INTERSTATE AVIATION COMMITTEE

AIR ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT
ON THE INVESTIGATION OF THE NON-FATAL ACCIDENT

Type of occurrence	Accident
Type of aircraft	Airplane, Boeing 737-300
Registration	EI-DON (IRELAND)
Owner	Leasing corporation CIT CAPITAL FINANCE (IRELAND) LIMITED
Operator	JSC "KD Avia"
Aviation administration	North-Western AT ITA of Russian CAA
Place of accident	N54º 53' 36", E020º 36' 22", airport Kaliningrad (Khrabrovo)
Date and time	01.10.08, 19:17 hours UTC (the time is UTC hereinafter), local time 22:17

GLOSSARY

ATC of ATA	- Aviation Technical Center of Almaty International Airport
CA	- Civil Aviation
EAS	- engineering aviation service
PIC	- Pilot-in-Command
EASC	- Engineering Technical Service Center
КНТОР АП	- Scientific-Technical Commission
ITA	- Inter-regional Territorial Administration
IAC	- Interstate Aviation Committee
ITA	- Inter-regional Territorial Administration
CAFOM-85	– Civil Aviation Flight Operations Manual, issued in 1985
FOM	- Flight Operation Manual
OAO	- Public Corporation
ATS	- Air Traffic Service
FVR	- visual flight rules
AIS	- anti-icing system
FOM	- Flight Operation Manual
VHF	- very high frequency
FTOA	- Federal Transportation Oversight Agency
Altitude Alert	- audio altitude warning
ALT ACQ	- altitude acquire (autopilot mode)
ALT HOLD	- altitude hold (autopilot mode)
AMM	- Aircraft Maintenance Manual
AT ITA	- Air Transport Interregional Territorial Administration
APPROACH	- approach mode (autopilot mode)
AFM	- Airplane Flight Manual
CVR	- Cockpit Voice Recorder
G/S	- glideslope (autopilot mode)
EASA	- European Aviation Safety Agency
FDR	- Flight Data Recorder
FMA	- Flight Mode Annunciator
GPWS	- Ground proximity warning system
HDG SELECT	- heading select (autopilot mode)
LMM	- Locator middle with marker

LOM	- Locator outer with marker
LNAV	- lateral navigation (autopilot mode)
MCP SPEED	- MCP speed mode
VNAV	- vertical navigation (autopilot mode)
V/S	- vertical speed mode (autopilot mode)
VOR/LOC	- localizer signal reception (autopilot mode)
QRH	- Quick Reference Handbook
FCOM	- Flight Crew Operations Manual
RWY	- runway
UTC	- Universal Time Coordinated
TWR	- Aerodrome control tower

Synopsis

On the 1st October, 2008 in night time, during landing at aerodrome Kaliningrad (Khrabrovo) an accident with B-737-300 EI-DON operated by "KD Avia" airline of North-Western Air Transport (AT) ITA of Russian CAA occurred.

As a result the aircraft got damage to the fuselage and engines.

None of the crew or passengers was injured.

A commission for the investigation of the accident was appointed by Order No. 35/454-P, issued on October 02, 2008 by the Vice-Chairman of the Interstate Aviation Committee (IAC).In compliance with ICAO Annex 13, notifications about the accident were sent to the National Transportation Safety Board (NTSB), USA as a representative body of the State of Design and Manufacture and to the Air Accident Investigation Unit, Ireland as the representative body of the State of Registry. The NTSB and the AAIU assigned their Accredited Representatives to participate in the investigation.

Experts from KD Avia airline, Transaero airline, as well as the Boeing Company were involved in the investigation.

The Prosecutor General's office of the North-Western Region has not conducted a preliminary investigation of the accident.

Start of investigation – October 02, 2008.

End of investigation - August 24, 2009.

1. Factual information

1.1. History of flight

On 1st October, 2008 the crew of B-737-300 EI-DON of KD Avia airline of North-Western AT ITA of Russian CAA including PIC, copilot and four flight attendants performed a scheduled international flight KNI-793/794 en route Kaliningrad (airport Khrabrovo) – Barcelona – Kaliningrad (airport Khrabrovo).

The preflight briefing for route Kaliningrad-Barcelona was fulfilled on 07 May 2008 by the flight unit commander.

The crew passed pre-flight medical check at the ground medical point of airport Khrabrovo at 08:30. Based on the check results all the crew members were permitted to perform flight without any remarks.

At 08:35 the crew passed navigator check for flight readiness and at 08:45 got meteorological information from the weather officer on duty.

The meteorological conditions en-route, departure and arrival aerodromes, alternate airdrome were consistent with the crew weather minima.

The actual weather at Khrabrovo airport at 07:30 AM was as follows: wind 160 degrees, 6 m/s, visibility 3500m, shower rain, overcast, cloud base 420m, temperature $+10^0$, dew point $+9^0$, QFE 744, friction factor 0,6.

The actual weather at the airport of Barcelona at 08:00 was as follows: wind 350 degrees, 11kt, visibility 10 km, scattered at 520 m, temperature $+16^0$, QNH 1017 millibar.

The weather forecast for the airport of Palma de Majorca valid from 06:00 till 15:00 was as follows: wind variable, 3kt, visibility 10 km, cloud: scattered at 750m, changing from 09:00 till 11:00 wind 210 degrees, 10kt.

At 08:48 the PIC decided to fly from Kaliningrad to Barcelona.

At take-off from the airport of Kaliningrad there were 104 passengers on board the aircraft; 1129 kg of baggage, 11300 kg of fuel. The actual aircraft take-off weight was 53800 kg, and its center of gravity was 21, 87% MAC.

NOTE: *In accordance with the daily traffic schedule of the KD Avia, it was the third flight of the B'737'300 EI-DON on that day. Upon completion of the second flight (KNI-562 Chelyabinsk – Kaliningrad), the crew informed the Engineering Aviation Service (EAS) staff of the maintenance shop of the in-flight flap extension failure. After they extended synchronically to 15 degrees, during further extension the left flaps remained at 15 degrees and the right ones reached 19 degrees, after which stopped. The crew landed with flaps set 15 degrees and*

made a record about this in the Technical Log Book.

The EAS staff inspected visually flaps and flaps extension/retraction system components, checked if there was lubrication in jackscrews, did operational tests to check flaps extension/retraction and flaps asymmetry indication in conformity with the Aircraft Maintenance Manual (AMM 27-51-00).

As a possible cause of the failure, as a result of the tests performed, the flaps position indicator malfunction was detected. After its replacement and on-ground test of the flap control , the aircraft was approved for operations without restrictions in accordance with maintenance documentation. According to a log book record the aircraft had no malfunctions and was ready for passing to the crew.

Earlier (on March 25, 2008) a crew of the same aircraft made a note concerning flap disagreement when set at 15º. The maintenance staff conducted troubleshooting in accordance with (AMM 27-51-00/103) and a ground test (AMM 27-51-00/501). No faults or defects were detected.

During the pre-flight preparation, as they had got a report from the EAS staff of the defect revealed over the previous flight, the crew got acquainted with the log book contents and the PIC decided to perform a test of the system. During multiple extension/retraction cycles there were no system failures noticed.

Thus, there were no crew's claims on the aircraft operation after the pre-flight preparation.

The aircraft took off from airport Khrabrovo at 10.40.

NOTE: *The flight from Kaliningrad was scheduled for 09:45 but it was delayed due to a flaps operability check by the crew.*

The flight en route Kaliningrad – Barcelona proceeded without any troubles. The aircraft landed at Barcelona Airport at 13:43. No unusual operation of the flap control system was observed at takeoff or landing.

The pre-flight briefing at Barcelona Airport was complete.

The PIC made a decision to fly in compliance with the CAFOM-85 p. 5.5.11.1 requirements.

The airplane's payload was: 138 passengers, 2297 kg of baggage. The take-off weight was 57667 kg, center of gravity 21,5% MAC (the range of acceptable operational center of gravity for Boeing 737-300 is 5%-33%). According to the weather conditions at Barcelona Airport

(temperature +21 degrees, QNH 1014 millibar, RWY 25L, wind 320 degrees, 7 kt) the permissible weight for this flight was 58975 kg.

The airplane took off from Barcelona at 16.18.

During the flight (until the flaps were extended at approach) there were no ON/OFF signals or analog parameter values recorded by the FDR, which would mean any failure in flight, nor crew's reports about an abnormal situation on board.

The approach to Kaliningrad Airport was executed at nighttime, in shower rain, with a gusty crosswind to a wet runway and with Flaps 2. The airplane made a gear-up landing on the runway.

1.2. Injuries to Persons

Injuries to Persons	Crew	Passengers	Other
Fatal	-	-	-
Serious	-	-	-
Minor/none	0/6	0/138	-

1.3. Damage to Aircraft

As a result of the belly landing the aircraft's lower (belly) fuselage structures and engines were damaged.

1.4. Other damage

There was no other damage.

1.5. Personnel Information

Position	PIC
Sex	Male
Name, surname, father name	Azat Z. Gatiyatullin
Date of birth	18 October 1967
Class	Second class of civil aviation line pilot
Education	Balashov High Military Flight School in 1990
Weather minima. Date of last checkride in conditions corresponding to that minimum	Rated to fly CAT 1, with weather minima 60x550, take-off 200m. The date of last checkride in weather conditions corresponding to weather minima – 13 September, 2008.

Flight experience since graduating from the flight school	5,372 hours
As a captain	317 hours
Transition training on B-737-300	«SAS Flight Academy» STOCKHOLM SWEDEN, Stockholm (Sweden), certificate dated 19 July 2006.
Refreshing courses on radio communication phraseology in English	Sibir airline Avaition Training Center, certificate no. 17105-06 issued 31.01.07. Pilot certificate extension dated 08 September, 2008
Flight experience on B-737-300	1,258 hours
As captain on B-737-300	317 hours
Pilot's license, number, date of issue, validity	11 П no. 004052, issued on 06.01.97, valid until 03 September, 2009
Flight experience and number of landings over the last month	60 hours 45 minutes, 20 landings
Flight experience and number of landings over the last three days	10 hours 25 minutes, 5 landings
Flight experience and number of landings on the day of the accident	6 hours 03 minutes, 2 landings
Breaks in flights on type over the last year, reasons	Regular vacation since 10 August 2008 till 07 September 2008
Date of last checkride and airplane navigation check in accordance with CAFOM-85, mark	Checkride – on 22 July 2008, mark – "excellent". Airplane navigation – 22 July 2008, mark – "excellent".
Last simulator training	14.09.08, CSA TRAINING CENTRE (Czech Republic)
Rest (conditions and duration)	Home conditions, 14 hours
Time of staying at Kaliningrad and Barce-	

lona aerodromes before the flight	4 hours 45 minutes
Time on duty on the day of the accident	10 hours 48 minutes
Authorization to fly during spring-summer period	As per Order no.61 of 22 April 2008 issued by the air squadron commander
Accidents and incidents	None
Position	**Co-pilot**
Sex	Male
Name	Alexey M. Gaifutdinov
Date of birth	24 August 1984
Class	civil aviation third-class pilot
Education	High education, specialized education – Ulyanovsk High School of Civil Aviation (graduated in 2006).
Transition training on B-737-300	«FLIGHT TRAINING INTERNATIONAL» Center, Denver, state Colorado (USA), certificate dated 18 November 2006. By the moment of co-pilot's transition training the Centre did not have approval of Russian CAA, which was issued later on 02 April, 2007, No. 61.14-388
Refreshing courses on radio communication phraseology in English	ICAO Language proficiency level – 5 (Aviation Training Center of Moscow Aviation Institute – 25 March 2008), refreshing courses for crews flying on international air routes (St. Petersburg State University of Civil Aviation) – 11 July 2008)
Flight experience since graduating from flight school	1010 hours
Flight experience on B-737-300	1010 hours
Pilot's license, number, date of issue, valid-	11 П no. 014123, issued on 11.07.06, valid till

ity	June 09, 2009
Flight experience and number of landings over the last 30 days	43 hours, 14 landings
Flight experience and number of landings over the last three days	10 hours 55 minutes, 5 landings
Flight experience and number of landings on the accident day	6 hours 03 minutes, 2 landings
Breaks in flights on this aircraft type over the last year, reasons	Regular vacation from September 02, 2008 till September 09, 2008
Date of last checkride and airplane navigation check as per FG terms, mark	Checkride – July 21, 2008, mark – excellent. Airplane navigation – July 21, 2008, mark – excellent.
Last simulator training	July 03, 2008, CSA TRAINING CENTRE (Czech Republic)
Rest (conditions and duration)	Home conditions, 14 hours
Time of staying at Kaliningrad and Barcelona aerodromes	4 hours 45 minutes
Time on duty on the day of the accident	10 hours 48 minutes
Authorization to fly during spring-summer period	Order of the flight squadron commander dated April 22, 2008 no. 61
Accidents and incidents	None

All procedures concerning checking of theoretical knowledge and practical skills of the crew were fulfilled in due time. Qualification of the crew members was not an obstacle to perform the flight.

All crew members passed flight training for the spring-summer period of 2008 and had valid civil aviation pilot licenses, validated by the IAA.

The crew members passed annual medical check and were authorized to carry out flights based on their health without restrictions.

1.6. Aircraft information

Type of aircraft	B-737-300
Registration number	EI-DON
Serial number	23812
Manufacturer	The Boeing corporation (USA)
Date of manufacture	February 25, 1988
Airplane certificate of registration	№ 4528, of December 28, 2006 issued by the Irish Aviation Authority, Ireland
Airworthiness certificate	№ 2121, of 28.12.06, issued by the Irish Aviation Authority, Ireland and extended till December 27, 2008 on December 20, 2007.
Assigned life time and service life; service lifebetween overhauls, life time until the first overhaul	Based on condition; between repairs – 24000 hours, 12 years; until the first complete overhaul– 24000 hours, 12 years
Operating time since new	48514 hours
Number of landings since new	39949
Number of overhauls	2
Date and place of last overhaul	08 December 2001 (8C, 6C check), plant AAR Aircraft Services, Oklahoma
Operating time and number of landings since last overhaul	6917 hours, 3821 landings
Date and place of last base maintenance	23 August 2007, 4C-Check (16000 hours, 6 years), TOO «ATC of ATA» AVIATION TECHNICAL CENTRE, Kazakhstan, Alma-Aty
Operating time, number of landing since last base maintenance	2428 hours, 1095 landings
Date and type of last line maintenance	October 01, 2008, Daily + Transit + check KIN (MJSS), no. 5352, KITO OAO KD Avia
Engine №1 (left)	
Type of engine	CFM56-3-B1
Serial number	720991
Manufacturer	GE, Evandale, ON (USA))

Date of manufacture	January 1988
Assigned life time and overhaul life	On condition
Operating time since new	44886 hours, 36510 cycles
Date and place of last overhaul	17 December 2001, GE Engine Servicer (USA)
Operating time since last overhaul	6917 hours, 3823 cycles
Engine no. 2 (right)	
Type of engine	CFM56-3-B1
Serial number	722308
Manufacturer	GE, Evandale, ON (USA)
Date of manufacture	August 1988
Assigned and overhaul life	According to condition
Operating time since new	43489 hours, 29961 cycles
Date and place of last overhaul	16 March 2006, MTU Maintenance (Canada)
Operating time since last overhaul	6223 hours, 3889 cycles

The total JET A-1 fuel load on board the aircraft before the departure from Barcelona Airport was 11996 kg. During its work the investigation commission got specimens of kerosene. As a result of test of the specimens obtained it was determined that the kerosene met requirements to fuel and lubricants.

The aircraft take-off weight was 57667 kg, center of gravity 21, 9% MAC, which was within the B-737-300 FCOM limitations.

Generally technical maintenance of the aircraft by KITO JSC KDAvia was in compliance with requirements of regulating documents. Maintenance personnel had been properly prepared theoretically, had practical skills and were authorized to perform maintenance on their own.

1.7. Meteorological information

Meteorological information on flight route did not contain any data about hazardous meteorological phenomena and did not impede flight performance.

Weather at Kaliningrad (Khrabrovo) aerodrome during the day of October 01, 2008 was determined by a south cyclone periphery with a front of occlusion. Pressure dropped slowly and there were prevailing westerly winds aloft. Cold front was expected to pass within the time period from 19:00 to 21:00. There was no forecast or observation of the weather below aerodrome landing minima with RWY 24 (243) over the day and for the moment of landing.

Terminal Aerodrome Forecast for Khrabrovo airport issued on January 01, 2008 valid from 18:00 till 03:00 was as follows: wind 180 degrees, 7m/sec, visibility 5000m in light rain shower, cloud: broken at 450m, broken at 3000m, TEMPO from 18:00 till 03:00 visibility

2000m shower rain, cloud broken cumulonimbus, cloud base 210m, becoming from 19:00 till 21:00 wind 230 degrees, 8 m/sec, gusts 13 m/sec.

Actual weather at Khrabrovo aerodrome on October 01, 2008 at 19:00 was as follows: wind 180 degrees, 5 m/sec, gusts 10 m/sec, visibility 2000m shower rain, mist. cloud overcast cumulonimbus, cloud base 220m, temperature +11 ºC, QFE 740 mm, runway wet, friction factor 0,6.

At a controller's request a weather observation was compiled at 19:05: wind 180 degrees, 7 m/sec, visibility 3500m, light shower rain, mist, overcast at 250, cumulonimbus, temperature + 11ºC, QFE 740 mm, runway wet, friction factor – 0,6.

Upon hearing the alarm signal an extra measurement was done at 19:18: wind 180 degrees, 7 m/sec, visibility 4000m, light shower rain, mist, overcast at 280m, cumulonimbus, overcast at 3000m, air temperature + 11ºC, QFE 740 mm, RWY wet, friction factor 0,6.

Upon Shift Supervisor's request a control measurement was done at 19:23: wind 190 degrees, 8 m/sec, visibility 3000m in light rain shower and mist, overcast, cumulonimbus, cloud base 250m, overcast, cloud base 3000m, air temperature + 11ºC, pressure 740 mm of mercury, RWY wet, friction factor 0,6.

Meteorological service met the established requirements.

1.8. Aids to Navigation, Landing and Air Traffic Control

International Kaliningrad Airport is equipped with aids to navigation, landing aids and air traffic control in compliance with the reqirements.

For the support of the flight en route and approach to RWY 243° M, the following aids to navigation, landing and air traffic control of Kaliningrad aerodrome (Khrabrovo) were used: track radar Ekran-85 and monoimpulse radar MVRL-SVK, PLATAN direction finder instrumental landing system SP-90 (ILS), including localizer and glideslope beacons; aerodrome radio station ATIS.

There were no remarks made about the functioning of any aids to navigation and landing and they operated normally.

1.9. Communications

After the aircraft entered the area of responsibility of a controller of Kaliningrad ATC Center the communication was conducted on VHF 123,7 MHz. After it passed to a Ground Controller (landing, taxiing) of Khrabrovo airport, the communication was performed at 126,0 MHz.

There were no remarks about the functioning of communication equipment and it corresponded to technical conditions.

1.10. Aerodrome Information

Aerodrome Kaliningrad (Khrabrovo) is located 17 km north-east of town of Kaliningrad.

Its elevation (the highest point of the artificial RWY) is +13,5m.

Geodesic coordinates of the reference point of the aerodrome.

- north latitude – 54°53' 23"
- east latitude – 020° 35' 40"

Time zone number – 2. Local time: - T (UTC) +2 hours (in winter), +3 hours (in summer).

Magnetic declination: +2 degrees 47 minutes

Kaliningrad Aerodrome is a Class B aerodrome. As per "Civil Airport Operating Standards" p. 2.1 the aerodrome class is established based on the RWY length.

The aerodrome was allowed for ICAO Category 1 operation with magnetic landing course 243 degrees, which is confirmed by certificate No. 021 A-M issued by IAC valid till December 29, 2008.

The airfield has a shape of an irregular polygon with maximum dimensions 3300x1100m.

The aerodrome has one artificial RWY 24/06 measuring 2500x45m with artificial coverage.

- from the threshold to ARP 500m – cement concrete 24 cm thick

- the rest 2000m – asphalt concrete 7 cm, mesh HaTelit-C 40/70, asphalt concrete BM 6-16 cm, reinforced concrete 22 cm, cement concrete 20 cm.

Artificial RWY is lying with true bearing of 65 degrees 47 minutes/ 245 degrees 47 minutes. Established magnetic courses for take-off and landing are 63 and 243 degrees for thresholds 06 and 24 correspondently. RWY thresholds absolute elevations are:

- Threshold 06 – 13,05 m;

- Threshold 24 – 9,38m

Runway strip (RS) includes artificial RWY and extends longwise for 150m from the thresholds of RWY 24/06 and crosswise for 300 m from the centerline.

The RS portion which lies on both sides from the centerline is prepared and planned for 80 m each side from the centerline to minimize the risk of damaging aircraft in case of landing undershoot or overrunning the RWY.

RS portion which is beyond RWY thresholds is reinforced for full RWY width by 50m from the thresholds, in order to prevent erosion and landing aircrafts from impacting on the runway end.

The RWY has free areas 400 m long (threshold 24) and 200 m long (threshold 06) both 150 m wide. The distance from the extended artificial RWY centerline to the side edges is 75 m.

The aerodrome doesn't have stopways.

1.11. Flight Recorders

The aircraft was equipped with an cockpit voice recorder (tape recorder) FAIRCHILD A-100, installed in the aft part of the fuselage (the aft baggage compartment). The voice recorder registered acoustic information on three voice channels (left pilot seat, right pilot seat, area mike) and time channel during the last 30 minutes of flight.

After the accident the voice recorder was found on its normal position and was intact. The communication record was in satisfactory condition and was used to analyze causes of the accident.

The aircraft was equipped with a Honeywell QAR, installed in the e-bay (centre wing section area), and with a digital flight data recorder (DFDR) Honeywell Model UFDR, located in the aft part of the fuselage (galley zone).

Information recorded allowed assessment of condition and operability of the aviation equipment, as well as to analyze crew's actions before and during the occurrence and development of the emergency situation.

1.12. Wreckage and Impact Information

Initially the aircraft touched RWY surface with the lower part of the right engine nacelle, 340 m down the runway and 3 m to the right of the RWY centerline.

There were no evidences of impact by the left engine nacelle or the fuselage at that place, which means that the aircraft had a right bank at the moment of the first touch.

The track of right engine nacelle sliding over the cement concrete coverage showed minor but still visible damage of the RWY surface. The track direction along its whole length was parallel to the RWY centerline.

The track extension was 160 m (500 m from the entrance threshold of the RWY). Further the track was interrupting, which was the evidence of aircraft lifting off from the RWY.

The second impact of the aircraft on the RWY happened within 100 m from the liftoff point, 600 m from the threshold.

The second touch included two stages as follows:

- initially the aircraft touched the RWY surface simultaneously by lower parts of both engine nacelles (left engine – 7 m to the left of the RWY centerline; right engine – 3 m to the right of RWY centerline) and moved along the RWY centerline sliding on engine nacelles.

- then, within 30 m from the point of engine nacelle touch, the fuselage touched the RWY surface with its lower part. Further the aircraft moved forward with three points touching the ground (both nacelles and lower part of the fuselage) until the aircraft stopped.

The fact that touching moments of engine nacelles and fuselage at the moment of the second impact were not simultaneous resulted from the following:

- geometrical parameters of the aircraft construction (the lower part of the fuselage is higher over the ground compared to the lower part of engine nacelles):
- at engine nacelles' touching the RWY, a nosedown moment appeared, caused by engine nacelle friction at the RWY:
- specifics of aircraft longitudinal trimming when landing with flaps partially extended (landing at over-speed with smaller than normal pull-up control column deflection;
- structural position of engine nacelles ahead of main landing gear, as well as center of gravity located behind engine nacelles. On impact by engine nacelles (with landing gear retracted) this induced pitch-up increasing along with decreasing speed, which went on until the lower (belly) part of fuselage touched the runway:
- engine nacelles distortion during a certain (though short) period of time.

The aircraft moved over the RWY, bearing on engine nacelles and the aft part of the fuselage, generally along the centerline with little deviation.

At 1780 m from the beginning of the RWY (720 m before its end), the aircraft stopped bearing on engine nacelles and the aft part of the fuselage (aft luggage rack section). The position of the aircraft at the moment of the stop was as follows:

- the longitudinal aircraft axis – at an angle of 6 degrees to the left of the RWY center line (approximately with a magnetic heading of 237 degrees);
- the left engine nacelle – at 3,5 m to the left of the RWY center line, right engine nacelle – 6.5 m to the right of the RWY center line, the rear point of the fuselage was at a distance of 3 m to the right of the RWY center line.

As the aircraft moved on along the RWY, non-structural parts of engine nacelles and fuselage skin which touched the RWY surface broke off, and the aircraft belly painting was damaged.

Where the aircraft came to stop, in the area of engine nacelles location, some oil spillage occurred.

1.13. Medical and Pathological Information

The blood specimens collected from the PIC and the co-pilot in the medical unit of Khrabrovo Airport after the accident revealed no alcohol in their blood.

1.14. Survival Aspects

The crew and passengers were on their normal seats and were fastened with safety belts. Preparation for emergency landing was not announced, as it is not required when landing with

flaps in non-landing configuration. Flight attendants checked additionally if passengers were fixed properly with the belts. After landing no passengers were injured. All of them left the aircraft unassisted.

1.15. Fire and Rescue Operations

As the accident occurred during aircraft landing and within visibility limits, the "Alarm" signal (upon a report of a ground controller) was announced by the flight manager at 19:17 hours through a speakerphone.

Note: *After the aircraft appeared from the clouds, a Tower controller observed the approach visually guided with landing lights. As it was night time and it was raining heavily, the controller couldn't see the landing gear position on the aircraft.*

At the touch down moment the controller noticed fire on the right side of the fuselage and reported to the shift supervisor: He's got tires off! The shift supervisor asked him back: Who has got his tires off? The controller answered: 794 had sparks come out, he seems to have got his tires off, and repeated: he had sparks coming out. After that the supervisor passed the alarm signal to airport rescue teams: fire-fighting and rescue, medical, shift on duty of the technical maintenance center KITO, transportation service, aerodrome service, special vehicle service, flight safety service and a line unit of domestic affairs for transport.

At 19:18 hours three fire-fighting vehicles with brigades left for the accident site.

At 19:19 hours, on arrival at the accident place, the brigades commenced eliminating accident effects, by cooling-off engines, wings and the fuselage with sprayed water jets without the use of foaming agent.

The other airport services left for the accident site in due time.

At 19:43 hours the emergency and rescue works were completed, after which security guards cordoned off the site of the accident.

The actions of search and rescue team and fire services at the accident site were correct and complied with requirements of RPASOP GA – 91.

1.16. Tests and Research

1.16.1, The scientific and technical support investigation commission of IAC has performed works on calculating aircraft flight path. Besides, the QAR and FDR data was analyzed

as well as CVR information. Crew's actions and factors which could have influenced the occurrence and development of the accident were also analyzed.

The materials and results obtained are reflected in the Report on Investigation of Circumstances of Air Accident Involving the Boeing-737-300 EI-DON Aircraft operated by KD Avia airline on October 10, 2008 at Kaliningrad Airport, approved by the Chairman of the Air Accident Scientific and Technical Support Commission, IAC.

1.16.2. As during numerous ground checks in the course of the investigation the defect that appeared during the landing at Kaliningrad Airport did not recur (the standard troubleshooting procedures recommended by the AMM also did not lead to any results) additional investigation was conducted.

For this purpose two flap transmitters and two flap position indicators were sent to the Boeing EQA lab in Seattle, Washington. The findings of the examination are stated in Report No. 10655R of June 30, 2009.

The examination revealed presence of moisture in the interior part of the left flap transmitter beyond the sealing ring. Tests showed that after the transmitter was exposed to cold temperatures the left position transmitter output skewed out of tolerance.

1.17. Organizational and Management Information

1.17.1. JSC KD Avia has Operator Certificate no. 454 of August 10, 2005, issued by Flight Oversight Direction of FTOA, valid till March 03, 2010.

KD Avia carries passengers by air transport under License PP 0180, of May 16 2008, issued by Russian CAA and valid till May 16, 2013.

KD Avia carries cargoes by air transport under license no. PG 0180, dated 16 May 2008, issued by Russian CAA and valid till 16 May, 2013.

KD Avia activity is overseen by North-Western Air Transport IRTA of Russian CAA of Russian Ministry of Transport.

1.17.2. Last base maintenance of the aircraft in the form of 1C, 2C, 4C Checks was performed by TOO Aviation Technical Center of Almaty International Airport of Almaty city.

The aforementioned organization has a Certificate EASA.145.01.60. for B-737-200/300/400 maintenance dated 23 May 2006, issued by EASA. The certificate was approved by FTOA of Russian Ministry for Transport (report dated 12 September 2006. no. 6.6-392 GA).

1.18. Additional Information

1.18.1. An additional check of flap extension/retraction system operability which is part of the base maintenance was conducted in the course of the investigation.

The check revealed no. 4 and 5 ballscrews (screw-nut) wear over allowed limits (normal – 0,0095 inch, actual: no. 4 – 0,0115 inch, no.5 – 0,010 inch), the wear of the rest jack screws was approaching the service limits.

Note: *It was not possible to determine excessive ballscrew wear during normal flight operations and line maintenance as this kind of check requires special equipment and tools (C27030-34 BACKLASH TOOL ASSEMBLY) and is usually done as part of the 4C-Check base maintenance (every 16000 hours)*

Last base maintenance, 4C Check was carried out on 23 August 2007 in Alma-Aty by Aviation Technical Center of Almaty International Airport («ATC of ATA») when operating time was 46086 hours, 38854 landings (certificate of release to service dated August 23, 2007).

The periodical check of the ballscrews (Flap Ballscrew Backlash Test) was done during 4C-Check on 31 July 2007.

According to the data provided by the maintenance organization ("ATC of ATA") no faults or defects were detected during the checks, i.e. the wear was within the operational limits. It should be mentioned that during the maintenance checks the staff record the values of deviations to compare them with the further five-time checks and the deviation analysis data. If unaccepted deviation is detected a Non-Routine Card is issued where the deviation value is recorded for later correction. If no deviations are detected the records are not stored.

Therefore, the maintenance organization who performed the checks could not provide the records of the ballscrew test results after the 4C-Check.

13 months had passed since 4C-Check during which the aircraft operating time was 2428 hours, 1095 cycles, which was only 10% of intercheck time, and interrepair operating time was 6917 hours, 3821 cycles. In accordance with Boeing experts, in case full 4C-Check is done followed by qualified maintenance of flap jackscrews, intensive wear is not likely.

1.18.2. In the course of the investigation the investigation team analyzed information on 14 incidents connected with flap asymmetry on Boeing-737 (200, 300, 400, 500) aircraft in Russian airlines in 2006-2009. The analysis revealed that during neither of these incidents the flap asymmetry actually occurred. Five of the mentioned incidents were recurrent, meaning that after maintenance and checks the flap position indication fault recurred.

1.19. New investigation techniques

Standard procedures were used during the investigation.

2. Analysis

During the analysis the investigation team used the FDR data, the CVR record, the crew members' statements, the records of an inquiry of crew members and ATC controllers, the wreckage plot of the accident site, the materials of sub-commissions and working groups, as well as the Report of Scientific and Technical Support Commission of IAC dated November 20, 2008 and the Boeing Report No. 10655R of June 30, 2009.

It was established that:

After take-off from Barcelona Airport at 16:18 the aircraft climbed to FL 34000 ft at 16:40:30. The cruise flight proceeded in automatic mode, with autopilot and auto-throttle engaged. The crew used main autopilot modes – LNAV and VNAV, as well as HDG SELECT. During the cruise flight (at 16:49:18), auto-throttle manual disengagement was recorded for a period of about 1 minute.

Note: *The short-time auto-throttle disengagement was because the crew monitored engine parameters during the cruise flight.*

At 18:00:20 the crew changed flight level and reached 35000 ft. At 18:25:00 the flight level was changed again for 33000 ft. When changing flight levels the crew engaged V/S autopilot mode. Laterally, LNAV was used.

Information about KNI 794 entering the airspace controlled by Kaliningrad ATC Centre was obtained from a controller of Warsaw Airport at 18:19:30. It was noted in the information that the estimated time of KNI794's handoff to Kaliningrad ATC Centre was 18:50 over geographic point GOMED during the aircraft descent to FL 150 .

At 18:48:14 the crew reported entering the controlled zone: "Kaliningrad Control, Kaliningrad 794, good evening, descending FL 150, approaching GOMED, will enter traffic circuit at 59 minutes, alternate Riga". The Co-pilot was the PF and the PIC was the PM.

Note: : *The crew performed the SOP procedures for cockpit landing preparation and calculated landing characteristics. Landing weight by the estimated landing time, was to be 51600 kg (with maximum allowed landing weight of 51709 kg as per FCOM). The calculated aircraft centre of gravity at landing was to be 21,59% (admissible range of operational centre of gravity is 5%-33%). The crew planned to carry out landing with flaps set at 30 degrees. The calculated Vref was 140 kt, the go around speed – 150kt.*

A controller of ACC instructed the crew about descent: "Kaliningrad 794 Kaliningrad Control good evening landing course 243 heading to the base leg descend FL 60 at FL 70 contact Radar 126,0".

Descent was carried out in automatic mode, with LNAV and VNAV autopilot modes engaged.

At 18.51.20 the crew activated cowl anti-ice for left and right engines, which was on till the end of the flight.

At 18:53:51 while passing FL70 the crew reported to the Radar controller: "Kaliningrad Radar, Kaliningrad 7-9-4. Good evening. Crossing 70, descending 60, weather information received, 987, flight director approach".

After they had received controller's permission: "Good evening, Kaliningrad 7-9-4, Kaliningrad Radar. Approach approved, transition level 1800, QFE 987 hPa, descend 400 to base turn". The crew read back: "Descending 400 to base, QFE 9-8-7, Kaliningrad 7-9-4" and continued descent. At 18:54:24 the controller passed to the crew information about the actual meteorological conditions at the airport: "Kaliningrad 7-9-4, for 54 minutes visibility 2-100, shower rain, cloud base 240, and wind 180 degrees 5, gusting 10". The crew read it back.

At 18:55:09 the crew engaged autopilot modes LEVEL CHANGE and HDG SELECT. At that moment the aircraft was at altitude of approximately 6400 ft. As the autopilot modes changed, the crew called out the FMA readings.

At 18:55:15 the crew reported crossing transition level: "Kaliningrad 7-9-4, have set QFE 9-8-7 for transition level".

The flight passed in moderate turbulence conditions, which the co-pilot indicated in his remark: "You see it's plus/minus 5kt, jumping back and forth". Normal acceleration was changing in the range of 0,74-1,2 g.

Thus, until the flaps extension the flight was normal, without any faults noted by the crew.

At 18:58:41 the co-pilot gave a command: "Flaps 1", after which flaps were set at 1 degree. The flaps extended synchronically the IAS at that time was 220kt.

Note: *According to Boeing-737 AFM, the maximum permissible speed with flaps 1 is 230kt*

At 18:58:49 the autopilot ALT HOLD mode was engaged (at 400m, circuit altitude), the auto-throttle switched over to MCP SPEED. After that the throttles were set for idle and the airspeed started decreasing down to 190 knots. While changing auto-throttle and autopilot modes the crew did not call out the FMA readings.

After the throttles were moved to a position of less than 10 degrees, at 18:58:50, the Landing Gear Warning Horn activated.

Note: *As per FCOM of Boeing-737, Landing Gear Warning Horn gets activated if*

along with landing gear retracted and flaps extended to 1 to 15 degrees, throttles are in position between idle and 10 degrees. A crew has the possibility to deactivate the warning by pressing the button Horn Cutout. This button does not turn off the warning completely but suspends its operation in current conditions. Cleanup of current conditions (for example, shifting throttles to a position of over 10 degrees) and arising of new conditions for warning activation would cause the warning to go off again.

The crew deactivated the audible warning which is proved by the fact that it sounded just for 2 seconds, while conditions for its activating remained for 20 seconds. After that the throttles moved to a position of over 10 degrees.

Note: *According to Boeing-737 FCOM (Landing Procedure) during standard approach first flaps should be extended to intermediate position. Landing gear and flap extension to 15 degrees is performed when Glide Slope activates. Therefore Landing Gear Warning Horn sounding could occur almost in every flight. The analysis of the previous landing of B-730-300 EI-DON has revealed that during approach at Barcelona Airport, conditions for Landing Gear Warning Horn activating continued for more than 3 minutes. It should be noted that in case flaps are extended to 15 degrees with throttles in a position less than 30 degrees, as well as flaps extended to over 15 degrees with landing gear retracted, the Landing Gear Warning Horn could not be switched off.*

The aircraft was approaching the base turn with a heading of approximately 40º at the circuit altitude. During the base turn maneuver, the crew started to extend them to position 5. The co-pilot: "(illeg) flaps 5 now", PIC: "Speed checked flaps 5". The crew checked the flaps configuration, which is seen from the PIC's report: "Synchronically". At 18.59.20 flaps were at position 2 degrees, but later, according to the FDR, right flaps went on extending while the left ones remained 2 degrees. At that moment the aircraft was in a right roll of about 24 degrees. By 18:59:24 the right flaps reached position 3 degrees, after which flaps extension stopped.

Note: *Analysis of the available information revealed that there was no actual flap asymmetry during the flight. The emerging situation was the result of flap position indication system fault*[1]*. This is confirmed by the fact that despite the recorded flight position split there was no banking or yawing moment. Such situation occurred several times during the Boeing 737 type aircraft operations in other airlines. Just as in the acci-*

[1] Hereinafter whenever the flap position split is mentioned it will refer to the flap position indication split only. The actual flap position was symmetric and corresponded to the indicated position of the right flap.

dent flight, in all other cases there was no actual flap asymmetry, but only a flap position indication fault.

The examination of flap transmitters and flap position indicators of the Boeing-737-300 EI-DON conducted by the Boeing Company revealed that the most probable cause of the flap position indication fault was inaccurate indication of the left flap position transmitter caused by presence of moisture in the internal part of the transmitter beyond the sealing ring. Such defect only occurs when the transmitter is exposed to cold temperatures. Under indoor temperatures the indicator was functioning within the operational limits.

The flap shutdown occurred as a result of flap indicator needle split. If the flap indicator sees a difference between the two needles of more than a certain value, the indicator will send a signal to a bypass valve to shut off hydraulic power to the flap drive system. The comparator of the flap position indicator is triggered when the needle position split reaches 22+/- 5°. The indication is not linear, so the needle split of 22º corresponds to actual flap position split of ~1º when the flap extension starts and ~10º by the end.

At 18:59:34 the PIC determined an abnormal flap position: "So, flaps 2?"

18:59:37 the co-pilot: "Flaps 2?"

18:59:38 PIC: "Disagree"

The crew almost immediately determined the abnormal flap position indication, which meant that they constantly monitored flaps position indicator pointers, probably because of the previous defect in this system.

Note: *Flap asymmetry on the Boeing-737-300 EI-DON aircraft was recorded at landing in one of the previous flights on October 1, 2008 (two flights before the accident). In that case, according to the FDR, the flaps were synchronically set at 15º. When further extended the left flaps remained at 15º, while the right flaps reached 19º, after which the flap extension stopped. The aircraft was neither banked or turned.. Landing was performed with flaps at 15º.*

In the previous flight (Kaliningrad – Barcelona) this fault did not occur, the flaps were extended symmetrically at a required angle.

After determining asymmetry in flaps extension system, the PIC was flying the aircraft and conducting radio communication.

At 18:59:52 PIC: "So, I have control. Trailing edge disagree checklist, please".

Note: *Trailing edge disagree – malfunction in flaps extension/retraction system when actual flaps position is not consistent with the flaps deployment lever.*

First PIC erroneously determined the malfunction as a "disagree" instead of just "asymmetry". Later, the co-pilot chose correctly the right item of QRH recommendations for the case of asymmetric flaps deployment.

Further on the crew commenced to perform the SOP, provided in p. 9.18 of QRH Boeing 737-300 EI-DON, and made a decision to put flaps extension/retraction lever at the nearest position, in which there was no asymmetry, that is at position 2 (these actions complied with FCOM recommendations for Boeing-737-300).

The base turn was completed at 19:00:03, the flight was at the circuit altitude, and the IAS was approximately 180 kt.

At 19:00:08 PIC made a decision to pass over the RWY without descending: "Well we'll not descend now. Let's make a circuit and get prepared".

At 19:01:04 (2 min 20 sec after the flap shutdown) the flaps returned to 2º, according to the FDR.

Note: *The flaps could have been retracted after the flap drive actuator activated. If the flap drive system experiences an asymmetrical flap shutdown (no hydraulic power is supplied to the drive system) there will be no flap movement until both flap transmitter synchros indications (needles position) are within limits. When this happens, hydraulic power will be supplied to the flap drive system and the flaps will move towards the commanded position of the flap handle. Most probably at some moment the left flap position indicator showed correct indication (there was an intermittent failure). The flap position transmitter contains three different synchros and the information indicated on the flap position indicator in the cockpit comes from a different synchro than the information recorded by the DFDR. The flap position indicator information comes from the flap position synchro, while the DFDR information comes from the autopilot synchro. The three synchros are not linked, so the DFDR recorded data may differ from the actual needle position of the flap position indicator. During the first extension attempt the DFDR did not record the left flaps moving from Flaps 2 position. This could have been caused by inaccurate work of the left autopilot synchro or by insufficient frequency of data recording on the DFDR, as movement from Flaps 3 to Flaps 2 is rather rapid.*

As soon as the flap indicator needles came back together, the flap bypass valve provided hydraulic power to the flap drive system, and the flaps moved to the commanded flap handle position (Flaps 2).

At 19:01:44, 2 minutes 20 seconds after the flaps stopped, right flaps´ retraction to position of 2 degrees was registered on the FDR, so the positions of right and left flaps became symmetric. At 19:01:48 the PIC checked the flaps position and decided to extend them again to position 5: "So, they have extended up to 2, Lyoha. Let's make it 5".

Note: *According to the QRH of Boeing-737-300, section «Non-Normal Checklist Use» point CI.2.6, the PIC had a right to decide on his own in case of emergency situations.*

Later, according to the FDR, the right flap was at Flaps 4, while the left remained at Flaps 2. Most probably the flaps were shut down again due to the flap indicator needle split.

At 19:01:58 the PIC's command followed: "Cancel" and "Two", as (according to the FDR) the right flaps were in position 4 degrees and the left were still in position 2 degrees. The co-pilot confirmed: "Flaps 2" and "That's it, let's leave Flaps 2 not further. Go ahead and report". At that time the aircraft was on final and joined a heading 242 degrees. The IAS was approximately 180 kt. It should be noted that the AFM does not contain recommended speeds for the flights with flaps 2, .because Flaps 2 is not certified for takeoff and landing. The QRH recommends the crew to use VREF40+30 kt (161 kt for the actual conditions) during approach and landing with Flaps 2. The flight proceeded in the automatic mode with autopilot modes ALT HOLD and HDG SELECT engaged, auto throttle worked in MCP SPEED mode.

Note: *In the course of the investigation it was established that the most probable cause of the non-synchronous flap extension was the "jamming" of screw mechanisms during the work of flaps extension/retraction system during approach aircraft evolutions. The"jamming" of the screw mechanisms occurred due to the wear of the screw pairs.*

Thus, the crew made a decision to land with flaps extended to 2 degrees, which, because of landing conditions (night, rainfall fading, gusty lateral wind, wet RWY), required additional attention and produced additional mental and emotional load.

At 19:02:05 the crew reported to a controller: "Kaliningrad 7-9-4, we'll make a circuit without descent " and to the controller's question: "Kaliningrad 7-9-4, report your reason?", he informed him about the malfunction: "The reason is flaps fault". The controller confirmed the receipt of the information: "7-9-4 roger".

When passing over the RWY the co-pilot did estimations for landing taking in account conditions which had arisen.

At 19:05:03, after they had got controller's permission, the crew commenced performing the crosswind turn with a right roll of up to 26 degrees and completed it at 19:05:46. The recorded data show that just before the start of the crosswind turn, 3 minutes and 10 seconds after

another flap stop the right flaps retracted to 2º. According to the FDR record, the flaps position got symmetrical and did not change until the end of the flight. By the time the right flaps started retracting after Flaps 4 (2 seconds before the retraction started) left flaps reached Flaps 4. Then both flaps symmetrically moved to Flaps 2. Such abrupt change of parameters confirms the flap position indication system fault (see Appendix, Figure 3). When the left and right needles matched, the hydraulic power was provided to the flap drive system and the flaps moved to Flaps 2 in accordance with the flap handle position which was set earlier, as follows from the cockpit communications.

When performing the crosswind turn, after the controller's request: "Kaliningrad 7-9-4. Report situation on board?", the captain reported: "Situation on board is normal. We have extended flaps 2. Performing checklist with flaps 2".

At 19:06:33 downwind turn was initiated with a roll of up to 26 degrees. At 19:07:16 the aircraft joined a heading of 62 degrees, the flight proceeded in the automatic mode, 2 km to the left of the circuit, the IAS was 180kt, flaps 2 degrees, landing gear remained retracted.

While proceeding to the base leg, the crew calculated the required and available landing distance (the co-pilot: "…In short, runway distance will be enough for us …").

Note: *While doing calculations according to the QRH book, the crew made a mistake in landing speed value, having got 172 kt instead of 161 kt. They also made a mistake estimating the needed distance – 6530 ft instead of 4240 ft. Further, apparently, being not sure in their calculations, the crew reverted repeatedly to them, which was an additional factor that distracted the crew from flight data monitoring and SOP.*

At 19:09:17 the crew instructed flight attendants to prepare passengers for landing at overspeed (the co-pilot: "That's what we have actually. We are going to have a hell of a landing. Well, at a very high speed. That's it. You can see it. So you get ready there.". The flight attendant: "They are prepared already".

At 19:09:55 the crew initiated the base turn with a right roll of up to 27 degrees. The base turn was performed by the crew intentionally later, than it's specified in the approach procedure for RWY24, in order to have more time to carry out the approach maneuver. By the moment of the base turn completion the aircraft was 6 km left of the circuit.

Note: *The aircraft B -737 EI-DON was equipped with the IRS. During the flight error accumulation occurs in aircraft coordinates determination (according to technical conditions up to 1,2 miles for one hour of flight). In case there is no correction of the aircraft position with the use of on-ground radio navigation aids,*

like during this flight, due to the natural drift of the IRS, the error can reach a significant value[2]. According to the analysis carried out, the error was about 3 km. Thus, during the approach at Kaliningrad Airport, the on-board inertial system did not allow performing approach with the required precision level. According to the crew's statements they monitored their position with the help of an automatic radio compass, stopwatch and on-ground reference points (using radar). In general the approach was carried out in compliance with the SOP.

After completing the base turn the crew continued going through the Check List as per the Boeing-737 QRH book, Part Trailing Edge Flap Asymmetry (in case of asymmetric flap extension from 1 to 15).

At 19:10:18 the co-pilot's reported: "«Ground proximity flap/gear inhibit switch as installed. Flap/gear inhibit. Flap/gear inhibit checked». While doing this the co-pilot cut off the flaps and landing gear warning by shifting toggle switches FLAP INHIBIT and GEAR INHIBIT to the position INHIBIT (the position of GPWS audio warning lockup).

Note: *Aircraft Boeing-737-300 has three types of GPWS warning toggle switches layout at the co-pilot's instrument panel: three switches - FLAP INHIBIT, GEAR INHIBIT, TERRAIN INHIBIT; two switches - – FLAP/GEAR INHIBIT and TERRAIN INHIBIT; one switch - FLAP/GEAR/TERRAIN INHIBIT.*

On EI-DON there were installed three switches:

- FLAP INHIBIT;

- GEAR INHIBIT;

- TERRAIN INHIBIT.

Out of the 17 Boeing 737 aircraft operated by the airline at the time of the accident, 8 aircraft had a three-switch layout, 1 – a two-switch layout and 8 a one-switch layout. However, all of these aircraft, including the EI-DON had the same revision of the QRH.

In the Additional Deferred Item of the part Trailing Edge Flap Asymmetry of the available revision of the QRH, which was on board EI-DON, the following actions are prescribed in the case of flap asymmetry:

- GROUND PROXIMITY

FLAP/GEAR INHIBIT

switch (as installed)…… FLAP/GEAR INHIBIT;

[2] The GPS system was not installed on the aircraft.

- GROUND PROXIMITY FLAP

INHIBIT switch (as installed)…… FLAP INHIBIT.

The first pattern is applied in case of two switches and the second – of three switches.

Thus, in case three switches are installed, only one should be turned off.

The co-pilot, having read the first requirement, fulfilled it mechanically by cutting off two switches FLAP INHIBIT and GEAR INHIBIT, without trying to understand the further text and the specifics of the actual switch layout at their aircraft. As a result of these actions during the descent with landing gear retracted and flaps in position 2 degrees, GPWS system did not activate to produce audio warning.

Information about wind gusts made the co-pilot doubt that the speed and landing distance were estimated correctly.

19:10:36,9 CP: "How much do we get?"

19:10:37,4 PIC: "Look once again";

19:10:38 CP: "172, we get 172, Init Ref gives forty plus one hundred thirty-one…";

19:10:49 PIC: "Forty";

19:10:51 CP: "We should set V reference forty plus thirty. Plus 30. So we get 161";

19:10:58 PIC; "Right";

19:10:59 CP: "V reference forty plus thirty";

19:11:01 PIC: "And we get…"

19:11:02 CP: "161";

19:11:93 PIC: "161, all right"

Thus, the repeated calculation of the landing speed was done by the crew correctly, in compliance with the QRH recommendations.

At base leg the atmosphere in the cockpit got more tense, as after the repeated calculation of landing parameters, the section Approach Briefing was carried out in a hurry (the co-pilot: "Checked. Altimeters. Opps, Approach checklist at once, Altimeters one zero one, er… 9-8-7").

At 19:11:24 the crew reported to the controller performing the final turn: "Kaliningrad 7-9-4, ready for final".

At 19:11:31 co-pilot reported: "That's it, then landing checklist". Thus, the co-pilot completed the Check Lists up to the section "LANDING CHECKLIST", meaning to fulfill it later. Later, the crew didn't accomplish this section ("LANDING CHECKLIST", where a point about landing gear was).

As they performed the final turn, the crew requested from the controller permission to land: “Kaliningrad 7-9-4, ready for final, flight director approach, QFE 9-8-7 millibar”. The controller cleared the approach: “Kaliningrad 7-9-4, cleared for final, perform final turn”. The landing approach was carried out in automatic mode, with the autopilot and auto-throttle activated.

At 19:12:04 the localizer was captured, autopilot mode changed from HDG SELECT to VOR/LOC. After intercepting the track at 19:12:23 the APPROACH mode was engaged.

Note: *Actual weather at Kaliningrad Airport at the moment of landing was as follows: wind 180 degrees, 7m/sec, visibility 4000m, light shower rain, mist, overcast at 280 m, cumulonimbus, overcast 3000m, air temperature + 11º, pressure 740mm, RWY wet, braking action 0,6.*

When the crew was on the final leg before entering the glide path a dialog between crew members followed:

PIC: “Be ready for go-around. Just in case”

CP: “Go ahead, I’m ready . Flaps, so, once more. Go around flaps one?”;

PIC: “Flaps one, right”;

CP: “Positive rate, gear up”;

PIC: “Maybe we should not retract flaps at all? Let’s not retract flaps, we’ll manage without them”.

This conversation showed that during previous actions as per the QRH, the captain did not consider the possibility of going around.

At 19:14:07 PIC reported: “Well, approaching glideslope” and the co-pilot answered: “What? Ah, yes, approaching. Glide slope alive.”.

Note: *Under Boeing-737FCOM, at this moment the crew had to extend landing gear and flaps to 15º . In this situation flaps were not required to be extended, nevertheless the crew did not check the landing gear position.*

It should be noted that already during the first approach, while they were descending to the base turn, the emotional tension of the crew was a high-level one, which was apparently caused by the specifics of the forthcoming landing.

For the analysis of the emotional state of the crew main voice tone frequency values were used. This human speech characteristics most fully reflects the pilot’s neuropsychic tension dynamics during a flight.

At a high-level of emotional stress, the concentration level decreases significantly, situation perception gets fragmented and the capability of correct

integral assessment of the flight situation diminishes naturally. That's why the probability of wrong actions (e.g. skipping necessary SOP operation, failure to carry out obligatory procedures completely, etc.) increases.

At 19:14:23 after the autopilot mode G/S activation, the aircraft began descending down the glide path. During the landing approach the crew called out the FMA mode changes.

At 19:14:35 in the cockpit the Landing Gear Warning Horn was activated again as the autothrotle moved throttles to a position less than 10 degrees, which, along with the landing gear retracted, and flaps 2º, provided conditions for the warning activation. The warning sounding stopped 3 seconds later, which indicated that the warning was deactivated by the crew, as the throttles remained in a position of under 10 degrees for 16 seconds. Thus, the crew deactivated the warning without checking landing gear position. This action was done automatically, without analyzing the existing situation. The pilots got used to the warning activation during approaches at different airports (especially where the approach pattern provides for late gear-down), and they acted in that situation according to the stereotype that had emerged. With Flaps 2, after pressing Horn Cutout button, the horn ceased. During the further descent the throttle was at more than 10 degrees, so the warning horn did not activate.

When descending down the glide path the crew's attention was drawn to landing on the wet runway.

19:15:04 CP: "Ok, but let's make it somehow… I think we can even land a little harder. One thousand".

19:15:11 CP: "The main thing is – we should not overshoot, cause the runway is wet, *(expl)*t".

At 19:15:29 the crew reported the controller: "Kaliningrad 794 on glideslope, ready for landing" and received permission to land.

As the aircraft was descending down the glide path the co-pilot reported: "Five hundred final flaps thirty cleared to land". That indicated that the crew did not monitor flap position at the moment (which were not set 30 degrees, but 2 degrees) and a disinterested attitude to the fulfilment of requirements of Boeing 737-300 FCOM.

Thus, in instrumental conditions (night time, shower rain, gusty crosswind, wet runway, abnormal flap configuration, approach over-speed), the crew did not deploy landing gear and check its position. GPWS warning did not activate as the switch GEAR INHIBIT was set at INHIBIT (Fig. 2).

At 19:16:11 the autopilot was disengaged, at 19:16:15 – the auto-throttle as well. Since that moment landing was performed manually. At the moment of autopilot disengagement the aircraft was at a height of 60 m, the IAS was 160 kt.

Just before the touch down (at 19:16:30), while the throttles were moved to idle, the Landing Gear Warning Horn went off again, and sounded over 20 seconds not being cut out by the crew. In that situation the pilots did not pay attention to the horn anymore.

The aircraft touched the runway at 19:16:32 almost without drifting from its centreline, at a speed of 158kt, pitch-up angle of 7 degrees. Vertical acceleration was 1,22 points. 3 seconds after touch-down air brakes were extended and the throttles set at thrust reverse. According to the information recorded, thrust reverse was not engaged, most probably due to reverser damage.

While moving over the RWY the aircraft did not deviate significantly from the centreline (the maximum drift from the centerline was 4 m). The aircraft stopped at a heading of 234 degrees at a distance of 1440 m from the place of the first touch (Fig. 1). There was no fire on board.

During the roll the crew did not realize that the landing gear was retracted and acted in normal way until the aircraft came to stop.

19:17:00 the controller: “7-9-4, landing in 16 minutes. Can you taxi to apron yourselves”:

19:17:05 P: “Affirmative, 7-9-4”.

The crew and the passengers left the aircraft with the use of standard means (passenger stairs).

3. Conclusion and Findings

The aircraft, its systems (except the flap retraction/extension system), equipment and engines had no malfunctions and were in operable condition during the flight. The weight and centre of gravity were within the limits established.

The crew had valid certificates of CA experts, validated by the Irish CAA.

The crew's preparation corresponded to the task.

The crew passed annual medical check in due time and based on their health they were permitted to fly without restrictions.

The navigation service met the requirements of the applicable standard documents and did not contribute to the accident.

The crew carried out the pre-flight preparation entirely and in compliance with the Aircraft Preparation Workloop of KD Avia Company as well as Boeing-737-300 SOP.

Approach and landing were performed in night time, in shower rain, with gusty crosswind, on wet RWY, with an abnormal flap configuration, at over-speed.

During preparation for landing and flap extension (from 2º to 5º), the flap shutdown occurred due to flap position indicator needle split (left flap synchro failure). There was no actual flap asymmetry.

Fulfilling requirements of QRH (due to the false indication of flap asymmetry) the crew selected the GPWS flap inhibit (correctly) and landing gear inhibit (erroneously). As a result of warnings deactivation the GPWS system did not activate later and did not produce the landing gear aural warning.

The recommendations to crew in Additional Deferred Item, Chapter Trailing Edge Flap Asymmetry of the QRH available on board the Boeing-737-300 EI-DON are not customized for the particular aircraft, but just describe the procedures for possible GPWS switches layouts on this aircraft type.

The crew did not fulfill requirements of the Check List, section «LANDING CHECK-LIST» (which includes an item referring to landing gear extension).

As a result of Boeing-737-300 FCOM violations and incompliance with the requirements of the QRH, the crew did not extend the landing gear nor check its position, which caused the aircraft to land with retracted landing gear.

The crew twice cut off the aural Landing Gear Warning Horn, which alerted about the non-landing flap configuration and non-extended landing gear (when the throttles were moved to a position of less than 10 degrees), without checking the landing gear configuration. Frequent warning activation during landing approach at different airports (where approach patterns pro-

vide for late gear-down), and the fact that the pilots got used to it, was the cause of negative stereotype creation.

During the approach the level of emotional tension of the crew was a high one, which was apparently a result of the specifics of the coming landing (night time, shower rain, gusty crosswind, wet RWY, non-standard flap configuration, over-speed of approach).

Actions of the rescue services of the Kaliningrad airport and KD Avia Company were timely and proper.

Conclusion

The cause of the accident was a belly landing, which lead to aircraft structure's and engine's damage and was a result of the following negative factors:

- erroneous cutout by the co-pilot of the Landing Gear Warning Horn of the GPWS system, which was a result of the incorrect fulfillment of QRH recommendations regarding flap warning cutout in case of flap asymmetry.

- the use of the QRH which was on board the Boeing 737-300 EI-DON and which contains recommendations in its Additional Deferred Item, Chapter Trailing Edge Flap Asymmetry that were not customized to the particular aircraft layout.;

- violation of the Boeing-737-300 FCOM and a failure to comply with requirements of QRH (section LANDING CHECKLIST) by the crew, which resulted in the crew forgetting to extend the landing gear and check its position;

- The crew having a negative stereotype about the Landing Gear Warning Horn activation when approaching, which caused the crew to deactivate it more than once without checking landing gear position;

- An unsatisfactory CRM, which resulted in the absence of cross-checks when following the FCOM and QRH requirements, when an abnormal situation emerged and developed.

4. Shortcomings detected in the course of the investigation

4.1. The co-pilot underwent transition training to Boeing-737 in November 2006 in the FLIGHT TRAINING INTERNATIONAL (FTI) centre, Denver, Colorado (USA). According to information of the FTOA and Russian CAA, the aforementioned FTI Centre did not have a Russian CAA approval as per chapter 4 "Certification of Aviation Training Centres" of Federal Aviation Regulations, approved by Order No. 23 dated January 23, 1999 of Russian FAA .

When undergoing transition training, the co-pilot who did not have solo flight experience since graduating from the flight school, did not get any remarks from an instructor of the FTI Centre. This is not a typical situation when undergoing 7 FBS sessions and 8 FFS sessions during transition training to a completely new aircraft type.

The information received allows an assumption about a disinterested attitude of the instructors of the abovementioned Centre to the transition training.

4.2. In the Kaliningrad ATC Centre of the branch "North-West Air Navigation" of the Federal State Unitary Enterprise "State ATM Corporation" due to service sectors integration, sectors of "Radar", "Landing", "Ground" work on one frequency, which overload the air and produce difficulties for the air-ground radio communication , especially during the periods of mass aircraft departures and arrivals.

Besides, as at the all abovementioned sectors only one ATC controller works, this could affect negatively the air-ground interaction because of a heavy workload on the controller.

4.3. Analysis of incidents connected with flap asymmetry on Boeing 737 (200, 300, 400, 500) aircraft in Russian airlines revealed that in most cases the examinations of faulty parts and appliances are not conducted, representatives of states of design, manufacture and registration are not invited to participate in the incident investigations, which undermines the quality of the investigations and does not allow to establish the real causes of such incidents.

4.4. In the course of the investigation, the commission of the FTOA of the Ministry of Transport of Russia performed an irregular inspection of JSC KD Avia and detected the following shortcomings:

4.4.1. In the aviation enterprise JSC KD Avia regulations about flight shift distribution do not comply with requirements of the "Provisions for Work and Rest Schedule for Flight Crew Members" p.p. 29, 30;

4.4.2. When estimating the total time of a flight shift the time of flight delay is not taken in account;

4.4.3. When daily flight scheduling is done, requirements of the pre-flight rest and regulations on the flight shift distribution are ignored;

4.4.4. Requirements of the instruction “About the format of flight-staff documentation in flight divisions of civil aviation”, No. 3.1-154, of 23 March 1988, approved by a Vice-Minister of Civil Aviation, are not complied with.

5. Flight Safety Recommendations

5.1. To the Russian CAA[3]

5.1.1. Study circumstances and causes of the accident with the aircraft B-737-300 EI-DON operated by JSC KD Avia at special debriefings using investigation materials;

5.1.2. Consider the practicability of including flap asymmetry situations into the regular training programs of Boeing-737 crews on a Full Flight Simulator,. Instructors should ensure that the B-737 SOP is strictly followed by crew members.

5.1.3. Consider the practicability of an extra qualification check of the pilots who have undergone transition training to Boeing-737 type in the FTI Center. Decide on the need for additional training on the basis of the check.

5.1.4 Conduct additional training on crews actions in case of high-lift devices extension/retraction failures and malfunctions in aviation enterprises.

5.1.5. Make more extensive use of examinations of faulty parts and appliances when investigating occurrences to western made aircraft and invite representatives of the states of design, manufacture and registration to participate in the investigations.

If flap asymmetry is revealed in the course of aircraft operation, to perform the above mentioned works before the aircraft is released to flight.

5.2. The Boeing Company:

5.2.1. Consider the practicability of changing the Landing Gear Warning Horn activation algorithm in order to exclude the effect of flight crews getting used to the activation of the warning when extending wing high lift devices to an intermediate position with gear up;

5.2.2. Consider the practicability of conducting extra flap ballscrew checks before the 4C-Check (16000 hours) is due.

5.3. JSC KD Avia Airline and other airlines[4] of the Contracting States should

5.3.1. Conduct refresher training for the flight crews with regard to flight performance calculations;

5.3.2. In cooperation with the Boeing Company and the relative oversight authority revise the QRH on Boeing 737 type aircraft and make it consistent with the actually installed equipment on each particular aircraft;

5.3.3. Draw the flight crews' attention to the requirement to go through all the Checklist items again from the beginning in case it is interrupted for any reason.

---

[3] Aviation administrations of other Contracting States to the Agreement on Civil Aviation and Airspace Use should consider the applicability of these recommendations to the actual state of things in the States.

[4] Airlines should consider the applicability of these recommendations on the basis of their actual situation.

5.4. **Kaliningrad ATC Centre** of “North-Western Air Navigation” branch of the Federal State Unitary Enterprise “State ATM Corporation” should rule out “Radar”, “Landing”, “Ground” sectors with one controller working on one frequency.