AIR ACCIDENTS INVESTIGATION
INSTITUTE OF CZECH REPUBLIC
Beranových 130
199 01 PRAHA 99

CZ-08-562

FINAL REPORT

Investigation into serious incident of Boeing 737 - 400, registration mark OK-WGX, at Ostrava Mosnov Airport, on 14 November 2008.

Prague
December 2009

The report's information, findings and conclusions concerning the aircraft accident or system failures endangering operational safety are solely of informative nature and can only be used as recommendations to prevent similar accidents due to similar causes. The author of the Final report states explicitly that it cannot be used to lay the blame or responsibility for the accident on anyone or to file insurance claims.

Used abbreviations:

°C	-	Degree Celsius (unit of temperature)
AAII	-	Air Accidents Investigation Institute of Czech Republic
ACC	-	Area Control Centre
AIP	-	Aeronautical Information Publication
APP	-	Approach control service
ATPL (A)	-	Airline Transport Pilot Licence
ATS	-	Air Traffic Services
BiOL	-	Biological protection airport
BKN	-	Broken (category of cloud amount: 5-7 octas)
CPT	-	Captain
CSA	-	Czech Airlines J.S.C.
CTR	-	Control zone
DY Check	-	Daily check
E	-	East (cardinal direction)
FO	-	First Officer
FS	-	Flight Safety
ft	-	Foot (unit of length – 0,3048 m)
GEO	-	Geographic
HEGN	-	Hurghada airport
hPa	-	Hectopascal (unit of Atmospheric pressure)
HPC	-	High Pressure Compressor
HPT	-	High Pressure Turbine
HPT NGV	-	High Pressure Turbine Nozzle Guide Vanes
ILS	-	Instrument Landing System
kg	-	Kilogram (base unit of mass)
km	-	Kilometre (unit of length)
kt	-	Knot (unit of speed – 1,852 km h^{-1})

LC	-	Line check
LKMT	-	Ostrava Mosnov airport
LKPR	-	Praha Ruzyne airport
LPC	-	Low Pressure Compressor
LPT	-	Low Pressure Turbine
LT	-	Local Time
m	-	Meter (unit of length)
MAG	-	Magnetic
MA-TL	-	B737 engineering group
METAR	-	Aviation routine weather report
MHz	-	Megahertz (unit of frequency)
MLW	-	Maximum Landing Weight
N	-	North (cardinal direction)
NIL	-	None
NSC	-	Nil Significant Cloud
OPC	-	Control indicated is operational control
QAR	-	Quick Access Recorder
QNH	-	Altimeter sub-scale setting to obtain elevation
QRH	-	Quick Reference Handbook
RA	-	Height measured by radio altimeter
RWY	-	Runway
s	-	Second (base unit of time)
S Check	-	Weekly check
SCT	-	Scattered (category of cloud amount: 3-4 octas)
SIM	-	Simulator
SW	-	South West
SWY	-	Stopway
TMA	-	Terminal control area
TWR	-	Aerodrome control tower

TWY	-	Taxiway
UTC	-	Co-ordinated Universal Time
VRB	-	Variable

A) Introduction

Operator:	Czech Airlines J.S.C.
Aircraft manufacturer and model:	The Boeing Company, B737-436
Registration Mark:	OK–WGX
Place of incident:	CTR LKMT – Ostrava Mosnov airport
Date :	14.11.2008
Time:	11:57 LT (10:57 UTC, all times are UTC)

B) Synopsis

On 14 November 2008, AAII was notified by CSA of a serious incident involving a Boeing B737, registration mark OK-WGX, which happened in CTR of LKMT airport.

After taking off from RWY 22 at the LKMT airport, a bird was sucked into the engine 2. The crew noticed increased vibrations and shortly after that the limit temperature of exhaust gas was exceeded. The crew shut down the engine and decided to fly to and land at the LKPR airport with just one engine working. The cabin made preparation for emergency. The aircraft landed at LKPR airport without any further problems, no one was injured.

The cause of the incident was investigated by an AAII commission comprising:

Commission Chairman:	Mr. Viktor HODAŇ
Commission Member:	Mr. Josef PROCHÁZKA
	Mr. Marek MINCBERGR, CSA, MA-TL
	Mr. Ladislav MUSIL, CSA, FS

The final report issued:

AIR ACCIDENTS INVESTIGATION INSTITUTE
Beranových 130
199 01 Prague 99, Czech Republic

7 December 2009

C) The report includes the following main parts:

1. Factual information
2. Analysis
3. Conclusions
4. Safety recommendation

1. Factual information

1.1 History of flight

The event description was based upon the crew´s testimony, evaluation of the flight data recorder, radar flight record, radio communications record between the crew and ATS and the chief of fire brigade.

On 14 November 2008 the flight crew of Boeing B737 registration mark OK-WGX was due to make a commercial flight from LKMT airport to HEGN airport. The crew pre-flight preparation and passengers´ embarkment went in a standard way. The first officer was the pilot flying on this route. According to the flight recorder, the parameters of both of the engines were alright during the start and taxiing. RWY 22 was used for taking off. At the beginning of the take-off run the crew spotted a bird of quite a big size. At the final stage of the aircraft´s take-off run the bird flew out, headed for the aircraft passing it to the right. A moment later the crew felt something hit the fuselage on the starboard side, thinking the shock took place at the right-hand main landing gear.

At a speed of 176 kt the aircraft left the runway surface and then retracted the landing gear. The TWR controller informed the crew he had spotted flashes coming from the engine. The crew received the information and at the same time noticed that engine 2 vibration got to the limit value.

From RA 620 ft the engine 2 regime was gradually reduced to flight idling because of the vibration growth.

At RA 1932 ft after the flaps retraction, the autopilot on the co-pilot side was switched on. 40 s later the crew put the landing gear down because they thought the right landing gear tyre had been damaged after collision with the bird.

The crew told the TWR controller they intended to fly back and land at the LKMT airport as soon as they had finished Non – Normal Checklist 7.22 High Engine Vibration according to QRH. At that time the captain took over the control and switched the autopilot to his side. After 36 s he switched the autopilot off because as he said he was not able to make turns with it. During vectoring the aircraft to approach to land on RWY 22 by ILS, the red tell-tale, over the engine 2 exhaust gas temperature indicator came on, showing that the limit values of this temperature had been exceeded.

The crew told the TWR traffic controller they wanted to stop approaching and asked for vectoring to solve the problem with engine 2. The TWR traffic controller issued the instruction to go over to the approach control station. The crew contacted this station and sent out a MAY DAY signal. Then the crew continued following instructions by the approach control station.

The crew worked on the problem of exceeding exhaust gas limit temperature in accordance with QRH Non – Normal Checklist 7.14 Engine failure or Shutdown by shutting down the engine 2. Then there was preparation to landing at LKMT airport in accordance with QRH, Non – Normal Checklist 7.24 One Engine Inoperative Landing.

During the vectoring the LKMT airport OPC CSA Prague asked the crew through air traffic controllers whether they would rather fly to Prague instead. Shortly after that the captain decided to fly to LKPR airport.

On contacting ACC Prague the crew sent out a MAY DAY signal again. In preparing for landing at LKPR airport the crew again kept to QRH Non – Normal Checklist 7.24 One Engine Inoperative Landing.

The aircraft landed on LKPR airport RWY 24 with a landing mass of 54,594 kg experiencing no more failures. After the aircraft had come to a halt, been inspected and towed to a stand, the passengers got off in a standard way.

1.1.1 Collaboration between cockpit crew and cabin staff

After the captain had decided to return and land at LKMT airport, he called in the chief of cabin by a radio command PURSER TO THE COCKPIT and gave him an instruction to proceed with the emergency situation prepared.

But in the end the captain of the aircraft took the decision to fly to LKPR airport and informed the passenger about the whole situation. This information was very important for the passengers, bringing them relief, according to the purser´s testimony.

On landing at the LKPR airport and towing the aircraft from TWY D the first officer on captain´s instruction called off the prepared emergency by radio command CABIN CREW AND PASSENGERS KEEP YOUR SEATS.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others (Inhabitants, etc.)
Fatal	0	0	0
Serious	0	0	0
Minor / None	0 / 6	0 / 120	0 / 0

1.3 Damage to Aircraft

On landing at the LKPR airport and inspection by operator´s technical staff it was confirmed that the engine 2 had been seriously damaged. Other damage, to the skin, airframe, or the supposed damage to the main landing gear wheel tyre, has not been found.

1.3.1 Damage to engine

The engine 2 was seriously damaged as a consequence of having sucked a bird. Directly on the stand of the aircraft it was found that the fan blades were damaged, the inlet cowl inner wall had been pierced, and a small amount of fuel had leaked from the engine control system. A closer inspection revealed that assemblies on the engine outer part and their hinges (starter, Main Engine Control, fuel pump) were damaged too.

Based on this findings and after discussion with the engine manufacturer it was decided to remove the engine and send it to a foreign repair shop to know the damage in more detail and the way and scope of repair.

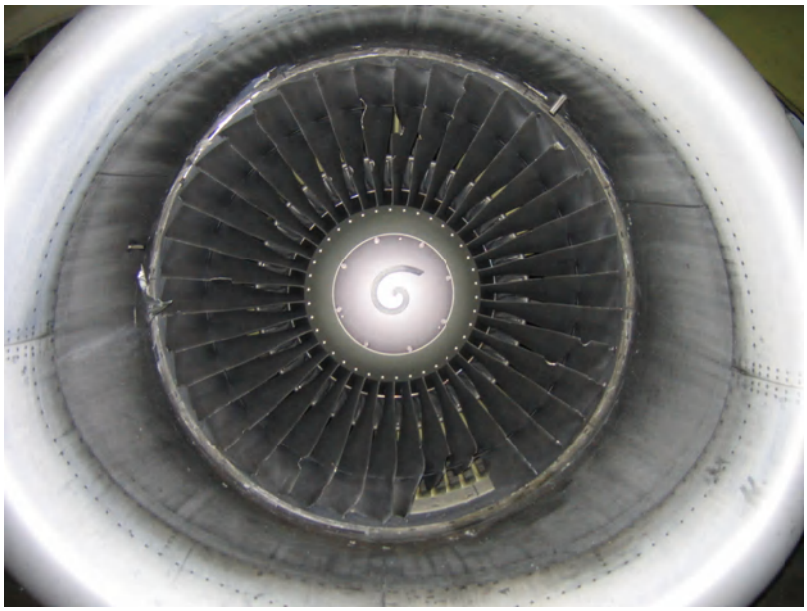

Fig. 1 Overall view of engine inlet

Apart from the damage already mentioned, extensive damage to the compressor was also found. The low pressure and high pressure rotor blades were ground off by the contact with compressor case and seriously damaged. The combustor was without damage only some deposit of brushed dust from the compressor was found. The high pressure turbine had its cooling holes blocked with brushed dust, which caused its overheating. The low pressure turbine moved to the rear due to the nut of bearing 1 coming loose, thus making contact between the rotor and stator of the turbine, resulting in low pressure turbine damage.

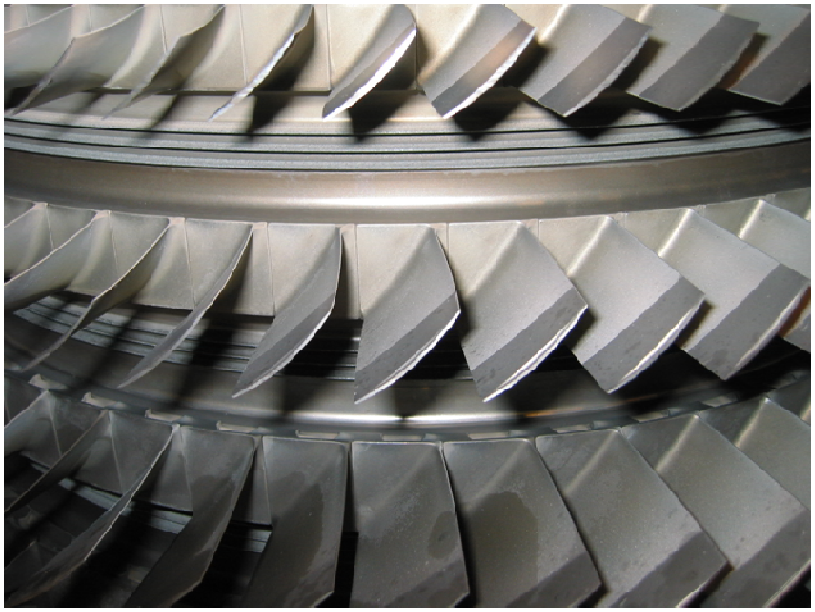

Fig. 2 Abrasion of high-pressure compressor blades

Fig. 3 Deposit of abrasion dust on high-pressure turbine stator blades

1.4 Other damage

NIL

1.5 Personnel Information

1.5.1 Captain of aircraft

Age / gender:	50 years / male
Pilot license:	ATPL (A) valid till 20.02.2013, rating – CPT B737
Medical:	valid till 14.01.2009

Flying experience:

Flying hours	Last 24 hours	Last 90 days	Total
as CPT on B737	2:25	135:42	4 059
as CPT	2:25	135:42	6 689
Total flying hours	2:25	135:42	9 416

The pilot had a rest of 13 hours 45 minutes before the flight. At the time of the incident he had been on duty for 5 hours 13 minutes.

The pilot took his last check exam LC on 06.01.2008 and SIM on 18.07.2008, either of them with results PASSED.

1.5.2. First officer

Age / gender:	32 years / male
Pilot license:	ATPL (A) valid till 25.02.2013, rating – FO B737
Medical:	valid till 04.09.2009

Flying experience:

Flying hours	Last 24 hours	Last 90 days	Total
as FO on B737	6:13	225:57	2 398
as FO	6:13	225:57	2 781
Total flying hours	6:13	225:57	3 450

The pilot had a rest of 13 hours 45 minutes before the flight. At the time of the incident he had been on duty for 5 hours 13 minutes.

The pilot took his last check exam LC on 15.02.2008 and SIM on 08.08.2008, either of them with results PASSED.

1.6 Aircraft Information

1.6.1 Information on airframe

The Boeing B737-436 is a twinjet transport category low-wing aircraft for flight crew and 162 passengers.

Type / model:	Boeing B737 / B737-436
Registration :	OK-WGX
Manufacturer :	Boeing
Serial number:	25349
Year of manufacture:	1991
Time since new:	37,923
Cycles since new:	26,621
Airworthiness Review Certificate:	valid till 13.08.2009
Insurance Certificate:	valid till 30.11.2008

1.6.2 Power plant:

To power the aircraft two CFM International engines were used.

Engine No.1:	CFM56-3C.1
Serial number :	858850
Year of manufacture:	1998
Time since new:	30,206
Cycles since new:	16,747
Time since last repair:	27,655
Cycles since last repair	15,628

Engine No. 2:	CFM56-3C.1
Serial number :	860128
Year of manufacture :	1999
Time since new:	20,421
Cycles since new:	12,583
Time since repair:	0
Cycles since repair:	0

1.6.3 Aircraft operation

The aircraft was used for passengers´ short and medium-range transport with a maximum landing mass of 54,884 kg.

The latest maintenance was carried out on 13.11.2008 in the range of S + DY CHECK at total flight hours 37,913 and 26,617 cycles.

Since this maintenance the aircraft had accumulated 10 hours and 4 cycles.

1.7 Meteorological information

1.7.1 Report METAR LKMT

Extraction from METAR reports of LKMT (Ostrava Mosnov) meteorological station:

Time	QNH	Wind direction / wind speed	Visibility	Cloud / Height of cloud base	Temperature / Dew point
11:00	1,027 hPa	calm	4 km	SCT / 800 ft	8 / 6 °C
11:30	1,027 hPa	VRB / 2 kt	6 km	BKN / 900 ft	7 / 5 °C

1.7.2 Report METAR LKPR

Extraction from METAR reports of LKPR (Praha Ruzyne) meteorological station:

Time	QNH	Wind Direction / Wind Speed	Visibility	Cloud / Height of cloud base	Temperature / Dew point
11:30	1,023 hPa	210° / 6 kt	9 km	NSC	5 / 4 °C
12:00	1,023 hPa	220° / 7 kt	9 km	NSC	5 / 3 °C

1.8 Aids to navigation

NIL

1.9 Communications

Radio communication records between the crew and the air traffic control stations were secured:

- TWR LKMT on frequency 120.8 MHz,
- APP LKMT on frequency 125.1 MHz,
- ACC on frequency 127.125 MHz,
- APP LKPR on frequency 127.525 MHz,
- TWR LKPR on frequency 112.1 MHz

All of the records were comprehensible and legible.

1.10 Aerodrome information

LKMT is Public International Aerodrome. It´s location is 20 km SW from main railway station in Ostrava.

LKMT reference point:

Geographic coordinates:	N 49°41´46,0´´
	E 018°06´39,0´´
Elevation:	257.0 m

Runways´ selected physical characteristics:

Designations RWY	TRUE & MAG bearing	Dimensions of RWY	Surface RWY a SWY	Slope of RWY-SWY	Obstacle free zone
04	046°GEO 044°MAG	3,500 m x 63 m	concrete	-0.32%	NIL
22	226°GEO 224°MAG	3,500 m x 63 m	concrete	0.32%	NIL

AIP AD 2 LKMT in point 2.23.1 calls attention to possible presence of birds in the vicinity of the airport and the map 2-41 shows zones with dangerous concentration of birds.

It follows from the testimony by a LKMT BiOL worker that the runway was checked in accordance with an air traffic plan. At the time the operation surfaces were checked the situation was calm and there was no flock of birds observed. Just a kestrel or a buzzard flew about from time to time but in a safe distance away.

The chief airport operator stated in his report on that extraordinary event that rests of the bird collision had been found at RWY – TWY C crossing on an area of around 80x40 m. Bird´s rests, debris of plastic, metal, and laminate have been found at this place.

1.11 Flight recorders

The course of the flight has been evaluated from the QAR. The data record was easy to read.

It is evident from the recording that engine´s parameters had not deviated from standard values till the moment the bird was absorbed.

Time sequence of the values of selected parameters:

- 10:54:28 engines 1 and 2 are on idle regime, parameters of either engine are steady and vibrations of fans of either of them are at value 0.20
- 10:56:28 take-off regime set in the course of take-off run, fan vibration of engine 1 at value 0.18, fan vibration of engine 2 at value 0.10
- 10:56:43 at an airspeed of 166.5 kt revolutions shoot of engine 2 low-pressure compressor (take in a bird)
- 10:57:08 ramp change of engine 2 fan vibration from 0.10 to 4.88; engine 1 fan vibration at 0.27 value
- 10:58:07 engine 1 regime reduced to flight idling
- 11:05:27 exhaust gas began to rise from 531.4 degrees Celsius
- 11:06:15 exhaust gas maximum temperature reached 974.8 degrees Celsius
- 11:06:18 engine 2 shut down

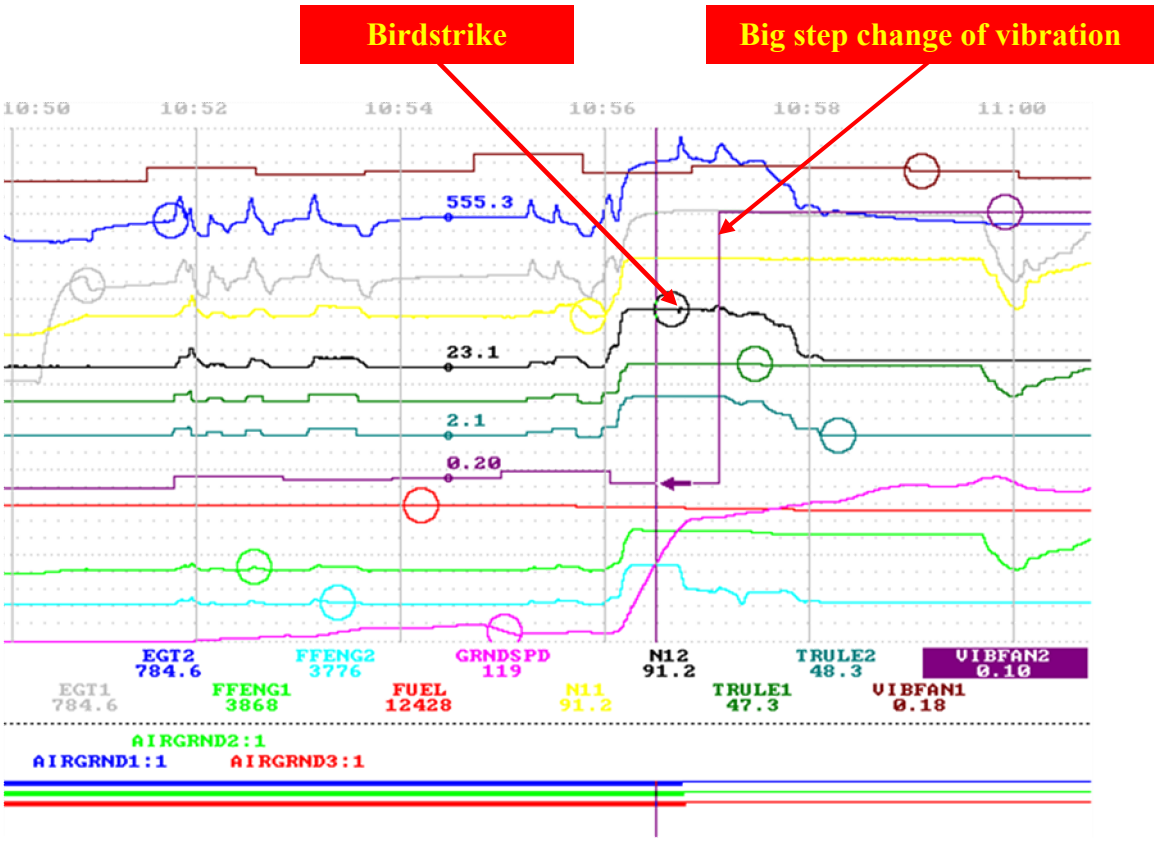

Fig.4 Engine parameters as recorded at the time of collision with bird

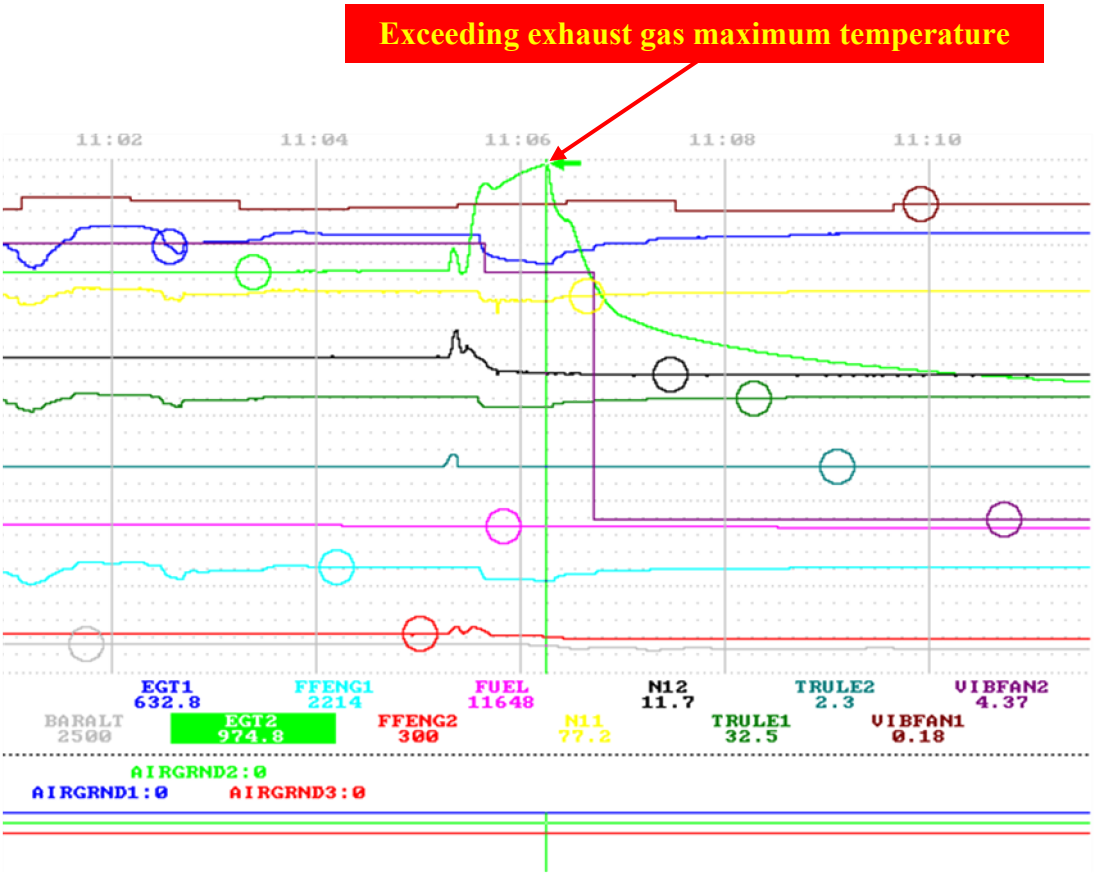

Fig.5 Engine parameters as recorded when exceeding exhaust gas maximum temperature

1.12 Wreckage and impact information

NIL

1.13 Medical and pathological information

NIL

1.14 Fire

NIL

1.15 Survival aspects

Search and rescue were not organized.

The following steps were organized at LKMT airport:

- 10:59:20 LOCAL STAND-BY was called with anticipated one-engine landing in 6 minutes
- 11:25:28 FULL EMERGENCY was called
- 11:32:32 FULL EMERGENCY was called off after the captain´s decision to fly to LKPR airport

The following measures were taken at LKPR airport:

- 11:44:30 FULL EMERGENCY was called
- 12:06:00 airport operation was suspended
- 12:27:00 airport operation was resumed

1.16 Tests and research

NIL

1.17 Organizational and management information

NIL

1.18 Additional information

When the aircraft landed, there were some disturbances in communications between the flight crew and the chief of fire brigade and the TWR traffic controller, which led to delay in finishing emergency actions.

1.19 Useful or effective investigation techniques

The serious incident has been investigated according to L-13 National Regulation (Investigation into Air Accidents and Incidents of the Czech Republic as per recommendation of ICAO - Annex 13).

2. Analysis

2.1 Analysis of factual information

The flight crew had valid pilot licenses for transport aircraft and valid ratings.

The flight crew had valid first class medicals.

The aircraft had valid airworthiness review certificate and valid insurance certificate.

2.2 Flight crew activities

Immediately after the bird had been taken in engine 2 and its vibration had risen, the flight crew correctly used Non – Normal Checklist 7.22 High Engine Vibration and took the decision to land at LKMT airport.

The crew´s decision to abort ILS approach to RWY 22 was also correct because of the indication that exhaust gas temperature was beyond the limit value. But the crew misused Non – Normal Checklist 7.14 Engine Failure or Shutdown. In this case it would have been correct to use Non – Normal Checklist 7.2 Engine Limit or Surge or Stall. However, the crew despite the use of a wrong checklist shut down the engine, which was a right solution in the circumstances.

Since the captain took over the control and steered the plain manually during the major flight route, his capacity to make further decisions and communicate with his first officer, cabin purser, and traffic controller was reduced.

To tackle the problems with failures on the aircraft, it would have been better for the captain to climb to the minimum sector height and execute flight in the waiting pattern, not having himself disturbed by instructions from air traffic controllers in vectoring the aircraft.

For the whole time the crew believed the tyre of the right main landing gear was damaged, which was not true. This miscalculation got the captain to try to reduce the landing mass.

OPC CSA Prague was constantly informed about the situation in the LKMT area. During the time the aircraft was waiting in TMA I Ostrava due to the runway clean-up before landing, the OPC CSA Prague asked the crew, through TWR traffic controller and LKMT approach control station, whether they would rather fly to Prague. Shortly after that the captain decided to fly to LKPR airport. This decision of his was in that situation in contradiction with QRH Non – Normal Checklist 7.2 Engine Limit or Surge or Stall and with Non – Normal Checklist 7.14 Engine Failure or Shutdown. It was also in contradiction with the manual OM-A Chapter 8P.2.2.3 Flight crew Decisions point a): If a take-off airport is suitable for one-engine takeoff and landing, LAND AT THE DEPARTURE AIPORT AS SOON AS POSSIBLE.

Communications with air traffic control service deviated from the standard prescribed phraseology. This fact had no effect on the event.

2.3 Likely cause of engine failure

A few fan blades broke off after engine 2 took in a bird. Rests of the bird and blades left the engine with by-pass flow, damaging the fan case. Broken blades caused the engine to vibrate strongly. Consequently, parts on the engine external side were damaged. The bearing no.1 nut came loose, causing the LPT shaft to loosen and move back. This made the stator get in contact with the LPT rotor discs. The strong vibration caused mutual oscillation of the high-pressure rotor and the HPC box, which in turn caused LPC and HPC rotor blades and box to get in contact. The blade tips were ground off on the case. The created grind dust moved to the rear through the engine where it plugged cooling holes on HPT NGV and HPT blades. Consequently, the cooling capability was gradually reduced, causing exceeding of engine maximum allowable temperature even at flight idling regime.

2.4 Effect of meteorological conditions

The meteorological conditions had no effect on event.

3. Conclusion

3.1 Commission came to the following conclusions.

3.1.1 Aircraft´s crew

- Had valid pilot licenses and ratings;
- Had valid medicals;
- Was qualified for making the planned commercial flight;
- Reacted correctly to the situation by shutting down engine 2;

- Followed a wrong checklist when tackling the problem of exceeding exhaust gas maximum temperature;
- Reacted properly when they sent out a MAY DAY signal and let it on all the time until landing at LKPR airport;
- Both flight crew and cabin crew proceeded right when they gave instruction to go ahead with prepared emergency actions;
- Violated rules when did not make a landing at the take-off airport, contradicting the used checklists and OM-A manual.

3.1.2 Aircraft

- Had valid airworthiness review certificate,
- Was insured properly,
- Its mass at landing was within limits (MLW was not exceeded).

3.1.3 Meteorological conditions

- Were good at either airport (LKMT, LKPR)

3.2 Causes

The cause of the serious incident was extensive damage to engine 2 at taking off due to a bird intake and wrong flight crew´s decision to land at LKPR airport.

4. Safety recommendations

B737 operator will make flight crews familiar with the commission´s conclusions.

Take measures to secure direct radiotelephone communications between flight crew and chief of fire rescue team.