occurred on 11.12.2015 at landing at Kyiv (Zhulyany) Airport.

According to the standards and recommendations of the International Civil Aviation Organization, the present report is issued for the only purpose of air accidents prevention in the future.

The purpose of this investigation is not to establish a share of someone's fault or responsibility.

The Draft Final Report was submitted for comments to the involved parts, according to the provisions of the international regulatory framework.

This investigation report and materials should not be used by administrative, office, public prosecutor's, court bodies, insurers for establishment of fault or responsibility (according to requirements of Article 119 of the Air Code of Ukraine).

## **ABBREVIATIONS**

AC – aircraft;  
AFM – aircraft flight manual;  
ATC – air traffic control;  
AMM – aircraft maintenance manual  
AMSC – aviation meteorological station civil  
CPL – commercial pilot licence;  
CRS – certificate release to service;  
DA – decision altitude;  
DH – decision height;  
MAINT – maintenance;  
MH – magnetic heading;  
PIC – pilot in command;  
PAN-PAN – the international, radio-telephony urgency signal. When repeated three times, indicates uncertainty or alert followed by the nature of the urgency;  
PCN – pavement classification number;  
RVR – runway visual range;  
RWY – runway;  
TC – dispatcher of tower control;  
TW – taxiway;  
UTC – coordinated universal time.

### **1. Circumstances**

On December 11, 2015, the crew consisting of PIC, copilot and one flight attendant performed a charter passenger flight en-route Larnaca (Cyprus) – Kyiv (Zhulyany) on Challenger 850 CL aircraft, registration OY-VGA, of “ExecuJet Europe A/S” airline (Denmark). There were 2 passengers aboard. The take-off was carried out from the airport of Larnaca (Cyprus) at 16:18 UTC. At landing approach to Runway26 at Kyiv (Zhulyany) Airport, PIC switched the flap extension lever to 8°, however, “Flaps Fail” alarm was triggered, and flaps remained in “UP” position. PIC made the decision on a go-around maneuver. After the go-around flight maneuver and performance by the crew of the procedures envisaged by AFM, a safe landing was conducted at Kyiv (Zhulyany) Airport on 19:28 UTC with flaps “UP” position.

There were no injured among the crew members and passengers.

NBAAI was notified in written of this incident at 23:39LT (20:39 UTC) on 11 December 2015.

The NBAAI sent to the Accident Investigation Board (Denmark) the incident notification No. 4.11-77 of 14 December 2015.

## 2. Factual Information

### 2.1. Crew Details

Post	PIC
Sex	Male
Age	48 years old
Pilot Licence	CPL(A) , #E/FCL/00038286, initial issue 06.08.2007. Spain, valid to: 31.05.2016.
Rating	CRJ100/CL65 IR, valid till 31.05.2016.
Minimum for landing (distance and altitude)	RVR – 800m. DA – 787ft. DH – 200ft.
Flight hours (total)	7500h
Private pilot flight hours	200h
Commercial flight hours	7300h
Flight hours as a Captain	2550h
Flight hours on CRJ2	5150h

### 2.2. Ground Personnel Data

Not relevant to the incident.

### 2.3. Aircraft Information

Type:	CL-600-2B19 (Regional Jet Series 100) (Bombardier Challenger 850 CL)
AC registration no:	OY-VGA
Serial no.:	8077
Manufacturer	Bombardier Inc. – Canadair
Engines:	General Electric Co. 2 x CF 34-3B1 turbofan engines
Airworthiness Review Certificate (ARC) valid until 31 Jul 2016	
Year of production:	2008
Total airframe hours/cycles:	1386h 57min / 758
Date of Base maintenance:	14.07.2015
Airframe hours/cycles after last Base maintenance:	45h 04min / 20
Base maintenance performed by:	Lufthansa Bombardier Aviation Services GmbH (Part 145 Approval Reference)

### 2.3.1 Flap Actuating Mechanism System – Description and Operation

1) The flap actuating – mechanism system extends and retracts the flaps. The flap Actuating – mechanism system contains the components that follow:

- Ten flexible drive shafts;
- Four inboard flap actuators;
- Four outboard flap actuators.

2) Component Details description:

- Flexible Drive Shafts:

a) Ten flexible drive shafts are found aft of the wing rear spar. The flexible drive shafts have different lengths and diameters. There are five different types, and there are two of each type. The flexible drive shafts on the left wing and right wing are the same. The flexible drive shafts are designated as No. 1 (inboard most) through No. 5 (outboard most).

b) Each flexible drive shaft contains an outer tubing and a core that you can remove. The core is made from carbon steel impregnated with grease. The outer tubing is made from a continuous, extruded, smooth bore, graphite/Teflon tubing, with an outer layer of braided corrosion-resistant steel. (Refer to Figure 1, 2).

- Flap Actuators:

a) The eight flap actuators are installed on the wing trailing edge, two actuators to each flap panel. There are five different types of flap actuators. The four actuators that operate the inboard flaps are interchangeable. Each of the outboard flap actuators are different. Two different gear reductions at the inboard and outboard flaps are used to get a uniform movement of both flaps.



Fig.1



Fig.2

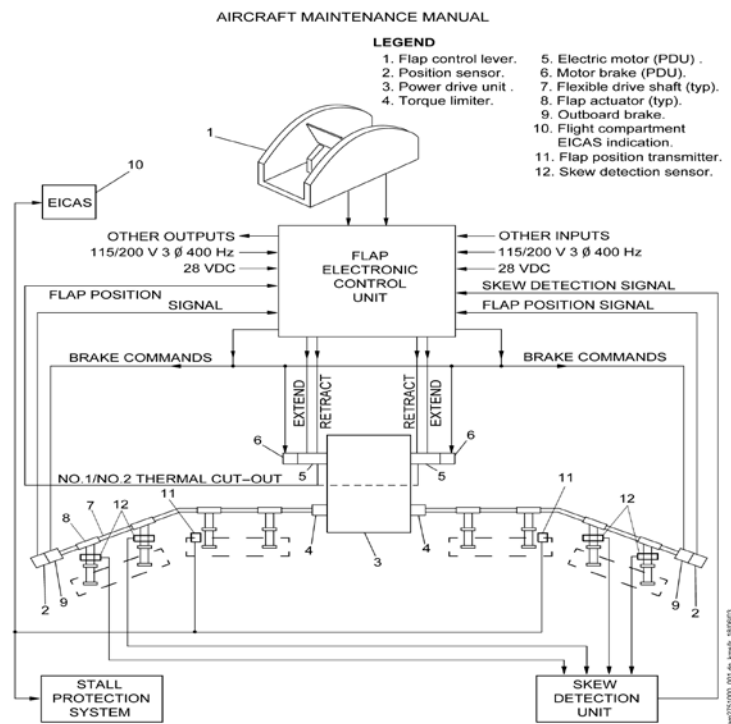
6) The flap actuators are of the linear ball-screw type, gimbal marked to the wing rear spar and the flap hinges (Fig.3). The ball screw circuits are dual for redundancy. They also incorporate ice scrapers and wipers. Each flap actuator

has a ball nut and screw assembly with single-stage helical gearing. A torque limiter, which is used as a load limiting device, is included in each flap actuator.



Fig.3

b) The torque limiter has a series of alternative friction plates. Half of these are splined to the input shaft and half to the stationary housing. Excess torque through the gear mesh causes the spring pack to close. This lets the input shaft and the friction plate's move. This also causes a pressure on the friction plate stack, which causes brake torque. This keeps the output force of the actuator to a limit. The scheme of Flap actuating mechanism system refers on Fig.4.



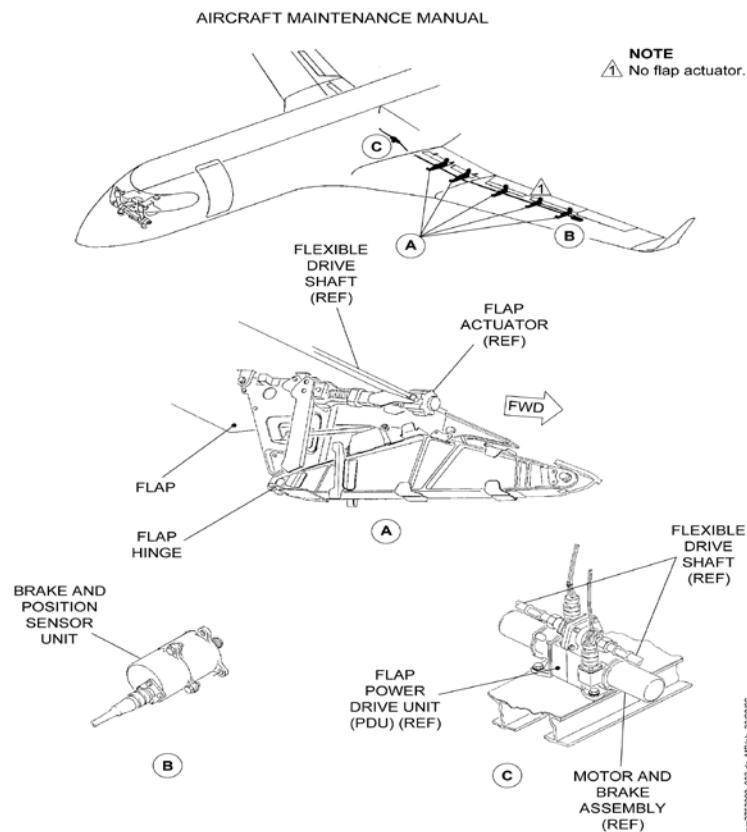
Flap Actuating Mechanism System – Schematic  
Figure 1

Fig.4

### 3. Operation

The flexible drive shafts transmit torque from the power drive unit (PDU) to each flap actuator, and to the brake and position sensor unit (BPSU). Rotation of the input drive causes the ball screw shaft to turn. This rotation causes the ball nut to move along the shaft in the extend or retract direction.

Component Location of the Flap actuating mechanism system refers to Fig. 5.



Flap Actuating Mechanism System – Component Location  
Figure 2

Fig.5

### 2.4 Meteorological Information

The factual aerodrome meteorological information at the moment of the incident occurrence was as follows:

Wind in touchdown zone – 240°, 4 m/s, variable, changed from 200° to 270°, visibility – 10 km, continuous cloudiness, altitude – 360m, air temperature was 2°C, dew point temperature minus 0°C, QNH – 1024 hPa, a forecast for landing had no changes.

The crew had all the necessary information about factual and forecasted meteorological conditions at aerodrome Kyiv (Zhulyany).

Meteorological conditions had no effect on the incident occurrence.

## 2.5. ATC and Communications

Not relevant to the incident.

## 2.6. Aerodrome Information

Aerodrome «Kyiv» (Zhulyany), which was an incident site, is a certified civil aviation aerodrome included to the state register of civil aerodromes of Ukraine. It has the Aerodrome Certificate No. AII 09-02, valid until 16.03.2017. Runway dimensions are 2310x45m, type of pavement – asphalt-concrete, PCN 44/R/C/X/T, equipped for a precision approach (I category). With MH259° threshold of RWY displaced by 48m, with MH79° -150m.

Aerodrome Class is B (4C).

The Aerodrome is suitable for operation in the day and night, all the year round.

The aerodrome is equipped with the landing system – landing system equipment, radio beacon system type landing system-90 and aerodrome lighting equipment (high intensity lights).

The required firefighting level is Category 7.

Before both RWY ends, the reinforced parts of the strip are provided (width 45m and length 50m). The strip extends beyond the end of RWY 26 for 150m and has the overall length of 2460m. In view of presence of obstacles, it is impossible to provide such a distance beyond the end of RWY 08, therefore, the available distances were reduced. The strip on both sides from RWY center line extends for 150m (the overall strip width is 300m). The maintained part of the strip extends from the center line of RWY on both sides for 70m. At the end of take-off run available distances, with both MH, the Aircraft Flight Manual indicates the clearways, which have the length of 150m and extend for 75m to the both sides from the continuous center line of RWY.

ARP coordinates: 502407N; 0302707E.

Aerodrome elevation – 178.9 m.

Magnetic variation – 7°E.

Available distances:

### **With MH259°:**

TORA = 2160m

TODA = 2310m

ASDA = 2310m

LDA = 2262m

### **With MH79°:**

TORA = 2310m

TODA = 2460m

ASDA = 2310m

LDA = 2160m

In accordance with i.9 of the Appendix to the Certificate, the aerodrome is suitable for operation of aircrafts with index 4 (code 4C with restrictions), all types of helicopters and lighter aircrafts.

Pursuant to classification set out in Doc 9157 ICAO, part 2 «Taxiways, Aprons and Holding Bays», for an aircraft type of Challenger CRJ 100LR with the assigned code 4B, the calculated airfield length for this type is 1880m.

The required landing distance, which was calculated by PIC, made 1328m. The available landing distance published in the Aircraft Flight Manual made 2262m for this aerodrome.

After the incident, at 19.32 UTC, the commission consisting of shift head of aerodrome service, flight safety inspector and PIC, prepared the runway pavement inspection report. As a result of the inspection, it was established that RWY was wet, treated with a solid chemical reagent, friction coefficient = 0.6/0.6/0.6, braking action – good. Foreign objects were absent.

Thereby, the available landing distance at the aerodrome was sufficient for landing of this type of aircraft, including a case of landing with flaps in «UP» position. The runway condition didn't contribute to the emergency escalation during the aircraft landing.

## **2.7. Actions of Emergency and Firefighting Services**

According to the information, which was provided by the airport and aero navigation service provider, on 11 December 2015, after the crew declared alarm «PAN-PAN» at 19:18 UTC and after their request to call the airport firefighting team, at the moment of aircraft landing, at 19:19 UTC, the tower supervisor declared an emergency alarm, indicated a place for arrival of the emergency and firefighting teams in square 3D (end of taxiway 1 from the apron).

In accordance with records of internal airport talks, the firefighting team was ready to occupy taxiway-1 at 19:21 UTC (that is in 2 minutes after the declared emergency alarm), however, the tower supervisor gave an order for fire fighting vehicles to wait for aircraft landing. In 6 minutes (3 minutes before the aircraft landing), at 19:25, the firefighting and emergency teams arrived to the indicated place. The emergency team including 47 persons and 11 vehicles arrived to the incident place.

After go around, at 19:28 UTC, the crew conducted a successful landing at the aerodrome with MH261°.

In connection with absence of the emergency situation on the board during the aircraft landing, there was no need to attract the emergency and firefighting teams, none of the passengers and crew members was injured, and the tower supervisor cancelled the emergency alarm at 19.34 UTC.

Therefore, actions of the regional controller center and tower supervisor, and actions of the head of emergency and firefighting service of the airport were adequate and, in general, conformed to requirements of the Ukrainian emergency and firefighting rules for civil aerodromes, which were approved by the Order of the Ministry of Infrastructure of Ukraine of 07.05.2013 No. 286.

## **2.8. Injuries to Persons**

No persons were injured during the incident.



## **2.9 Damage to Aircraft**

There was no damage to the aircraft.

## **2.10 Works Carried Out by the Board**

During the investigation, the Board performed the following works:

1. Cooperation with representatives of ExecuJet airline (Denmark) was organized for the purpose of obtaining information on the crew, technical condition of the airplane, crew's explanatory notes, respective sections of the Flight Crew Operating Manual and Aircraft Maintenance Manual, as well as the data concerning operation, troubleshooting of the airplane systems.

2. The following enquiries were prepared for obtaining the information required in the course of the investigation:

- to Ukraerorukh - for receiving extracts of crew-controller communication and internal aerodrome communication;

- to International Kyiv (Zhulyany) Airport - for obtaining the report of performance of rescue and salvage operations;

- to AMSC Kyiv – for obtaining the meteorological information.

3. For the purpose of the final report compilation and establishment of the incident causes, the received investigation materials were considered and analyzed.

## **2.11. Other Information**

The Board has made the analysis of the airplane operation for the last 2 years and flap actuator failure frequency on this airplane. The Board has established that during the period from December 16, 2014, to December 11, 2015, the airplane had 3 failures of the flap actuator.

During the investigation, the Board established that on 16.12.2014, at landing approach at the Boryspil Airport, at extending the flaps to 8 degrees, flaps got stuck at 0° degrees. Check of the flap actuator operation on the ground has not yielded results. The system operated without critical remarks.

According to the conclusion made by the technical personnel of AAS AirSupport GmbH, which performed troubleshooting operations, a probable cause of flap non-deployment was freezing of the flap actuator in cruising flight at a temperature lower than the freezing temperature. The Work Order (WO-14VGA2916) and Technical Act on Aircraft Condition of 17.12.2014 are attached. The aircraft operating time as of this incident made 1062.11 flight hours and 652 cycles (landings). Upon performance of the works, this airplane has been cleared for performance of flights without restrictions.

During the period from 29.12.2014 to 14.01.2015, at the aircraft operating time of 1063.48 flight hours and 654 cycles, the planned maintenance was conducted on the airplane according to the Work Order (WO-No.:140265). Works were performed by a maintenance organization - Lufthansa Bombardier

Aviation Service. At performing the maintenance, there were also implemented the recommendations of the Designer (Bombardier) related to the previous flaps jamming incident.

These recommendations envisaged cleaning and application of a new lubricant on drive shafts of the flaps actuators in the shortest possible time, and also recheck of the flap actuator system. In the course of a visual inspection, a black lubricant was found on the inboard flap actuators.

The right inboard flap actuator with the drawing number P/N 601R93101-25 S/N 7645 was substituted for S/N 7602.

After the maintenance, the airplane has been cleared for operation with no restrictions.

On 28.03.2015, the second flap non-deployment incident took place at landing approach at Kyiv (Zhulyany) Airport.

Check of the flap actuator operation on the ground has not yielded results. The system operated without critical remarks.

The technical personnel of AAS AirSupport GmbH has performed the works envisaged by the Work Order (WO-15VGA3052) and made lubricating of ball mechanisms of the drive with Grease 7 lubricant for the purpose of failure prevention, and has recommended to remove cores of flexible drive shafts of the flaps for the purpose of their inspection and lubricating.

Fault isolation works were carried out according to the Fault Isolation Manual – FIM 27-50-00, Chart 103, Unit 23. Also the technical personnel noted that, at the moment, it is not capable of reproducing the fault, and that the operator agrees to conduct inspection of cores of flexible drive shafts during the next depot maintenance, where possible. The operating time of the aircraft, as of this incident, made 1074.02 flight hours and 662 cycles (landings).

After performance of works, the airplane has been cleared for flights.

Thus, between the first incident of 16.12.2014 and the second one of 28.03.2015, the interval was 3.5 months at operating time of 11.51 flight hours and 10 cycles (landings). Also, it should be noted that these incidents happened during the period from December, 2014, to March, 2015, inclusive, that is during a winter period (low temperatures of the ambient air).

On 04.04.2015, there were malfunction repair works on the airplane, connected with two previous incidents of flap non-deployment (jamming in "0" degree position). These works were carried out by the technical personnel of "AAS AirSupport GmbH" according to the Work Order (WO-15VGA3056), taking into account the recommendations stated in the Certificate of Release to Service (CRS) dated 30.03.2015 and in coordination with the Designer (Bombardier). The aircraft operating time at the time of the work performance was 1075.56 flight hours and 665 cycles (landings).

Fault isolation works were carried out as in the previous cases – according to the FIM 27-50-00 Fault Isolation Manual.

According to the recommendation of the Designer (Bombardier), verification of the rotation moment of two internal drives of the left and right flaps has been conducted at a low temperature according to AMM 27-53-750-801 (as specified in CRS).

*Note:* according to FIM 27-50-00-01, Chart 103, Unit 23, works on check of the flap actuators vs. cooling shall be carried out according to AMM 27-53-00-750-801.

Verification of the rotation moment of two inboard flap actuators at a low temperature has not revealed deviations in actuators operation. After installation of the inboard flap actuators at the aircraft, the torque of the drive system was verified according to AMM 27-53-00-750-802, at which, it was revealed that the rotation moments of two inboard flap actuators were beyond the limits. As a result of the fault isolation, it was revealed that the torque of flexible drive shaft No. 1 was beyond the limits. The flexible drive shaft No. 1 (inboard, right) P/N 601R93106-107, S/N 14415 was replaced with P/N 601R93106-107, S/N 18484.

After replacement of flexible drive shaft No. 1, operation of the flap actuation system was inspected, which operated satisfactorily with no critical remarks.

After performance of works according to the Work Order (WO-15VGA3056), on 04.04.2015, the airplane has been released for operation.

The flap actuator operation was without critical remarks up to 11.12.2015, when the third incident took place – i.e. the flap non-deployment (jamming in position «0»).

The aircraft operating time at the moment of the incident was 1198.38 flight hours and 713 cycles (landings).

The aircraft operating time after the incident of 28.03.2015 has made 124.36 flight hours and 51 cycles (landings) for 8.5 months.

### **3. ANALYSIS**

On December 11, 2015, the crew consisting of PIC, copilot and one flight attendant performed a charter passenger flight en-route Larnaca (Cyprus) – Kyiv (Zhulyany) on Challenger 850 CL aircraft, registration OY-VGA, of ExecuJet airline (Denmark). There were 2 passengers aboard. The take-off was carried out from the airport of Larnaca (Cyprus) at 16:18 UTC. At landing approach to Runway26 at Kyiv (Zhulyany) Airport, at the altitude of 4000 feet for the purpose of descent to 2500 feet, at the speed of 195 knots, PIC switched the flap extension lever to 8°, however, Flaps Fail alarm was triggered, and flaps remained in “UP” position. PIC made the decision on go-around and, approximately at 16:54 UTC, reported of his decision to the controller of TC-5, having specified the reason of the actions. PIC has reported to the controller

about the need to keep the altitude of 4000 feet, that he is over an edge of clouds and continues the go-around maneuver in the visual weather conditions for solution the flap problem. During this period of time, the crew carried out "Flap Fail" "CheckList" AFM, in particular, PIC made recalculation of the required landing distance at the condition of the flaps remaining in Up position, which length made 1328.25 m (the distance increase coefficient is equal to 1.65, speed gain - 30 knots.)

*Note:* In such a way, the aircraft landing speed was 163 knots. The available landing distance declared in the Flight Operation Instruction at "Kyiv" (Zhulyany) airfield is 2262 m.

At 17:18 UTC, the crew send the priority alarm "PAN-PAN" and reported to the controller of ATM Regional Control Center about the need in a fire fighting team at the time of the aircraft arrival. The flight operations director of the Regional Control Center reported the information to the flight operations director of the Tower at 17:19 UTC, who, in turn, declared "Alarm" signal at 17:19:25 UTC to all squads of the emergency rescue team and indicated TW-1 as a gathering point. At 17:25 UTC, a squad of the emergency rescue team arrived to the designated place. The workforce and means consisting of 47 people of staff and 11 pieces of equipment were moved to the incident site.

After the aircraft go-around maneuver and performance by the crew of the procedures envisaged by "Flaps Fail CheckList" of AFM, it conducted a safe landing at the Kyiv (Zhulyany) airport with the MHLand (Landing Magnetic Heading)=261° with flaps up at 17:28 UTC, taxing was made independently. During landing, the reverse (50-60%) was applied, braking was normal. There were no injured among crew members and passengers.

There was no any need for attraction of the emergency rescue team's resources and personnel.

At 17:34:05 UTC, the flight operations director of the Tower declared "All Clear" of the Alarm signal.

For clarification of the cause of the flap non-deployment and fault repair, the operator requested help of a contractual maintenance organization – "AAS AirSupport GmbH" and issued Work Order: WO-15VGA3604 dated 12.12.2015.

The flap retraction system was visually examined with no critical remarks. During the procedure of the Fault Isolation Manual (FIM 27-50-00), the FECU system indicator showed a deviation (jam of flaps) - "JAM" indicating a possible cause of flaps failure in flight. According to FIM 27-50-00, Chart 103, Unit 23, an operational check of flaps operation was carried out, and according to AMM 27-54-00-710-801 – no any defects were found. Subject to FIM 27-50-00 and having passed to Unit 23 envisaging the works, which could not be performed outside of the maintenance base, the airplane was cleared for a flight to the maintenance base for troubleshooting according to FIM 27-50-00, Chart 103, Unit 23.

The flight was made with the de-actuated flaps in a retracted position - UP Position. A record about the fault was entered under number 9 in the list of deferred defects - Hold Item List.

After the flight to the technical maintenance base of “AAS AirSupport GmbH”, the works contained in the Work Order (WO-15VGA3610) were carried out within the period from 16.12.2015 to 23.12.2015.

In the course of performance of the fault isolation works according to FIM 27-50-00, Chart 103, Unit 23, an inspection of cores of flexible drive shafts, as well as the flap actuators freezing test according to AMM 27-53-00-710-801 were conducted.

Unlike the previous inspection of the flap actuators, which was carried out on 04.04.2015 according to AMM 27-53-00-710-801, the test was carried out on all eight flap actuators.

In the course of carrying out the freezing test (Fig. 6), at cooling the drives to minus 60°C for not less than 2 hours, the maximum breakaway torque and maximum torque of the drive shaft were checked, which, under the specified conditions, should not exceed 15 inches/pound (1.69 Nm) and 13 inches/pound (1.47 Nm), respectively.

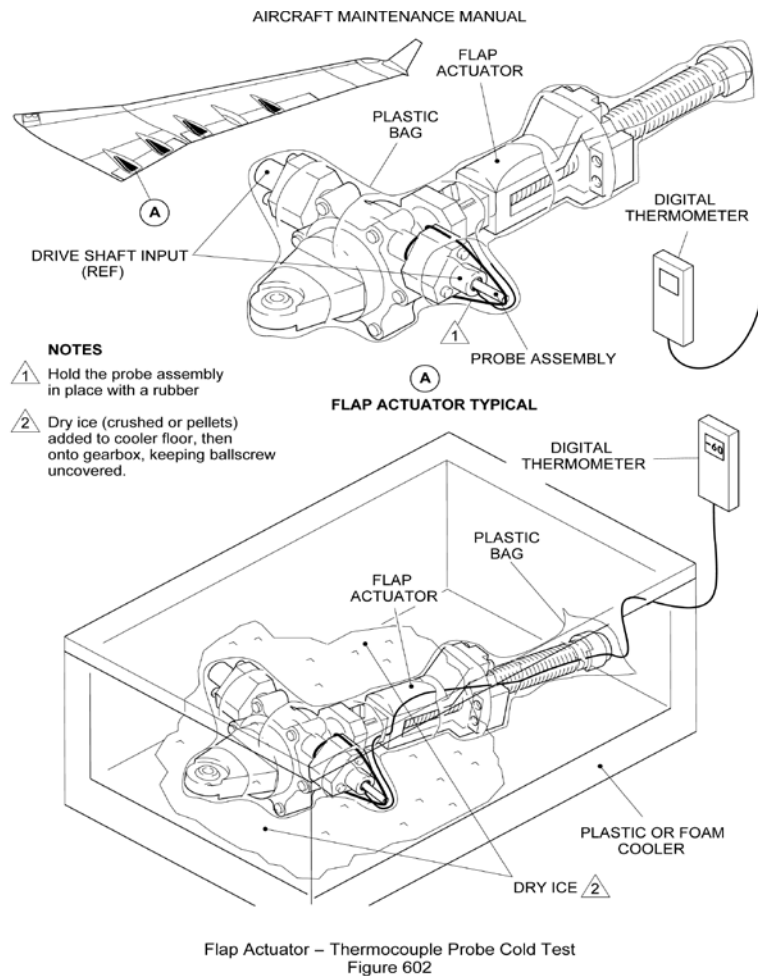


Fig. 6

The check has shown that all flap actuators, except No. 2, have not passed the test of the maximum breakaway torque of the drive shaft. No. 2 flap actuator had a leak and upper limit of the maximum breakaway torque of the drive shaft. The test results were entered into CRS of 23.12.2015.

Inspection of cores of flexible drive shafts has shown that the flexible shaft of the left flap No. 1 had an excessive off-load torsion torque, and flexible shaft of the left flap No. 2 had corrosion from water ingress. Other flexible drive shafts of the left and right flaps had no defects and traces of moisture ingress.

It should be noted that, at replacing flap actuators, actuator P/N 601R93101-25 S/N 7602 has been replaced, which was installed aboard the plane on 09.01.2015 at fault repair after an incident with flap non-deployment on 16.12.2014 at landing approach at the “Boryspil” Airport.

After replacement of eight flap actuators and two flexible drive shafts, the airplane was released to service.

Considering results of the performed work for identification of a cause of the flap actuation system failure, it is possible to draw the following conclusions:

- fault of eight flap actuators became the cause of flaps non-deployment (jamming in "0" degree position) in view of moisture ingress into the internal cavities of the drive mechanism and into cavities of flexible drive shafts No. 1 and No. 2 of the left flap.

- three incidents connected with non-extension (jamming in "0" degree position) flaps, happened during the winter period at low temperatures of the outboard air (during the period of December 16, 2014, to December 11, 2015);

- the troubleshooting works, which were carried out by “AAS AirSupport GmbH” on 14.01.2015 and 04.04.2015, were inefficient and have not prevented reoccurrence of the flap actuator failure and they have not prevented the incidents reoccurrence.

## **4. CONCLUSION**

### **4.1. Findings:**

4.1.1. The aircraft was maintained in an airworthiness condition.

4.1.2. The applicable airworthiness directives, modifications (MOD's) and service bulletins (SB's) have been carried out at the aircraft.

4.1.3. Preparation of the airplane for flights was carried out according to the technical maintenance program by the qualified personnel.

4.1.4. Weather conditions did not influence incident emergence.

4.1.5. Pilots were appropriately licensed and had sufficient experience and qualification for flight operation.

4.1.6. During approach, when the wing flap control lever was established in the position  $8^{\circ}$ , Flap Fail message appeared.

4.1.7. PIC made the decision on go-around maneuver and approximately at 06:54 PM reported of his decision to TC-5 controller, having told the reason of his actions.

4.1.8. PIC reported to the controller about the need to keep an altitude of 4,000 feet that is over the edge of clouds and that he will continue the go-around maneuver in the visual weather conditions to solve the flap problem.

4.1.9. The crew carried out "Flap Fail" "CheckList" AFM, including recalculation of the required landing distance at the condition of Flaps Up position, which length made 1328.25 m (the distance increase coefficient was 1.65, gain of speed was 30 knots). At that, the aircraft landing speed made 163 knots, and the available landing distance declared in the Flight Operation Instruction at "Kyiv" (Zhulyany) airfield is 2262 m.

4.1.10. At 17:18 UTC, the crew sent the priority alarm "PAN-PAN" and reported to the controller of ATC Regional Control Center about the need of a fire fighting team at the time of the aircraft arrival.

4.1.11. A safe landing was performed at the Kyiv (Zhulyany) airport with the MHLand (Landing Magnetic Heading) =  $261^{\circ}$  with flaps up at 17:28 UTC, taxing was made independently. During landing, the reverse (50-60%) was applied, braking was normal. There were no injured among crew members and passengers.

4.1.12. There was no any need for attraction of the emergency rescue team's resources and personnel. At 17:34:05 UTC, the flight operations director of the Tower declared "All Clear" of the Alarm.

4.1.13. For clarification of the cause of the flap non-deployment and fault repair, the operator has requested help of a contractual maintenance organization – "AAS AirSupport GmbH" and issued Work Order: WO-15VGA3604 dated 12.12.2015.

4.1.14. The check has shown that all flap actuators, except No. 2, have not passed the test of the maximum breakaway torque of the drive shaft. The flap actuator No. 2 had a leak and upper limit of the maximum breakaway torque of the drive shaft. The test results were entered into CRS of 23.12.2015.

4.1.15. Inspection of cores of flexible drive shafts has shown that the flexible shaft of the left flap No. 1 had an excessive off-load torsion torque, and flexible shaft of the left flap No. 2 had corrosion from water ingress. Other flexible drive shafts of the left and right flaps had no defects and traces of moisture ingress.

4.1.16. After replacement of eight flap actuators and two flexible drive shafts, the airplane was cleared to service.

4.1.17. There were 3 incidents for the reason of failure of the aircraft flap actuators during the period from December 16, 2014 to December 11, 2015.

4.1.18. Three incidents connected with flaps non-deployment (jamming in "0" degree position) happened in a winter period at low temperatures of outside air (during the period from December 16, 2014, to December 11, 2015.)

4.1.19. The troubleshooting works, which were carried out by "AAS AirSupport GmbH" on 14.01.2015 and 04.04.2015, were inefficient and have not prevented reoccurrence of the flap actuator fault and have not prevented the incidents reoccurrence.

#### **4.2. Cause of Incident:**

The cause of flap non-deployment (jamming in "0" degree position) was a failure of eight flap actuators in view of moisture ingress into the internal cavities of the actuator mechanism, as well as into the cavities of the flexible drive shafts No. 1 and No. 2 of the left flap, which led to its freezing at the airplane operation in the conditions of low temperatures.

#### **Contributing Factors:**

Insufficiently effective analysis and troubleshooting actions conducted on 14.01.2015 and 04.04.2015 after two previous incidents.

### **5. SAFETY RECOMMENDATIONS**

#### **5.1. To: the Operator and Maintenance Organization:**

- for prevention of the flap actuator system failures – to take into account the Designer's (Bombardier's) recommendations related to the system functioning, fault recovery and best operation practices - "CRJ200 Flap System, System Function, Troubleshooting and Best Practices", the section of "Main Failure Drivers."

Investigator in Charge: O. Tymoshchuk

Investigation Board: O. Babak

G. Shendeliuk

NBAAI of Ukraine

Kyiv, 23 November 2016