



AIR ACCIDENTS INVESTIGATION
INSTITUTE
Beranových 130
199 01 PRAGUE 99

No. CZ -13 - 459

FINAL REPORT

**Investigation into the Serious Incident of aircraft type Boeing B737-800,
registration mark OK-TVG, at LKPD aerodrome
on 25th August 2013**

Prague
March 2014

This investigation has been carried out in accordance with the Regulation EU No 996/2010, Act No 49/1997 Coll., on civil aviation and Annex 13 to the ICAO Convention on International Civil Aviation. The sole objective of the investigation of an accident or incident under these Regulations shall be the prevention of accidents and incidents. It shall not be the purpose of such an investigation to apportion blame or liability.

The Final Report, findings and conclusions therein concerning air accidents and incidents, and possibly systemic shortcomings endangering operational safety, are only of an informative nature and cannot be used otherwise than as a recommendation for the implementation of measures in order to prevent further air accidents and incidents with similar causes. The creator of the Final Report explicitly states that the Final Report cannot be used to determine blame or responsibility in connection with determining the causes of an air accident or incident and cannot be used for enforcing claims in the event of an insurance claim.

Abbreviations used

AACU	Antiskid/Autobrake Control Unit
ATC	Air Traffic Control
ATCo	Air Traffic Controller
ATS	Air Traffic Service
ATPL(A)	Airline Transport Pilot Licence
ATIS	Automatic Terminal Information Service
IAS	Indicated Airspeed
CWY	Clearway
CPT	Captain
ČHMÚ	Czech Hydrometeorological Institute
CVR	Cockpit Voice Recorder
CC	Cabin Crew
DFDAU	Digital Flight Data Acquisition Unit
FH	Flight Hour
FI (A)	Flight Instructor/
FO	First Officer
GP	Glide Path
GS	Ground Speed
LHT	Lufthansa Technics
LKPD	Pardubice airport
MAC	Mean Aerodynamic Chord
MACC	Military Area Control Centre
MEL	Minimum Equipment List
MCTR	Military Control Zone
MLW	Maximum Landing Weight
NOTAM	Notice To Airmen
METAR	Aerodrome Routine Meteorological Report
OVL MO	Military Aviation Authority Ministry of Defense
PF	Pilot flying
p/n	Part number
RCC	Rescue Coordination Centre
SIM	Simulator
s/n	Serial number

SCC	Leader of Cabin Crew
SOP	Standard Operating Procedure
TD	Touchdown
THR	Threshold
TLB	Technical logbook
TRI	Type Rating Instructor
TWR	Tower
TWY	Taxiway
VHJ	Military Fire Brigade
WO	Work Order
WDI	Wind Direction Indicator
UTC	Co-ordinated Universal Time
ÚCL	Civil Aviation Authority
AAll	Air Accidents Investigation Institute

Units:

°C	Temperature on the Celsius scale
ft	Feet (unit of length-0,3048 m)
h	Hour (unit of measurement of time)
sec	Second (unit of measurement of time)
Kg	Kilogram (unit of mass) /
kt	Knot (unit of speed-1,852 km h ⁻¹)
m	Meter (unit of length)
Psi	(jednotka tlaku)
ft/sec/sec	(ft.sec ⁻²) Decelerace
MPa	Megapascal
n _y	Vertical overload

A) Introduction

Owner/Operator	Travel Service, a.s.
Manufacturer and aircraft model	Boeing Company, B737-800,
Registration mark	OK-TVG
Site	LKPD
Date and time	25 th August 2013, 14.47 UTC (all times are UTC)

B) Synopsis

On August 25, 2013, during a landing of B737-800 aircraft at Pardubice aerodrome at the taxing, the aircraft overrun on the paved surface. The aircraft came to a full stop 156 metres in the RWY 27 clearway. After the stop, the passengers and the crew left the aircraft in regular way, no injury to the passengers or the crew and no damage to the aircraft were reported. Recovery of the aircraft from the unpaved clearway was performed by a company specialized therein.

The cause of the incident was investigated by an AAIL commission. The investigation team comprised:

Investigator In Charge	Ing. Lubomír Střihavka
Members	Ing. Josef Procházka Ing. Vladimír Vlk

According to paragraph 55(a)(4) and (6) of Act No. 49/1997 on Civil Aviation, expert consultants from the Military Aviation Authority of the Ministry of Defence of the Czech Republic aided in the investigation.

The Final Report was issued by:

Air Accidents Investigation Institute
Beranových 130

199 01 PRAHA 99

On March 17, 2014

C) The report includes the following main parts:

- 1) Factual information
- 2) Analysis
- 3) Conclusions
- 4) Safety recommendation
- 5) Apendixes

1 Factual information

1.1 History of the Flight

1.1.1 Events Preceding the Incident Flight

The operation of the aircraft was begun on 25 August 2013 at 5:00 o'clock - flight from Prague to Burgas (TVS 2900) - and then continued by flight from Burgas to Budapest (TVS 5503) and from Budapest to Burgas (TVS 5502). The last flight from Burgas to Pardubice was begun at 13:05 under the code TVS 2907. The first and second flights as the PF was captain. The third and fourth flights as the PF was First Officer. All the mentioned flights were fully occupied. A record of postponing of dealing with the defect MEL 78-7 was entered into TLB.

1.1.2 The Event Flight

The flight procedure has been described from the data recordings from DFDAU and CVR recording devices, from the crew statements and from the recordings of ground recording devices and Pardubice aerodrome security system cameras. The event flight has been divided into several stages, from the commencement of the flight till the moment of touchdown and movements of the aircraft on the ground until the full stop. The crew operation and activity after the full stop has been described in accordance with the records of communication between the flight crew and from the statements of the cabin crew and several statements of testimony by the passengers.

1.1.2.1 The Event Flight – from the TKOF until the touchdown

According to the submitted operational flight plan the TKOF was supposed at 13:20. According to the record in the TLB, the TKOF procedure from Burgas was in fact commenced at 13:05. One of the lady-passengers commented the TKOF time as follows:... *"the departure from Burgas was about half an hour earlier"*... The flight to Pardubice was carried out on the flight route as stated in the flight plan. According to the statements of the pilots and according to the in-flight data recordings no deviations from the flight and technical flight parameters have been indicated. At 14:44:10 the crew established a radio contact with the ATS LKPD and at 14:44:56 the crew was received about the conditions for landing.... *runway two seven, cleared to land, wind zero niner zero degrees, five knots, runway is wet....* The captain's confirmation of the message and the FO started to repeatedly enquire for the up-date information on wind at 14:45:54. FO received the following reply from the air traffic control unit ... *wind zero niner zero degrees, five knots....*, which he confirmed. Based on the conversation recorded by CVR, the Captain and FO were comparing and evaluating the information received with the data provided by aircraft computer, stressing namely the tailwind component effect on landing as the ATIS report was wind 090/7kt, rain. They were also reasoning that in case of the tailwind component did not change, they would perform "Go-around" and carried out landing from the opposite direction. During the descent they ascertained from the on board computer reading that the tail component was decreasing and the ascertained decrease, together with the ATS LKPD notification, assured the flight crew about the final decision of course and aircraft configuration for the landing. The PF

continued in the original landing direction for the RWY 27 and setup the flaps to 30 degrees and AB2 braking mode. According to his statement he was attempting to perform the landing as close as possible to the THR 27 and in the final stage piloted the aircraft in descent one dot below the GP (*“duck under”*). FO stated that he touched down still before the crossing of RWY 27 and TWY B. According to the DFDAU recording made at 14:47:29, the touchdown took place 821 m from THR RWY 27. The security system cameras recorded the section of landing from the level of reaching THR 27 to the moment of touchdown. The footage recorded confirmed that the aircraft touched down only after the TWY B level.

1.1.2.1.1 The Time Event until the touchdown by DFDAU:

14:46:14 – location 5 747 m to THR 27

H 1 000 ft, IAS 153 kt, GS 181 kt, N1 54/53, MLG-on, Flaps 30°;

14:46:46 – location 2 824 m to THR 27

H 500 ft, IAS 156,2 kt, GS 174 kt, N1 47,4/46, MLG-on, Flaps 30°;

14:47:07 – location 985 m to THR 27

H 200 ft, IAS 154 kt, GS 164 kt, N1 52,9/49,1, MLG-on, Flaps 30°;

14:47:14 – location 412 m to THR 27

H 100 ft, IAS 153,2 kt, GS 163 kt, N1 54/57, MLG-on, Flaps 30°;

14:47:19 – location 3 m to THR 27

H 46 ft, IAS 152,5 kt, GS 161,5 kt, N1 54,9/58,1, MLG-on, Flaps 30°;

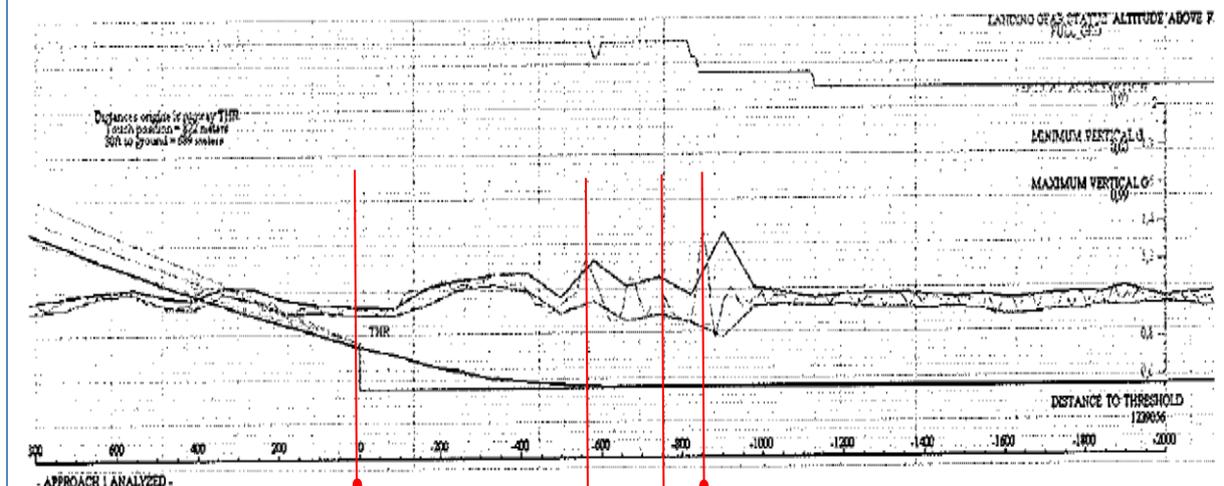
location between THR and TD

IAS increase + 1 kt and next decrease, N1 64,1/64

14:47:29 – TD 821 m after THR 27

H 0 ft, IAS 143,3 kt, GS 155,5 kt, N1 IDLE, MLG-on, AB2 from TD 6 sec to 14:47:35;

Vertical acceleration = max 1,36 v bodě přistání, 1,51 na konci letové dráhy (zřejmě při opuštění dráhy)



THR 27 1 TD TWY B TD

The graphical chart landing procedure by DFDAU

1.1.2.2 Aircraft movement - from the touchdown to full stop

According to the CVR record, the captain assessed the landing ... "as into a featherbed". At this point, the captain stated that "the speed-brakes did not even want to come out" ... and at the same time carried out a manual extension of the "speed brake". FO, bearing in mind the non-operational reverse of the right engine, used the left reverse in IDLE. Approximately at the TWY C level, he received instruction from the ATS about RWY clear at TWY D. Captain acknowledged the said notification and confirmed he could see the "Follow me" vehicle. At the same time, both the pilots observed that the deceleration of the aircraft is slow to which they responded by the change of braking mode to AB3. After the said intervention they exchanged informative comments regarding the situation wherein the FO uttered: "we just might overrun" At that moment the Captain took over the control and responded to the situation arisen by another change of braking mode by setting "MAN FULL BRAKE". The Captain further responded by setting the maximum thrust reverse of the left engine and by simultaneous maximum braking and course control he was trying to direct the aircraft to the left from the axis of the track next to the lighting system he had had in front of himself. The aircraft came to the full stop 156 metres beyond the end of RWY 27 on a grass surface. The nose was turned by more than 90 degrees to the left. After the stop both the pilots were verbally evaluating the situation occurred. At that moment an aerodrome "Follow me" vehicle came to the standing aircraft waiting on the TWY D. The driver-technician who drove the said vehicle communicated verbally with the crew cabin member who was leaning out of the open front left door and enquired whether there were any injuries. Then he made verbal communication the Captain, who leaned out of the left side cockpit window, and enquired whether there was any fire detected in, on or around the aircraft. After ascertaining that the aircraft was not on fire, the technician asked the Captain to shut down the engine No. 2 as it was still running. The technician consequently performed a quick visual inspection of the standing aircraft. By that time a unit of Military Fire Brigade came to the location and the technician informed the fireman of command that there had

been no fire detected anywhere, the landing gears had been secured and no fluids were leaking from the aircraft. Consequently, the ground handling unit arrived and brought the passenger boarding stairs to the open door (1L). The technician who was watching the final stage of the aircraft landing run from the "Follow me" vehicle that was waiting on TWY D, described the OK-TVG aircraft movement in the runway end section as faster in comparison with other aircraft. When the aircraft approached the technician station nearer, he noticed it was diverted to the left and after the run out into the grass it turned by skidding by approx. 90 degrees to the left. During the inspection, the engineer did not observe any fluid leakage, fire or visible damage to the landing gear. He noticed that no smoke was coming out from the main gear wheels and that their temperature was not significantly higher as it usually is the case after the landing of aircraft of similar type.

1.1.2.2.1 Aircraft movement - from the touchdown to full stop by DFDAU and CVR:

14:47:29 – location TD 821 m after THR 27

H 0 ft, IAS 143,3 kt, GS 155,5 kt, N1 IDLE, MLG, MAN Speed brake, AB2, $n_z=1,36$

14:47:34 - FO say (by CVR) ... *we set AB3* ...

14:47:35: 6 sec after TD, change the braking mode on AB3, N1 IDLE;

14:47:39 – location 1 607 m after THR 27

H 0 ft, IAS 111 kt, GS 121 kt, N1 IDLE, change the braking mode on MAN FULL BRAKE,

14:47:47 – location 2000 m after THR 27

H 0 ft, IAS 88 kt, GS 98 kt, N1 MAX. REVERZ, MAN FULL BRAKE,

14:47:53 - FO say (by CVR) ... *we just might overrun* ...

14:48:00 – leave the RWY 27

H 0 ft, GS 51 kt (*exited speed*), N1 REVERZ, MAN FULL BRAKE,

14:48:17 – stop distance 2706 m from THR 27

H 0 ft, GS 0 kt, N1.1 0, N1.2 IDLE, shut down reverser

1.1.2.3 Crew Operation after the Full Stop of the Aircraft

All of the CC members described the landing at the moment of touchdown as normal, then they sensed a skidding movement of the aircraft on the runway and heard the reverse thrust of the engine. In the final stage before the full stop they sensed a very sharp skid and turning of the aircraft. A few seconds after the full stop a command was issued from the cockpit which was incomprehensible, CC in the 1R position identified the same as "*Cabin Crew at Stations*". SCC from the 1L position went into the cockpit and received information from the Captain at 14:49:31 that evacuation was not necessary and to unbrace and open the door 1L (with no escape chutes). After the opening of the door 1L he established a verbal communication with the technician who had arrived with the "Follow me" vehicle. The other CC members were notified to stay at their stations and wait for further instructions. After the passenger stairs were put to the door 1L the disembarking of the passengers was commenced. All of the CC members described the said operation as calm. Some of the passengers enquired at their travel agents for explanation of the events linked with the aircraft landing and reluctant conduct of the CC.

From the information gathered from the letters sent by the passengers describing the CC activity the said conduct of the CC towards the passengers cannot be generally characterised as reluctant or unwilling.

The contemporaneity of the flight and cabin crews activities after the stop (T) has been described in accordance with the recordings of sound in the cabin and the recordings of the radio-telecommunication correspondence with the ATS.

T + 2 sec - the Captain issued a very incomprehensible instruction that was later identified as „*Cabin Crew at Stations*“ .

T + 19 to 26 sec the Captain notified the SCC to instruct the passengers to remain seated, noise and commotion can be heard from the passenger cabin,

T + 29 sec the Captain relayed the information about the situation to the ATS,

T + 46 sec the SCC assured the Captain that everything is in good order,

T + 1 min 6 sec the Captain issued an approval with opening the door 1L without the chute,

T + 1 min 19 sec the Captain was communicating with the technician outside who told the Captain that APU was running and that engine No. 2 (engine No. 2 was immediately shut down by the Captain consequently),

T + 2 min 3 sec the Captain requested ATS for the passenger stairs,

T + 3 min 41 sec the siren sound of the coming fire brigade truck, at the same time the Captain instructed the passengers via the airline telephone to remain seated and apologized to them for "short delay".

Throughout the whole time of the critical situation the Captain was communicating with the FO about the causes of the overrun.

1.2 Injuries to Persons

Injury	Crew	Passengers	Others (inhabitants, etc.)
Fatal	0	0	0
Serious	0	0	0
Light/No injury	0/6	0/188	0/0

1.3 Damage to Aircraft

After overrun of RWY 27 no damage was caused to the aircraft. Upon the recovery procedure a preventive change of all the landing gear wheels was carried out.

1.4 Other Damage

No facility or equipment of the aerodrome was damaged.

1.5 Crew Information

1.5.1 Captain

Male, age: 52y.
Type of licence: CZ ATPL (A) issued 13. 3. 2012
TRI (B737 300-900) valid to 13. 3. 2017
qualification B737 300-900 IR
Medical: 1. Class, valid to 11. 1. 2014 (VNL)

Total on all types: 14 778 FH
Total as PIC: 11 275 FH
Total on B737: 8 175 FH
In the last 90 day: 239 : 20 FH
In the last 30 day : 56 : 48 FH
In the last 24 hours: 6 : 58 FH, (as the PF 3 : 26 FH)

Captain had the rest before flight on 14 hours On the day of incident occurrence he came on duty at 11:05 hours.
The pilot had the last examination extend of REC, OPC, APP, MPA on May 10. and 15, 2013, result - PASSED.
The Captain was performing their duties for the given airline company on a temporary basis.

1.5.2 First officer

Male, age: 47y.
Type of licence: CZ ATPL (A) issued 12. 7. 2012
qualification B737 300-900 IR
Medical: 1. Class, valid to 16. 11. 2013

Total on all types: 7 320 FH
Total as PIC: 838 FH
Total on B737: 6 000 FH
In the last 90 day: 277 FH
In the last 30 day : 40 : 34 FH
In the last 24 hours: 6 : 58 FH, (as the PF 3 : 32 FH)

First Officer had the rest before flight on 14 hours. On the day of incident occurrence he came on duty at 11:30 hours.
The pilot had the last examination extend of REC, OPC, APP, MPA , January 1 and July 23, 2013, result PASSED.
The Captain was performing their duties for the given airline company on a temporary basis.

1.5.3. Cabin Crew - CC

The cabin crew was formed by mixed pairs of two men and two women.

Position on board :

- 1L, function SCC, male; all time of duty 9 month, last exam. 27/04/2013;
- 1R, function CC, female; all time of duty 3 month, last exam. 25/06/2013;
- 2L, function CC, female; all time of duty 9 month, last exam. 28/06/2013;
- 2R, function CC, male; all time of duty 12 month, last exam. 21/05/2013;

All of the CC were performing their duties for the given airline company on a temporary basis. The CC were assigned for the service only for the season, i.e. from the beginning of May till the end of October. The longest time in service - 5 months in 2013 - was served by the CC member at the station 2R.

1.5.4 ATS LKPD Shift

1.5.4.1 ATS Shift Supervisor

- 49y. male
- eligibility certificate valid till 30 June 2014;
- medical certificate: valid till 19 May 2014,
- experience since 1995 (before introduction of the eligibility certificates) the entry in the personal ID from 14 June 2000
- qualifications: air traffic control officer (TWR, APP, PAR), instructor, inspector

On the day of incident occurrence he came on duty at 5:00 in the position of the shift supervisor.

The History of the Shift: 5:00 – 6:00 controlling at APP

10:00 – 14:48 controlling at APP

After the overrun aircraft had he transferred the control and undertook the organizing of rescue operation. He immediately called for the Military Fire Brigade deployment. At 15:01 he drew NOTAM and ensured the enclosure and shutdown of the traffic operation at the aerodrome.

1.5.4.2 Member of the ATS Shift (ATCo)

- 32y. male
- eligibility certificate valid till 31 October 2013;
- medical fitness certificate: valid until 11 October 2013;
- vocational experience since 13 December 2005;
- qualifications: senior air traffic control officer (TWR, APP, PAR');

On the day of incident occurrence he came on duty at 5:00 in the position of EC TWR.

The History of the Shift: 6:00 – 7:00 controlling at APP

11:00 – 14:48 controlling at TWR;

1.6 Aircraft Information

1.6.1 General Specifications of the Aircraft

Boeing B737-800 is a two-engine airplane designated for flights on longer distances. It is equipped with two jet engines and a retractable landing gear. The wheels on all of the gears are doubled and form pairs on each of the landing gears.

Type:	B737-8Q8
Identification mark:	OK-TVG
Operator:	Travel Service a.s.
Manufacturer:	Boeing Company, USA
Year of manufacture:	2007
Serial number:	30719
TSN:	24 742 FH
Airworthiness:	valid
Maintenance:	valid
Insurance polici:	valid

1.6.2 Pohonné jednotky

Motor č.1:

Type:	CFM56-7B26
Manufacturer:	General Electric, USA
Serial number:	894617
TSN:	24 743 FH
Mounting on ACF:	2007

Motor č.2:

Type:	CFM56-7B26
Manufacturer:	General Electric, USA
Serial number:	895494
TSN:	11 322 FH
Mounting on ACF:	8/2013

The maintenance within the scope of AV5-6Y/2012 were carried out on 19 October 2012, since the aircraft flew 3,235 FH.

On 12 to 13 August 2013 the mechanics at LHT Sofia performed an exchange of the engine No. 2 due to the damage from the flight on 11 August 2013.

On 22 August 2013 an entry into the failure log under the serial No. 029480 was made about the deactivating of the reverse thrust system on the engine (hereinafter the "reverse") The operation of the aircraft was technically limited in accordance with MEL 78-7, category "C" and the deadline for the postponed defect elimination was set for 1 September 2013 inclusive. There were no technical and operational failure entries in the TLB on 25 August.

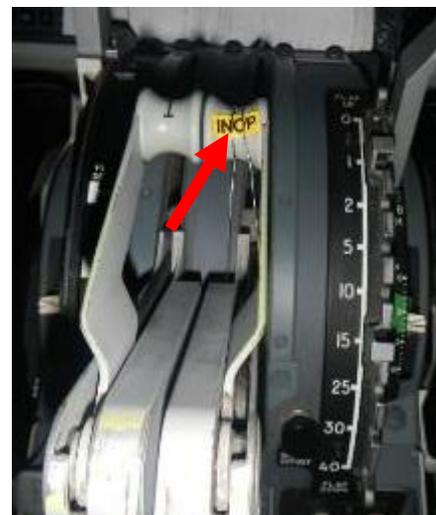
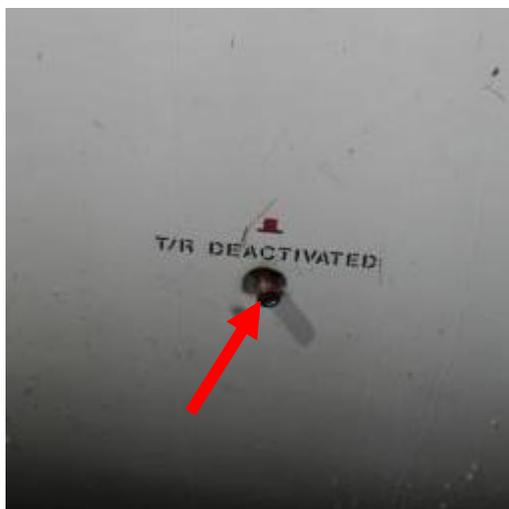
The first flight leg on 25 August was commenced with 7,600 kg of fuel, whilst at Burgas 9,650 litres were refuelled. For the final leg 10,511 litres were refuelled at Burgas. The flight was ended with 6,400 kg of fuel in the tanks.

1.6.3 Aircraft Weight and Balance

According to the data in "Loadsheets" provided by the operator, the aircraft TKOF for the flight from Burgas to Pardubice at TOW 68,821 kg (with the centre of gravity at 22.1 % MAC) and was intended to land at a weight of 63,921kg (with the centre of gravity at 22.7 % MAC). Based on the amount of fuel used the weight of the aircraft was at the time of landing 63,821 kg (with the centre of gravity at 22.7 % MAC). The maximum authorised landing weight for B737-800 is 66,360 kg. For the needed landing run and setting of the referential speed calculation, the pilots were estimating the landing weight to be 65,000 kg.

1.6.4 Technical Inspection of the Aircraft

The first inspection was carried out by the technician who arrived to the aircraft after it had stopped. After the arrival of the fire brigade the same technician carried out another inspection of the aircraft together with the fireman commander and both of them made certain that the aircraft was not on fire and that no fluids were leaking therefrom and that the landing gears were secured. After the arrival of the AALL inspector the technician informed the said inspector about the ascertained facts and provided a written report of his own activities. He further provided the information of the engine No. 2 cover wherein a pin indicating that the reverse of the engine had been deactivated was pulled out. On the control lever of the reverse of engine No. 2 the deactivated mode was marked by a yellow "INOP" sticker. From the readings of the cabin instruments the pressure in the brake hydraulic accumulator was determined to be $P_B = 3,000$ Psi. The wear indicators of the brake lining were checked with good results.



Pulled-out pin indicating that the reverse of the engine had been deactivated. The control lever of the reverse of engine No. 2 with the deactivated mode marked by a yellow "INOP" sticker.

1.6.4.1 The technical inspection of the aircraft performed by the operator's technician

After the arrival of the operator's technician the inspection of the aircraft was performed with the focus on selecting the means and technology of the recovery from the grass surface. It was found out that the aircraft landing gear was not damaged and that it was feasible to recover the aircraft by pulling at the nose hinge in the forward direction. After the recovery and towing to the parking stand, the aircraft was washed from the dirt

by pressurized water. With the AAI inspector participating the cassette was taken out of the DFDAU system (s/n 232) and the cockpit voice recorder (CVR). Both the recording media were to the data secured and sent for evaluation. Samples of the working fluids were taken from the hydraulic systems.

Upon the completion of all procedures and the check of systems condition the aircraft was released into operation and on 27 August 2013 departed from Pardubice aerodrome with no passengers on board. The procedures sequence and checks performed after the landing of the aircraft are listed in the annex 5.3.

All of the dismantled wheels were secured to be examined by specialists in regards to their condition and inspection of the traces on the tyre treads. The findings and results were incorporated in the report WO No. 799/2013. It has been found out that the pressure in the tyres was within the limits for operational levels 197 – 200 Psi. The rims were fitted with the correct type of tyres. No wheel showed signs of the tread separation from the tyre carcass, no abrasion surfaces were discovered. Between the longitudinal grooving's of the tyre tread there were slant grooves 4.5 – 9.5 mm in depth.

1.6.5 The data analysis results regarding the operational functionality of the aircraft systems

Based on the technical inspection result and on the test of the operational functionality of the brake system an analysis of data recorded by DFDAU was carried out. The described systems are activated automatically upon the touchdown or manually by the aircraft crew.

The flaps position setting at 30 degrees was confirmed. Throughout the whole time of flaps extension no asymmetry of extension was signalised. The slats extension on the leading edge was correct. The first touch of the landing gear wheels was guided at the RH landing gear and after 3 seconds the aircraft touched down on the both main landing gears. It was established and proven that the gravity load at the touchdown moment was $n_z=1.36$ and at the moment of leaving the paved area $n_z=1.51$.

Automatic braking system (AB2) was activated upon the touchdown of the aircraft. The system was active for 11 seconds overall from the touchdown; then the automatic braking mode was switched off by change to the manual mode (MAN FULL BRAKE). The brakes were originally operating in the set mode AB2, later changed after 6 seconds from TD to the mode AB3. The average speed decrease value in the AB2 mode reached 4.64 ft/sec/sec. Upon changeover to AB3 mode the level of 5.4 ft/sec/sec was reached. It was confirmed that the pressure in the brakes was reaching during the 6 seconds period the level of 250 Psi and it was gradually rising up to the level of 1.206 Psi. When changing over to the manual mode (MAN FULL BRAKE), the pressure in the brakes rose to 3.000 Psi and the average value of the speed decrease level was 5.91 ft/sec/sec. It was proven that during the whole time of braking, "Antiskid valve" was activated on each of the wheels. When the speed decreased under 8 kt, "Antiskid/Autobrake" was automatically disconnected and the skidding of the wheels occurred in the final stage of the movement.

Speed Brake System: - its availability for operation was lighted, it is not possible, however, by technical means to prove whether its automatic activation occurred during the aircraft's touchdown or the said moment was overlapping with the manual extension

performed by the Captain. The system was in operation for the period of 46 seconds from the touchdown.

Right engine reverse was deactivated and was not operational. Left engine reverse was operational for the period of 42 seconds from the TD. The crew used the maximum level of reverse mode of the left engine for the period of 21 seconds from the TD and 82.3% of engine revolutions (N1) was reached, until that point the reverse was operational at 48.1% of revolutions (N1). It was proven that the engine No. 1 was shut down 28 sec after the aircraft stopped (14:48:29) and the engine No. 2 was shut down upon the technician direction, 1 minute and 19 seconds after the aircraft stopped.

Through the analysis of the recorded data it was ascertained that during the flyover THR RWY 27 the altitude of the aircraft was 46 ft, IAS 152.5 kt, and GS 161.5 kt. Further it was confirmed that in the section from passing THR 27 to touchdown point (TD) the number of revolutions (N1) increased from 54.9 percent to 64 percent and the IAS increased by 1 kt. The aircraft ran out of the RWY at the speed 51 kt. During the whole time of flight and aircraft movement on the ground no indication of an incorrect state or failure in operation of the aircraft systems that would activate the central warning system and signalization. "Master Caution".

1.6.6 Flight Crew Operation Manual for 737 (QRH)

From the 737 Flight Crew Operation Manual and from the SOP of the operator it can be implied that for the selected configuration of the flaps at 30 degrees and the referential aircraft weight at 65.000 kg, "Good" reported braking action, wind direction and the selected braking mode (AB2) the essential stop distance would be 2.520 m. It is necessary to add 70 m to the said distance for one non-operational engine reverse. According to the Manual, it is necessary to add further 395 m to the tailwind component - if greater than 10 kt. The wind component, however, according to the ATC report, was under the said level, therefore not counted in by the pilots. In actual fact the tailwind component was somewhere between 5 and 9 kt.

1.7 Meteorological Information

1.7.1 METAR from LKPD aerodrome on 13.00-15.00 UTC

DDMM	UTC	Wind/KT	Vis./ RVR	Weather	Cloud/FTAGL	T/TD
2508	1300	100/05	10 -RA	F/3000	O >5000	15/14
2508	1400	090/07	10 -RA	F/4000	O >5000	15/14
2508	1500	080/03	10 -RA	F/4000	O >5000	15/14

Autentic forecast:

TAF - FT - vybraná stanice Pardubice - 25.08.2013			
STANICE	Čas [UTC]	S hod	Zpráva TAF - FT.
Pardubice	05:00		LKPD 250500Z 2506/2606 09008KT CAVOK BECMG 2507/2509 BKN037 BKN070 TEMPO 2509/2518 09016KT BECMG 2510/2512 7000 RA BKN023 OVC040 TEMPO 2518/2606 4000 RA BR SCT008 BKN013 OVC025=
	11:00		LKPD 251100Z 2513/2612 09010KT CAVOK TEMPO 2512/2520 09016KT 4000 RA BKN020 OVC033 PROB40 2520/2612 3000 RA BKN017 OVC030=

TAF-FT – LKPD

Metar - vybraná stanice Pardubice - 25.08.2013			
STANICE	Čas [UTC]	S hod	
Pardubice	blu	00:00	LKPD 250000Z 00000KT CAVOK 14/10 Q1014=
	blu	01:00	LKPD 250100Z VRB02KT CAVOK 15/10 Q1013=
	blu	02:00	LKPD 250200Z VRB01KT CAVOK 15/10 Q1013=
	blu	03:00	LKPD 250300Z VRB01KT CAVOK 15/10 Q1013=
	blu	04:00	LKPD 250400Z 07003KT 020V110 CAVOK 15/10 Q1012 NOSIG=
	blu	05:00	LKPD 250500Z VRB02KT CAVOK 15/10 Q1012 NOSIG=
	blu	06:00	LKPD 250600Z 07003KT 040V110 CAVOK 16/10 Q1012 NOSIG=
	blu	07:00	LKPD 250700Z 06004KT CAVOK 16/10 Q1012 NOSIG=
	blu	08:00	LKPD 250800Z 07005KT CAVOK 17/11 Q1012 NOSIG=
	blu	09:00	LKPD 250900Z 08005KT 040V110 CAVOK 17/11 Q1012 NOSIG=
	blu	10:00	LKPD 251000Z 10010KT 070V140 9999 -RA NSC 16/12 Q1013 NOSIG=
	blu	11:00	LKPD 251100Z 08008KT 060V140 9999 -RA FEW040 OVC060 15/12 Q1013 NOSIG=
	wht	12:00	LKPD 251200Z 10008KT 5000 -RA SCT030 OVC050 15/14 Q1013 NOSIG=
	blu	12:17	LKPD 251217Z 08011KT 9999 -RA SCT030 OVC050 15/13 Q1013 RMK BLU=
	blu	13:00	LKPD 251300Z 10005KT 070V140 9999 -RA FEW030 OVC050 15/14 Q1013 NOSIG=
	blu	14:00	LKPD 251400Z 09007KT 9999 -RA FEW040 OVC060 15/14 Q1013 NOSIG RMK BLU BLU=
	blu	15:00	LKPD 251500Z 08003KT 040V110 9999 -RA FEW040 OVC060 15/14 Q1013 NOSIG RMK BLU BLU=
	blu	16:00	LKPD 251600Z 07003KT 030V110 9999 -RA NSC 15/14 Q1013 NOSIG RMK BLACK=

METAR – LKPD

Předpovědi PÚ AČR & ČHMÚ		
25.08.2013	14:35	<p>FPCZ54 OKLA 251435</p> <p>PREDPOVED POCASI PRO LETOVOU OBLAST</p> <p>-----</p> <p>VYDANA DNE: 25.08.2013</p> <p>PLATNOST: 15-24 UTC</p> <p>SITUACE: POCASI U NAS OVLIVNUJE OKLUDUJICI FRONTALNI SYSTEM.</p> <p>-----</p> <p>PREDPOVED TEPLoty A VETRU VE STANDARDNICH HLADINACH:</p> <p>-----</p> <p>TROPOPAUZA: 380 AMSL -58 DEG C</p> <p>FL 400 -53 DEG C 220 DEG 20 KT</p> <p>FL 300 -42 180 25</p> <p>FL 240 -25 170 20</p> <p>FL 180 -14 170 25</p> <p>FL 100 -01 120 20</p> <p>FL 050 10 130 25</p> <p>PRIZEMNI VITR: 080-140 DEG 10-16 KT, MISTY S NARAZY DO 30 KT.</p> <p>-----</p> <p>OBLACNOST: BKN-OVC NAD 033 AGL, VE SRAZKACH MISTY 016-033 AGL.</p> <p>-----</p> <p>HORNI HRANICE: SC 060-090 AMSL, NS DO 300 AMSL.</p> <p>DALSI VRSTVY: BKN-OVC STREDNI A VYSOKE OBLACNOSTI.</p> <p>DOHLEDNOST: NAD 10 KM. VE SRAZKACH PRECHODNE 6-4 KM.</p> <p>-----</p> <p>POCASI: OBLACNO AZ ZATAZENO S OBCASNYM DESTEM.</p> <p>-----</p> <p>IZOTERMY: 0 DEG C: 100 AMSL</p> <p>----- -10 DEG C: 160 AMSL</p> <p>NEBEZPECNE METEOROLOGICKE JEVI:</p> <p>-----</p> <p>- NAMRAZA V OBLACNOSTI OD 100 AMSL DO 220 AMSL</p> <p>- VRCHOLKY HOR V OBLACNOSTI</p> <p>TLAKOVA TENDEENCE: SETRVALY STAV.</p> <p>-----</p> <p>RMK: VERTIKALNI UDAJE JSOU UVEDENY V HFT.</p> <p>---</p> <p>VYDALO STRHM VGHMUR / MPI</p> <p>=</p>

Military forecast - generally

1.7.2 The Current Weather According to the Hydrometeorological Service of the Czech Armed Forces and to ČHMÚ

According to the records of precipitation fall provided by the Hydrometeorological service of Czech Armed Forces at Pardubice aerodrome, the precipitation at the time of

runway check was in the lower parts of the scale at levels of 0.4 – 0.5 mm per hour and the rate was increasing towards the evening up to 0.6 – 0.7 mm per hour. In the supervising forecaster's opinion it was an occasional light rain with variable rates. In the METAR report marked by (-RA).

In Aviation Meteorology Department of the ČHMÚ report the situation is described as follows:

- cold front wave with a depression over the Alps was moving across the Czech Republic area only very slowly towards north up to north-east.

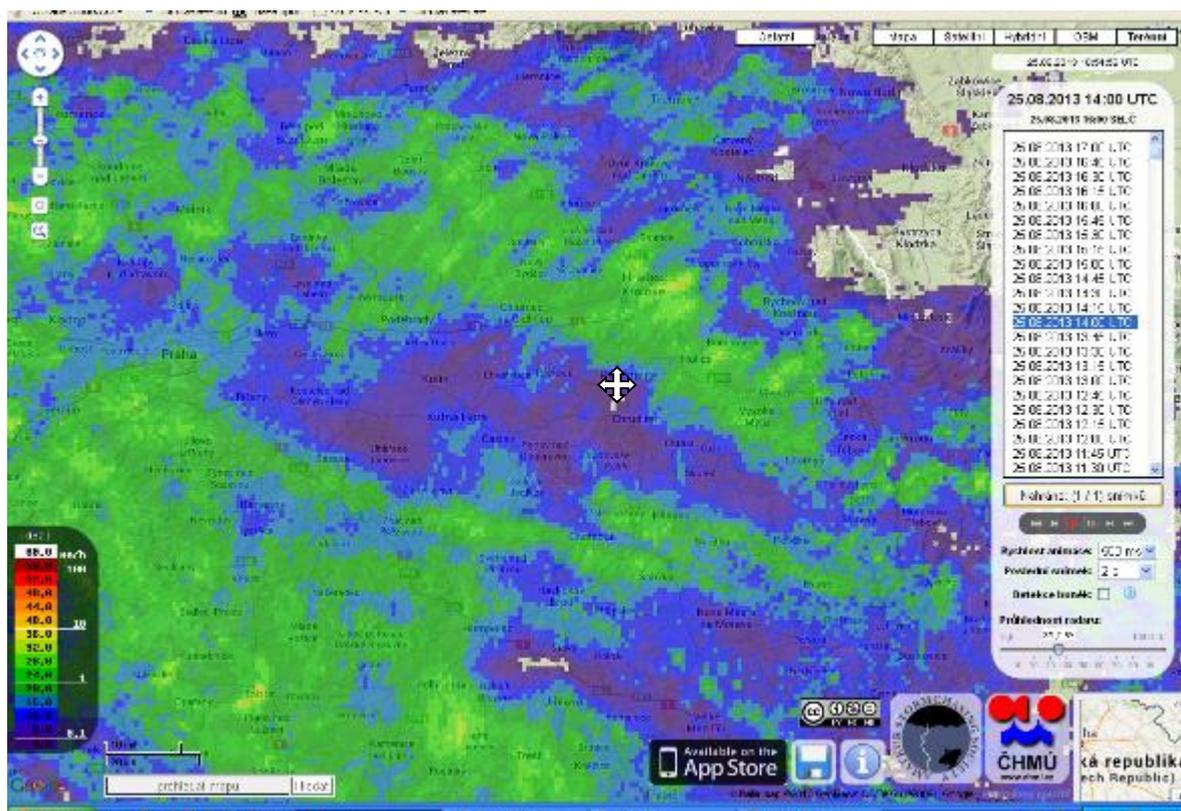
Ground Wind: 070-100 degrees./3-7 KT

Wind: 2000FT AMSL 110/17KT PS14 DEG C, 3000FT AMSL 110/22KT
PS13 DEG 5000FT AMSL 110/23KT PS08 DEG

Visibility: over 10 km

Current Weather: overcast with a mild rain

The precipitation started falling between 12:00 and 13:00UTC, hourly precipitation amounts between 14:00 and 15:00UTC reached for instance at two meteorological stations at Hradec Králové 1.3 to 1.7 mm/hour.



Meteorological situation – METRAD, white point shows LKPD aerodrome

1.7.3 Current Weather Report Relayed from the ATS LKPD

The statements of the ATS station members imply that after establishing communication with the flight TVS 2907 the landing clearance for RWY 27 was granted and the complete information about the wind and about the runway conditions was relayed, and also, upon the request of the pilot flying, the information about the wind was repeated, which the said pilot acknowledged. The same information was recorded by the cabin voice recorder as well as by the ground recording device at the TWR as follows: *...runway two seven, cleared to land, wind zero niner zero degrees, five knots, runway is wet* . No further weather or other anomalies occurred during the aircraft approach to landing.

1.7.4 Tailwind Component Data - Surface Wind Measurements

The surface wind at Pardubice aerodrome is recorded by two WDI anemometers located at both ends of the aerodrome. The wind speed data is displayed in "knot" units at the ATS station. The wind speed data information from the ATS station (14:44:59) was 5 kt. Through detailed analysis of the sensor recordings of direction of windspeed in the time period from 14:45:00 to 14:47:00 it was ascertained that the surface wind values were in the interval between 2.20 – 2.30 m/s (i.e. 4.2 – 4.4 kt) with gusts 3.60 to 3.80 m/s (i.e. 6.9 – 7.3 kt), the wind direction remained unchanged at 090 degrees. The onboard flight data analysis implies the values of tailwind component were decreasing during the aircraft descent. The difference between IAS and GS at the moment of THR RWY 27 flyover (14:47:19) was 9.0 kt.

1.8 Radio Navigational and Visual Aids

All of the radio-navigating and lighting devices at Pardubice aerodrome were operational. All of the devices were functional and operational without interruption during the whole time of TVS 2907 approach and landing, no breakdown or malfunction on the apparatus occurred throughout the said time. The approach and landing procedures were performed at daylight.

1.9 Communications

Upon entry into the MCTR Pardubice airspace the TVS 2907 flight was in communication with the ATC station at Pardubice aerodrome on publicised frequencies. The communication was not interrupted and no radio blackouts occurred, the recording thereof was comprehensibly readable and submitted to the AAI commission and subjected to a comparative analysis with other flight data. Throughout the whole flight the radio-telecommunication was led by the captain.

1.10 Aerodrome Information

The TKOF was commenced at Burgas aerodrome at 13:05. The departure scheduled was to take place at 13:20. The flight destination was the Pardubice aerodrome.

In compliance with AIP, the Pardubice aerodrome is a public international airport. From the operation viewpoint the said aerodrome is a military aerodrome with a civil aviation operation permit. EBA a.s. ensures and provides the complete dispatching of the

civil commercial flights. The ATS service at the Pardubice aerodrome for the civil aviation operation is provided contractually by the Czech Army Air Traffic Control. The runways and aerodrome facilities maintenance is provided and performed by the Czech Army Aerodrome Agency.

At 15:01, after the critical incident occurrence, the aerodrome was closed for all civil and military operations in accordance with the procedures of ATS. NOTAM was issued. The MACC and RCC stations were notified of the said state. The aerodrome was closed for operations until 05:00 the next day.

1.10.1 Aerodrome Operation and Maintenance

Runways and taxiways preparations at LKPD were, according to the statement of the representative of Military agencies of 25 August 2013, performed in compliance with the military regulation Let-1-6/L14 *on Military Aerodromes*, and by the civil regulation L14 - *Aerodromes*, and according to the Procedures of Pardubice aerodrome preparations for air operations. The visual inspection of RWY 09/27 was performed by the aerodrome specialist who is authorised to carry out the said procedure. Pursuant to the aforementioned regulations such inspection checks are performed 4 times per day. On the day of the event flight it was the third check, performed between 14:35 and 14:40. The task performing staff member reported the results of the inspection to TWR ... *Runway wet, clear...*, this information was entered into the Log of aerodrome movement areas and facilities inspections. The AAI commission received copies of the said documents and the voice recording confirming the relaying of the aforementioned information. The police took photographs of the runway surface conditions between 17:10 and 17:20. From the said photographs an uneven distribution of water throughout the whole runway profile is evident.

The physical properties of RWY 09/27 at LKPD are stated in AIP ČR, section AD 2-LKPD-7.

1.10.1.1 Surface Friction of RWY 09/27 Characteristics Measurements

After the event occurrence, additional measurements of surface friction of RWY characteristics were performed between 20:01 and 20:04 upon the request of the civil operator of the Pardubice aerodrome. The first measurement was performed in the course of RWY 09 and the second measurement in the course opposite towards RWY 27. According to the recording in the measuring device ADR/FM Friction Meter the friction factor was reaching levels of $F_c = 0.85 - 0.95$. The runway conditions did not show signs of worsening of friction factor levels during the second additional measurement.

Based on the Log of the aptitude of the measuring device ADR/FM for measuring the braking action on aerodrome movement areas No. 18660/93-250, approved by the Ministry of Transport of the Czech Republic on 20 April 1993, the ADR/FM Friction Meter fulfils the criteria of ICAO, as intended in Annex 14, Volume I, Appendix A, Section 7.9. The device was put in operation in 1998. The device has been used by the Aerodrome authority of the Czech Army and forms a part of equipment used for the aerodrome movement areas maintenance. The latest documented calibration of the said device was performed on 3 October 2012. The record from the performed measurement on the day of the incident and the certificate of the measuring device were both submitted to the AAI commission.

In connection with the aircraft recovery, at 15:25 a measurement of the bearing capacity of the grass surface in the RWY 27 clearway was carried out. The method of depth measuring spike penetration using penetrometer with dropping weight was applied. It was found out that in all measuring points the value 1.3 MPa was reached.

1.10.2 Additional Friction Factor of RWY 09/27 Surface Measurement

Upon the request of the civil operator of Pardubice aerodrome request, on 15 September 2013 a standard calibration measurements of antiskid characteristics of RWY 09/27 surface were performed. The staff of Prague Airport carried out the aforementioned measurements using SFL device with a low-pressure tyre ASTM E 1551, with a self-sprinkling device providing the level of 1 mm of water layer directly under the measuring wheel and in accordance with the stipulations as stated in 1.1.6, AIP ČR AD 1.1-10 and L14 regulation, Chart A-1.

The overall conclusion was drawn from the measurements that RWY 09/27 was as at the date of calibration measurement performance from the point of comparison of friction factors acquired from the measurements with standardised values in good order and it is therefore not necessary, in accordance with Article (4) of methodology, to perform immediate steps in order to secure the coarseness and braking factor on the runway, and that it also is not necessary to publish via NOTAM the RWY as "slippery when wet". Simultaneously, it was stated that the braking factors in some sections of the runway fall under the standardized value of the Maintenance Planning Friction Level, but still are higher than the standardised values of the Minimum Friction Level.

1.11 Flight Recorders and Other Means of Recording

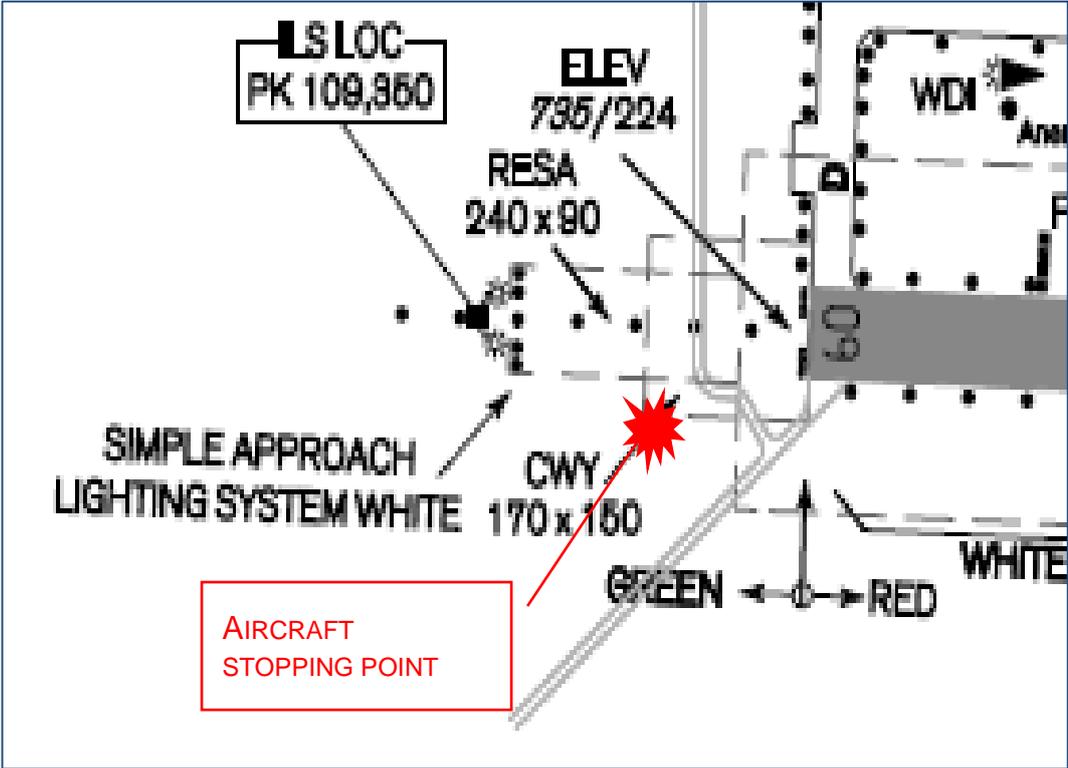
In order to establish the causes of incident occurrence, the recordings of in-flight data recorded in DFDAU Teledyne, p/n 233000-815, s/n 1369 and of the voice recorder Honeywell p/n 980-6022-001, s/n 120-09336 in the cabin were secured. The cassette s/n 232 with data recordings was physically removed from the DFDAU recorder. The recording was downloaded into portable recording device and sent for analysis. CVR recorder was physically removed from the aircraft and sent for analysis. Furthermore, the recordings from the ground devices of TWR Pardubice were used. The records provided for analysis were legible and complete.

1.12 Incident Location Description

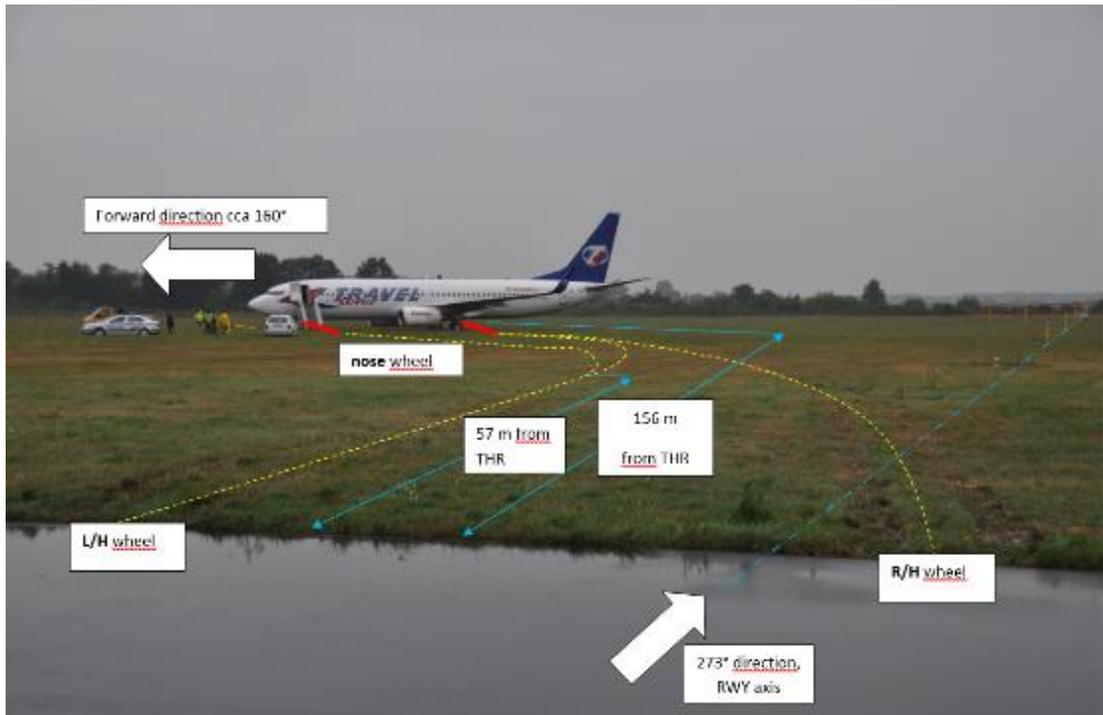
The incident location is at the western end of the aerodrome in RWY 27 clearway. The aircraft came to the full stop 156 m beyond the Stop End of RWY 27 on the grass turf. The starting point for carrying out of the measurements was chosen on the left edge of the end of RWY 27. From the transition concrete/grass (or THR 09) there were two distinct tracks in the grass from the landing gears wheels which after 57 metres from the edge divided into three tracks that continued all the way to the aircraft wheels. Each of the said tracks were doubled and the span of the tracks corresponded with the span of the wheels of the main landing gear. The wheels of the aircraft were not significantly sunk into the surface, the maximum track depth was at the maximum 5 cm. On the surface of the tracks there was no indication of skidding, the wheel were rolling up to the distance of 135 - 140 m, then there were noticeable distinct skidding traces leading to the wheels of

all landing gears. There were no foreign objects or parts of the aircraft and aerodrome equipment found in the tracks.

The surface of the coating of the lower fuselage parts, engine covers and landing gear wheels was stained with remains of grass and mud. In no place there were noticeable leakages of aircraft fluids or damage by impact and other deformations to the fuselage and wing structures.



Full stop position on end RWY 27



Overrun tracking

1.13 Medical and Pathological Information

No passengers or crew members were injured. After arrival of the patrol of Czech Foreign Police and investigators of the Czech Police a breath test for alcohol with both of the flight crew members with a negative outcome.

1.14 Fire

No fire was caused.

1.15 Survival Aspects

No rescue search was conducted, the incident took place in the aerodrome area. ATCo was following the landing and run out of the aircraft and upon receiving the pilot's report about the situation, immediately deployed the Military Fire Brigade to the stop end of RWY 27. From the voice recording of the exchanges he issued the instruction to the unit to start the operation at 14:48:50. The first one to reach the aircraft was the technician who was waiting in the Follow-me vehicle on TWY D. The Military Fire Brigade reached the incident location in three minutes after receiving the instruction to operation. The fireman commander together with the technician present carried out an inspection of the aircraft and the commander reported the aircraft's condition to the control tower. At that moment the handling unit arrived and put the passenger stairs to the aircraft. The passengers deplaned the aircraft between 15:10 and 15:15 and boarded the furnished buses waiting for them on the apron. The incident location was secured by the patrol of the Czech Foreign Police that was ready for the passengers' customs and passport check.

1.16 Tests and Research

NIL

1.17 Organisational and Management Information

1.17.1 Aircraft Operator

The aircraft operator is a domestic airline company. The majority of the aviation activities is concentrated on charter commercial air transportation. The company holds a valid Air operator certificate (AOC) to practice the said operation.

The company has the corresponding documentation executed for the operation of flight and cabin crews. It keeps records of re-examinations and keeps accounts of the length of periods of flight and Cabin Crews service. The company disposes of maintenance organisation designated for the maintenance of the operated aircraft fleet.

It has been found that the company requested the services at Pardubice aerodrome by the means of orders. The specifications of the flights in the period between 12 July and 26 October 2013 were submitted to the AAI commission. In the said context it has been also found that the company had previously performed no check or audit of the services provided at Pardubice aerodrome.

Incident occurred to the aircraft of the TVS company the operating aircraft of the Boeing B737-800 type when landing in Katowice, Poland on March 13, 2013 wherein the said aircraft run off from the paved area of the aerodrome. The said incident was documented in an internal report by the operator including the safety recommendations and preventive measures. The aforementioned incident was investigated by the appropriate authority for investigation in Poland, the results of the investigation were not discussed with the AAI Czech to the date of issue of this present Report.

1.17.2 Airport Operator

There is a contractual relationship established between the owner of the aerodrome, Ministry of Defence of the Czech Republic and the civil section of the aerodrome operator, which relationship specifies the activities assignments and allocation at the Pardubice aerodrome in regards to the civil aviation operation. The administration of the civil part of the aerodrome is performed pursuant to the licence to operate aerodrome granted by the Civil Aviation Authority to East Bohemian Airport (EBA) a.s. In the course of investigation it was found that the number of moves registered by EBA a.s. within the previous five years increased approximately by five times.

1.18 Additional Information

1.18.1 Aircraft Recovery Operation

The aircraft recovery was carried out by a group of specialists – the fire brigade members of Ostrava aerodrome – summoned by the aircraft operator. The said group arrived at night and together with the engineers of the operator, determined the way of the aircraft recovery. After the stop, the aircraft remained standing with its nose turned

toward the service road about 60 metres away. It was recommended to place special pads beneath the aircraft wheels and by pulling in the forward direction to move the aircraft onto the said road. A measuring device was placed on the tow bar in order to determine the level of pull needed during the aircraft towing. During the recovery operation – using a tow bar, the level of pulling force reached was $F_T = 4.400$ kg. The force reached approx. 45 per cent of the maximum allowed pulling force for pulling points.

1.19 Useful or Effective Investigation Techniques

The investigation of causes of the serious incident was carried out in compliance with the European Parliament Regulation and Council (EU) No. 996/2010 and National Regulation L13 Aircraft Accident and Incident Investigation.

2 Analysis

2.1 General

The AAI commission based the process of determining the causes of serious incident on the analysis of recorded flight and ground data from the event flight, from the flight and cabin crew statements and from the aircraft technical inspection results, and the aircraft documentation.

2.1.1 Crew Qualifications & Experience

Both the members of the flight crew held the valid qualifications for performing the flight, were trained and physically fit with valid medical certificates. Neither of them were on the service shift overtime and both of them had adequate time of rest before the flight. The distribution of positions and capacities to the crew was within the competence of the Captain, the FO was designated to the position of the pilot flying for final two flightpath legs. From their previous as well as current flying experience both the pilots knew well the manner of approach and landing at the Pardubice aerodrome.

The cabin crew was formed by mixed pairs of two men and two women. Generally, at the given airline company the cabin crews are summoned to service for a temporary period of time during the main tourist seasons. Before commencement of their service they had been instructed and tested. All of the cabin crew members were able to perform their duties arising from the flight TVS 2907.

2.1.2 The Pilots decision to Landing

Both the pilots (CPT and FO) based their decision on their own evaluation of the conditions for landing the aircraft at Pardubice. They formulated were continually adjusting their decision by adding the information about the flight conditions read from the onboard devices, reports and notifications from the ATC. They were namely emphasizing the wind speed and direction, and evaluating its effect on the manner and direction of landing. It was confirmed that in case the wind force did not decrease they would perform

a "Go-around" manoeuvre and complete the landing from the opposite direction (to RWY 09), in the likewise manner they were deliberating the flaps position. After receiving the information from ATS about the wind speed and direction, PF runway conditions the original direction for landing was held, the flaps were set to 30 degrees and AB2 braking mode was selected. Both the pilots were aware of the deactivated state of the right engine reverse.

By analysing and comparing the recommendations from the 737 Flight Crew Operation Manual (QRH) and SOP it was implied that for the selected flaps configuration at 30 degrees and the referential aircraft weight at 65.000 kg, Good Reported Braking Action, the wind direction and the selected braking mode (AB2) the basic Stop Distance necessary for landing 2.520 m and this distance itself already surpassed the technical characteristics of RWY 27. The flight crew had been able to influence the landing weight by refuelling a smaller amount of fuel into the tanks with regards to the load shipment (passengers and luggage) and minimal safe fuel aboard.

The distance 305 m from THR 27 to the touchdown point is also included into the basic Stop Distance in case the flight altitude level of 50 ft above the runway threshold is observed. During the event flight the altitude of 46 ft was recorded and can be considered as correct. The TD was during the event landing 821 m distant from THR RWY 27.

The subjective feeling of FO that he touched down before the junction of RWY 27 and TWY B, which is 750 m from THR 27, could have been correct as he very likely sensed the touchdown of the right hand side wheel, recorded approx. 581 m beyond THR 27 (therefore before the junction RWY 27 and TWY B). According to the recording, the full touchdown took place in 3 seconds, and at the same moment all of the required conditions for activating the automatic braking system and extracting of the "speed brake".

The manner in which the PF was piloting the aircraft towards the landing (according to the statement *...one dot below...*, (Note: meaning one dot below Glide Path - GP), and the Captain's evaluation *... "landing as into a featherbed"*, can be reliably interpreted as approaching at a smaller angle, and whilst the correct altitude was observed over THR 27, the prospective point of touchdown was flown over by approx. 500 m. The referential speed (v_{ref}) according to QRH for weight of 65.000 kg and the selected flaps position is 148 kt. According to the DFDAU recording, during the approach, the MCP selected speed was IAS=152,5 kt (i.e. $v_{ref} + 4.5$ kt) and this speed can be considered as correct. By adding the basic Stop Distance (2.250 m) and the additions (so called penalties) we can arrive at conclusion that the calculated value exceeds the RWY 27 length.

During the configuration for landing with flaps at 40 degrees and AB3 or MAN FULL BRAKE braking modes and observing the distance of touchdown point from THR 27, the basic Stop distance would be 1.840 m. For the configuration selected in the said manner a sufficient reserve would have been provided in distance before the Stop End of the runway. It is necessary to add additional values for one non-operational engine reverse (see QRH F40, MLW=65.000 kg).

2.1.3 Crew Operation after the Full Stop of the Aircraft

After the full stop, the flight crew (CPT and FO) were communicating about the causes of the critical situation. Meanwhile the Captain issued several decisions that lead to specifications of the cabin crew operation. From the CC statements it can be assumed that the situation was well managed and under control and the passenger cabin was calm. The decision of the Captain to open the 1L door in configuration without the slide can be assessed as premature as it could have caused panic among the passengers who might have begun disembarking into the free space below the door uncontrollably. At that moment the atmosphere was exponentiated by the sound of sirens of the approaching Fire Brigade vehicles. The engine No. 2 was still operating at the same time and there was a hazard of endangering persons on the ground. In the said context the enhanced risk of fire of the engine had an effect as the fuel was still fed into the engine. After the full stop the Captain transmitted notification about the situation and a request for assistance to the ATS. He had obtained the information from the SCC report and from the present engineer outside the aircraft. The crew did not apply the emergency procedure steps adequate to the situation arisen correctly, the Captain was relying on the information from the aforementioned technician standing outside the aircraft.

The ATC staff member confirmed the Captain's information and informed the Captain back about the assistance being on their way. The ATS staff member did not check by a request back the number of people on board, amount of fuel in the tanks and presence of dangerous cargo on board the aircraft. The Commander of the Military Fire Service unit correctly performed the inspection of the aircraft and correctly notified the ATS thereof.

2.1.4 Aircraft Systems Operation

Analysis of data files and of recordings of the DFDAU recording device indicates that the aircraft systems were operative with adequate response to the crew's intervention in accordance with the terms for automatic activation of systems. From the technical point of view, the impact of inoperable reverse of the right engine on operation of aircraft systems was nil. Inoperability was correctly classified as a postponed defect in accordance with MEL 78-01, and the flight was conducted within the valid deadline for its remedy. In terms of traffic, the pilot flying must take into consideration the asymmetric effect of solely one reverse load and overall smaller deceleration of the aircraft, in particular, on contaminated runways. No casual connection between the inoperable reverse of the right engine and replacement of the right engine on 11 August 2013 has been proven. The defect of reverse was recorded on 22 August 2013, i.e. 11 days after the replacement of the engine.

The fact that the operation of the braking system and wing mechanism system was correct and was not limited nor hindered by any defect may be supported by non-activation of any central warning system signal "Master Caution" or "Antiskid Inop". The initially selected braking mode AB2 is not set for protection against hydroplaning. Generally speaking, the automatic braking system module is programmed by the aircraft manufacturer so as to achieve the optimum deceleration for the selected mode. The system is controlled by AACU that is comparing signals from individual wheels and adjusting pressure in wheel brakes to prevent wheel locking. The pressure in brakes is bled off through an antiskid valve. If wheel locking is imminent, full pressure in brakes may not be achieved and subsequent deceleration of the aircraft may not achieve the

value declared by the manufacturer (737-600/700/800/900 Aircraft Maintenance Manual, Chapter 32-42-00). The brake pressure value was recorded by DFDAU.

In this specific case, in AB2 mode approx. 92 per cent of declared deceleration were achieved and after switching to AB3 mode, approx. 75 per cent were achieved. The lower deceleration values might have been influenced by varying braking actions measured on the monitored sections of RWY 27 during calibration measurement on 15 September 2013 as well as by uneven water layer distribution in RWY 27 profile. Overall, out of 176 values of calibration measurements 56 were above the MPFL level and 120 below the MPFL level and no value equalled MFL.

Analysis of the tyre tread surface of main wheels has proven that no defect in tyres occurred during movement of the aircraft. Based on the roll marks, the wheels kept rolling in the grass section of the trajectory. Intensive skidding and wheel locking took place only after GS dropped below 8 kt level when the antiskid system is switched off automatically.

Analysis of flight data has confirmed that touchdown happened with small vertical overload while the value of 2.1 was not exceeded even when running on the ground; therefore, there was no reason for inspecting the aircraft after hard landing. It has been confirmed that the aircraft ran off the concrete surface of RWY 27 with a left drift by 11.2 degrees at GS 51 kt.

2.1.5 System of Measuring the Braking Actions and CWY Capacity

At LKPD, ADR/FM Friction Meter, compliant with requirements for measurement, is used for measurement of friction effects on the movement areas of the aerodrome. After occurrence of the incident, the values $F_c = 0.85 - 0.95$ were measured. During calibration measurement on 15 September 2013, SFL device with a low-pressure tyre ASTM E 1551 was used in compliance with valid methodology and approximately half values than those achieved during measurement with ADR/FM Friction Meter were recorded. In both the mentioned monitored measurements the evaluation of runway condition and/or braking actions reached the classification good (Good Reported Braking Action). Comparison of the values of both the measurements shows that the runway condition was not such which would limit its availability. Differing measured values may be attributed to different focuses of applied measurement methods as in the case of calibration measurement, adverse conditions for measurement of friction effects are created artificially on the measured surface.

From the point of view of maintenance of the surrounding areas of the aerodrome, good bearing capacity of CWY grass turf may be assessed as positive. Thanks to such conditions the wheels did not sink in the grass turf and the aircraft was not damaged.

3 Conclusions

Findings:

- The pilots held valid certificates, qualifications for the said flight and valid medical certificates;
- The aircraft had a valid airworthiness review certificate, valid maintenance statement and release and valid insurance policy,
- Technical documentation included a record stating the right engine reverse system deactivation and that the pilots were aware of such limitation;
- Information about the runway condition and landing conditions was communicated by ATS in a correct and timely manner;
- Meteorological conditions affected the way of approaching and landing on RWY 27, but were not limiting and unsuitable for landing of an aircraft of the given type at LKPD;
- The pilots should have applied the landing mode for RWY 27 with flaps at 40 degrees and the braking mode set at AB3 or MAN FULL BRAKE, or they should have landed from the opposite direction on RWY 09;
- The crew failed to apply the operator's SOP correctly;
- No failures in the speedbrake or wheel brake systems;
- Braking action of the aircraft might have been influenced by uneven distribution of water layer in the runway profile;
- Measurement has not proven such condition of the runway which would limit usage thereof;
- When running out of RWY 27 and after full stop, the crew failed to apply emergency procedures correctly;
- During recovery from the grass turf the aircraft was not damaged.

Causes

The cause of aircraft's overrun was non-compliance with SOP by the crew and incorrectly selected landing mode for an aircraft of the Boeing B737-800 type under the given conditions at LKPD.

4. Safety Recommendations

During investigation, on 30 August 2013 the operator issued an internal guideline for securing of operating safety and took remedial measures with own B737-800 crews. The measures also focused on the issue of maintenance in order to reduce the time needed for elimination of postponed defects and provision of spare parts for the critical aircraft components.

On the basis of investigations results, AAI issues the following safety recommendation.

4.1 Aircraft Operator shall:

- adopt internal guidelines for monitoring of flight data and compliance with SOP by B737-800 crews;
- given the repeated occurrence of similar incidents, the company shall review training curricula for the crews and the methodology for calculation of the distance needed for landing on contaminated runways;
- as far as flight and cabin crews are concerned, adopt measures for training aimed at mastering the abilities to be applied to emergency procedures in aircraft running off and aircraft disembarkation;

4.2 Military and Civil Operator of the Pardubice Airport shall:

- on the regular basis, review the data collection system as regards the condition of aerodrome movement areas;

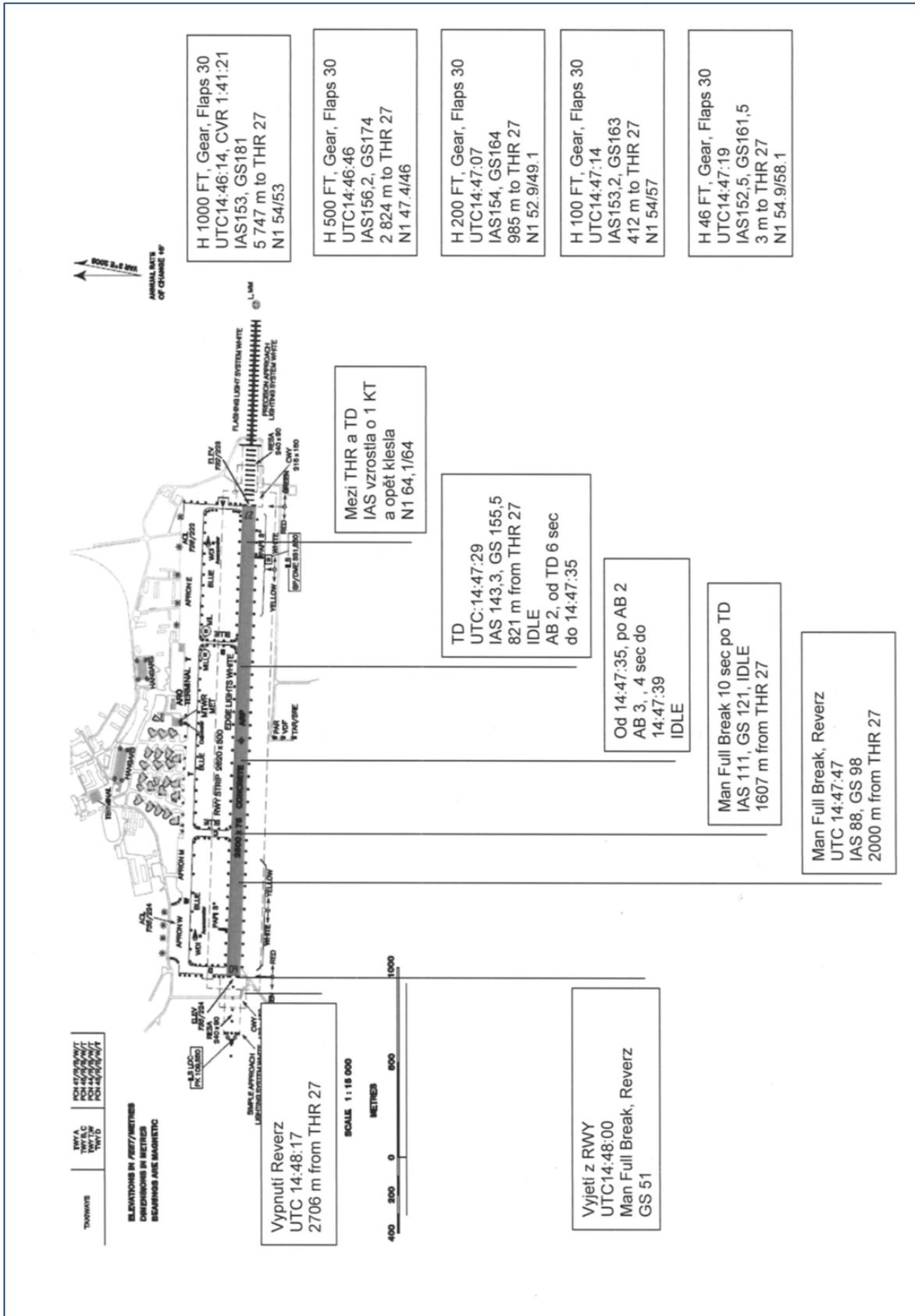
4.3 CAA and Military agency Ministry of Defense shall:

- jointly propose procedures for measuring of braking actions at the national level given the regulatory changes in this area by ICAO.

Written by Ing. Lubomir Střihavka, IIC

5. Appendixes

5.1 DFDAU analysis



5.2 Pictures



Pic.1 General situation



Pic. 2 Landing gear (LH) after full stop



Pic. 3 Touchdown point (crossing RWY 27 and TWY B)



Pic. 4 RWY direction to THR 27 (crossing RWY 27 and TWY C)

5.4. Aircraft Inspection after overrun

Travel Service a.s.

Provedené akce po incidentu (vše bez nálezů)

Akce pro uvedení letounu zpět do provozu a zajištění letových dat

- DL29484 -Airplane recovery
- DL29484 - Voice recorder removal
- DL29498 - Voice recorder installation
- DL29487 – SSFDR data download
- DL29486 - Fuel and Hydraulic fluid sample (canceled by UZPLN)
- DL29488 - FOD inspection on both engines
 - both engines borescope insp.
 - Mag. Chip detectors insp
- DL24999 - High Drag/side load landing
 - Flaps TE, spoilers visual insp
- DL19401 - Both engine gas path cleaning with pressure water (Snecma requirement)

Preventivní akce

- DL29489 -Antiskid/auto brake operational test
- DL29490 –DL29496 – all tires replacement (prevent)
- DL29497 – Dragged engine nacelle / fan blade ovt/ Engine seizure conditional inspection
- DL29500 – General lubrication