Investigation report

B1/2008L

Airliner veering off the runway at Lappeenranta airport on 31 January 2008

Translation of the Finnish original report

OK-CCD

SAAB 340B

According to Annex 13 to the Convention on International Civil Aviation, paragraph 3.1, the purpose of aircraft accident and incident investigation is the prevention of accidents. It is not the purpose of aircraft accident investigation or the investigation report to apportion blame or to assign responsibility. This basic rule is also contained in the Investigation of Accidents Act, 3 May 1985 (373/85) and European Union Directive 94/56/EC. Use of the report for reasons other than improvement of safety should be avoided.

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SUMMARY

A serious incident occurred at Lappeenranta airport on Thursday, 31 January 2008 at 00.08 Finnish time when a SAAB 340B airliner veered off the runway during its landing roll. There were 13 passengers and 3 crew members onboard. Accident Investigation Board Finland appointed an investigation commission for this occurrence. Investigator Ari Huhtala was named investigator-in-charge, accompanied by investigators Hannu Halonen and Asko Nokelainen as members of the commission. Dr Päivikki Eskelinen-Rönkä and MSc Markku Roschier were invited as experts to the commission.

Job Air scheduled flight JBR039 from Helsinki to Lappeenranta landed on runway 06 in snowfall. After touchdown the aircraft bore slightly to the left of the runway centre line. During the landing roll the aircraft slowly turned to the left and veered off the runway. The aircraft came to a halt on a grassy strip, perpendicular to the runway. The incident did not cause any injuries to persons. During the course of the occurrence the tips of the left engine propeller blades were broken. Airport vehicles transported the passengers to the terminal. At 00:26 the air traffic controller at Lappeenranta reported the occurrence to the Area Control Centre (ACC) South Finland, which, in turn, alerted Accident Investigation Bureau (AIB) Finland. Following this, AIB Finland phoned Lappeenranta ATC, requesting them to call the police to investigate the scene.

The occurrence took place at night. A light crosswind was coming from the right. Visibility in the snowfall was approximately 1500 m and the cloud base was 30 m. In preparation for the landing a 33 m wide runway section had been cleared. Due to the unremitting snowfall there was nonetheless fresh snow on the cleared area. Runway braking action was poor.

The incident was caused by the aircraft veering off the cleared section of the runway during the landing roll. The right engine failed after reverse thrust was applied which caused asymmetric braking, resulting in the aircraft turning to the left and skidding off the runway. There was also a contributing factor: snowflakes illuminated by the landing lights were blowing across the runway in the breeze and this may have confused the pilots with regard to the course of the aircraft in relation to the runway centre line. The centre line markings were completely covered by snow and the pilots were uninformed of the snow banks on the runway. The conditions in snowfall during nighttime were difficult and braking action was poor. The width of the cleared area of the runway was 33 m and there was a direct crosswind. The pilots had only limited experience with local winter operations and with the wintertime runway maintenance practices in use.

The investigation commission issued three safety recommendations. The first one recommends the airline ensure that their pilots have sufficient training and instructions with regard to operations in difficult winter conditions in northern Europe. The second one advised the airline to make certain that their pilots have the required emergency procedures training as well as instructions on handling the cockpit voice recorder (CVR) during incidents. The third safety recommendation urged Finavia to ensure that runway maintenance at Lappeenranta airport always be completed before allowing air traffic in the movement area, and that full information relating to runway conditions be reported to air traffic.

Finnish aviation authority did not have anything to comment to the investigation report. Neither did Air Accident Investigation Institude of the Czech Republic and Swedish Accident Investigation Board have any comments. The aircraft manufacturer did not have any comments. Finavia and Job Air – Central Connect Airlines s.r.o. do have comments. Those comments have been taken into account in the Investigation report.

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ABBREVIATIONS

AIP	Aeronautical Information Publication
Annex	Annex of the Civil Aviation Convention
AFS	Aeronautical fixed service
AIS	Aeronautical information service
ATIS	Automatic terminal information service
ATS	Air traffic service
CVR	Cockpit voice recorder
DFDR	Digital flight data recorder
DME	Distance measuring equipment
EASA	European aviation safety agency
EFES	Area control centre, South Finland
EFLP	Lappeenranta Airport
ft	Feet
hPa	Hectopascal
ICAO	International civil aviation organisation
IFR	Instrument flight rules
ILS	Instrument landing system
JAR	Joint aviation requirements
m	Metre(s)
mm	Millimetre(s)
MEL	Minimum equipment list
NDB	Non-directional radio beacon
AIB	Accident Investigation Board Finland
PF	Pilot flying
PNF	Pilot not flying
PHI	Occurrence reporting form (ATS)
QNH	Altimeter setting
RWY	Runway
SNOWTAM	A special series NOTAM notifying the presence or removal of hazardous conditions due to snow, slush, ice, slush, or standing water associated with snow, slush and ice on the movement area, by means of a specific format.
TWY	Taxiway
VHF	Very high frequency
VOR	VHF omnidirectional radio range

SYNOPSIS

A Czech Job Air - Central Connect Airlines s.r.o. SAAB 340B airliner, registration OK-CCD, was on a scheduled flight from Helsinki to Lappeenranta on Thursday, 31 January 2008. The call sign for the aircraft was JBR039. There were 13 passengers and 3 crew members onboard.

A serious incident occurred when the aircraft veered off the runway during the landing run. The aircraft came to rest outside of the runway on a grassy strip, perpendicular to the runway. Airport vehicles transported the passengers from the accident site to the terminal. The tips of the left engine propeller blades were broken in the occurrence, runway edge lights were not broken. The aircraft remained at the occurrence site and the airport was subsequently closed.

All times in the investigation report are in Finnish time. The occurrence took place at 00:08. At 00:26 the air traffic controller at Lappeenranta reported the occurrence to the Area Control Centre (ACC) South Finland, which in turn alerted the person on duty at Accident Investigation Bureau (AIB) Finland. Following this, the chief air accident investigator of AIB Finland phoned Lappeenranta ATC and requested them to call the Lappeenranta state local district police to investigate the scene. AIB investigators arrived at the airport early on Friday. The airport remained closed from the time of the occurrence until noon Friday when the aircraft was towed off the runway strip.

On 4 February 2008, based on additional information, Accident Investigation Board Finland appointed investigation commission B1/2008L to this occurrence. Investigator Ari Huhtala was named investigator-in-charge, accompanied by investigators Hannu Halonen and Asko Nokelainen as members of the commission. Dr Päivikki Eskelinen-Rönkä and MSc Markku Roschier were invited to participate as experts in the work of the commission.

The course of events was established from the accounts of the pilots and the air traffic controller, landing gear marks which were left on the runway and the runway strip and from the police patrol's report. Saab Aerosystems AB downloaded the Digital Flight Data Recorder (DFDR) in Linköping, Sweden. Finnair Oyj downloaded the Cockpit Voice Recorder (CVR) at Helsinki-Vantaa airport. In June 2008 a database of technical and aerodynamic sounds on the same aircraft had been recorded on a scheduled flight. This database was used as a frame of reference in the investigation. Documents were used to determine the condition of the airport and its equipment, the condition of the aircraft, crew proficiency and training as well as the operator's instructions at the time of the occurrence. The reference material used in the investigation is archived at Accident Investigation Board Finland.

Pursuant to the Accident Investigation Decree, a draft investigation report was promulgated for statement to the European Aviation Safety Agency (EASA), Finnish Civil Aviation Authority, Czech Air Accidents Investigation Institute, Swedish Accident Investigation Board (Statens haverikommission SHK), Finavia, Lappeenranta airport, Job Air - Central Connect Airlines s.r.o. and to Fly Lappeenranta Ltd. Statements and comments were received by 3.4.2009. The statements and comments have been taken into account in the investigation report.

The investigation was completed on 7.4.2009. The investigation report was translated into English.

1 FACTUAL INFORMATION

1.1 History of the flight

At 23:15 the Job Air co-pilot phoned Lappeenranta ATC from Helsinki-Vantaa airport, reporting that they would be airborne within approximately 20 minutes. At 23:16 the air traffic controller notified Lappeenranta airport maintenance that the flight would be landing approximately 5–10 minutes after midnight. Following this, runway maintenance trucks *Sweeper 1* and *Sweeper 2* began to clear the runway at 23:30 and 23:39, respectively.

The scheduled flight *JBR039* took off at 23:40. It was the crew's sixth flight during their shift. JBR039 called Lappeenranta TWR at 23:59 and said that they were maintaining FL 100 and had copied Lappeenranta ATIS information Oscar. The ATC cleared them to descend to 1800 ft on QNH 996 and informed them that they could expect an ILS approach to RWY 06. JBR039 acknowledged the inbound clearance.

Fresh snow was continuously falling on the runway. The ATC permitted the friction measuring vehicle *Break* to enter the runway to measure the friction. At midnight the ATC asked for the width of the cleared section of the runway. *Sweeper* reported that the cleared section was 30 m wide. The ATC acknowledged the information and replied that the aircraft would land in five minutes. At 00:03 *Break* reported being off the runway and went on to say that braking action was really poor. Due to time constraints, friction was only measured from a short section of the runway.

At 00:04 the ATC reported the width of the cleared section of the runway and the poor braking action to the aircraft. JBR039 thanked the ATC for this information. The air traffic controller then requested JBR039 to confirm accepting the poor braking action and the 30 m wide cleared section of the runway. JBR039 confirmed both pieces of information and reported being established on the ILS localizer for RWY 06. The ATC cleared JBR039 to approach RWY 06 and requested them to report the final approach fix inbound. JBR039 acknowledged the approach clearance. At 00:07 the ATC cleared JBR039 to land.

The aircraft touched down approximately 750 m from the threshold and approximately 10 m left of the centre line. After touchdown the aircraft bore slightly to the left of the centre line. During the landing roll the aircraft slowly turned to the left and skidded off the runway, coming to rest at approximately 1300 m from the threshold. In all, the aircraft turned approximately 100 degrees to the left from its original heading and its tail was over the line of the runway edge lights.

Figure 1. The aircraft off the runway

At 00:09 the ATC asked JBR039 whether everything was OK. JBR039 replied that they had veered off the runway and tried to make it back onto the runway on their own. The air traffic controller informed them that an airport vehicle was on its way to them. Simultaneously, the ATC raised the airport's rescue readiness. At 00:10 the ATC advised JBR039 to turn the engines off, to which the flight crew responded that they were in the process of doing so. At 00:12 airport maintenance staff reported to the ATC that the aircraft was on the grassy runway strip off the runway and that the engines were off. At the same time, airport maintenance personnel began to transfer passengers from the aircraft to the terminal. No rescue operation was launched. During an external inspection it was noticed that the left engine propeller blade tips were damaged.

At 00:26 Lappeenranta air traffic controller reported the occurrence to the Area Control Centre (ACC) South Finland, which, in turn, alerted the person on duty at AIB Finland. Following this, the chief air accident investigator of AIB Finland phoned Lappeenranta ATC at 00:42 and requested the air traffic controller to call the Lappeenranta state local district police to investigate the scene. AIB investigators arrived at the airport early on Friday morning.

Pursuant to aviation regulation GEN M1-4, the air traffic controller filed an ATS Occurrence Report (PHI reporting form). Also under aviation regulation GEN M1-4, the captain of the aircraft filed an air traffic incident report to the Finnish CAA, which forwarded both reports to AIB Finland.

1.2 Injuries to persons

No passengers or crew members were injured.

Injuries	Crew	Passengers	Other
Fatal			
Serious			
Mild/no injuries	3	13	

1.3 Damage to aircraft

The tips of the propellers (4) on the left engine were broken. No other damage was detected.

1.4 Other damage

There was no other damage.

1.5 Personnel information

OK-CCD pilot-in-command Age 64

Licences: JAR Air Transport Pilot's Licence, valid until 23.5.2012
Medical certificate: JAR class 1, valid until 27.2.2008
Ratings: All required ratings were valid.

Flying experience	Last 24 hours	Last 30 days	Last 90 days	Total hours
All types	4 h 40 min	58 h	172 h	12 300 h
Type in question	4 h 40 min	58 h	172 h	800 h

OK-CCD co-pilot: Age 32

Licences: JAR Air Transport Pilot's Licence, valid until 21.1.2009
Medical certificate: JAR class 1, valid until 23.3.2008
Ratings: All required ratings were valid.

Flying experience	Last 24 hours	Last 30 days	Last 90 days	Total hours
All types	4 h 40 min			1650 h
Type in question	4 h 40 min	13 h	89 h	1000 h

Air traffic controller: Age 35

Licences: Air traffic controller, valid until 8.5.2012
Medical certificate: Valid until 31.3.2009
Ratings: All required ratings were valid.

1.6 Aircraft information

Type SAAB 340B
Registration OK-CCD
Owner/Operator Job Air - Central Connect Airlines s.r.o, Czech Republic
Manufacturer Saab Aircraft AB, Sweden
Serial number 161

The Saab 340B is a two-engine, low-wing, 33 seat turboprop aircraft. Its length is 19.73 m, wingspan 21.44 m and height 6.97 m. Maximum takeoff weight is 13,155 kg and maximum landing weight 12,930 kg.

No defects or malfunctions were detected in the aircraft or in its systems prior to the occurrence.

1.6.1 Airworthiness

The certificate of registration Č. / no. 5280/1 was issued on 16.4.2007. The certificate of airworthiness was issued on 16.4.2007 and was valid until 15.4.2008.

1.6.2 Mass and balance

The mass and centre of gravity were within the permissible range throughout the flight. The fuel load was 1,150 kg (1,440 l) at the time of the occurrence.

1.7 Meteorological information

A heavy snow front spread into eastern Finland during the evening. In the southern part of the area precipitation was partly sleet or rain. Light southerly winds prevailed in the area.

Lappeenranta METARs were as follows:

At 23.50:

Wind 160 degrees 5 knots, variable 130–220 deg, visibility 1700 metres, snow, broken cloud (7/8) at 100 ft (30 m), overcast (8/8) at 600 ft (180 m), temperature -0 degrees and dew point -0 degrees, barometric pressure above mean sea level (QNH) 996 hPa.

At 00.20:

Wind 160 deg 5 kt, var 130–220 deg, vis 1100 m, RVR over 1500 m, snow, BKN (7/8) at 100 ft (30 m), OVC (8/8) at 600 ft (180 m), TEMP -0 deg, DP -0 deg, QNH 996 hPa.

1.8 Aids to navigation

Aids to navigation had no effect on the course of events.

1.9 Communications

The Lappeenranta airport (EFLP) radiotelephony communications (VHF 120.200 MHz), ground communications (UHF 445.350 MHz) as well as telephones were working properly.

Radio traffic and telephone conversations are recorded on airport recorders. The relevant radio and telephone recordings were given to the investigation commission.

Communications had no effect on the occurrence.

1.10 Airport information

Finavia operates Lappeenranta airport. The single asphalt-paved runway 06/24 is 2500 m long and 60 m wide. The dimensions of the grass-covered runway strip are 2620x300 m. Elevation is 106 m (349 ft). The bearing of RWY 06 is 066° (058 degrees magnetic) and the bearing of RWY 24 is 246° (238 degrees magnetic).

An ILS instrument approach procedure, a single-beacon NDB approach and VOR approach procedures, high intensity approach and approach path indicators as well as high intensity runway lights exist for runway 06. The airport's navigation equipment was flight calibrated in the late summer of 2007. No irregularities were detected and all of the equipment was in proper working order. There are no runway centre line lights.

Lappeenranta airport provides air traffic service (ATS). The competence of personnel has been certified as per aviation regulation PEL M3-10. The Civil Aviation Authority's Air Navigation Services unit had audited Lappeenranta airport on 4.4.2006.

The CAA had also audited Lappeenranta airport as per aviation regulation AGA M3 on 17.5.2004.

1.11 Flight recorders

OK-CCD was equipped with Fairchild flight recorders, manufactured by L3 Communications Aviation Recorders (USA). The recorders were of the following type:

- Digital Flight Data Recorder (DFDR) Sundstrand (Honeywell), part no. 980-4100-DXUN, serial no. 7682, and
- Analogue Cockpit Voice Recorder (CVR), part no. 93-A100-83, serial no. 26173.

On 5.2.3008 Saab Aerosystems AB downloaded the Digital Flight Data Recorder (DFDR) in Linköping, Sweden in the presence of the investigation commission. The device operated as expected and the recording was clear.

The CVR was not turned off immediately after the occurrence but, the occurrence itself was still audible on the tape. Finnair Oyj downloaded the Cockpit Voice Recorder (CVR) at Helsinki-Vantaa airport on 4.2.2008 under the supervision of the investigation commission. The quality of the recording was extremely poor.

1.12 Wreckage and impact information

1.12.1 Runway

Airport maintenance inspected and photographed the runway and the site of the occurrence immediately after the passengers had been transferred to the terminal. At the same time Lappeenranta airport was closed. A police patrol conducted the on-scene investigation.

The following day AIB Finland authorized the aircraft to be towed to a hangar. Following this, the airport was reopened to traffic.

1.12.2 Wreckage

The airline's mechanics and the members of the crew on the flight inspected the damage to the aircraft right after the occurrence. They noticed that the left engine propeller tips were damaged.

1.13 Medical and pathological information

No medical or toxicological tests were conducted.

1.14 Fire

There was no fire.

1.15 Survival aspects

There was no need to launch a rescue operation.

1.16 Test and research

1.16.1 Runway conditions

At the time of the occurrence Lappeenranta airport had two purpose-built clearing trucks, *Sweeper 1* and *Sweeper 2*, as well as a front loader for the purpose of clearing the movement area. A runway sweeper is a truck fitted with an approximately 6 m wide snow plough on the front and tows a 4 m wide modular sweeper unit, at the rear of which there is an air blower. The front loader's booms support a self-powered snow blower.

Maintenance crews monitored the progress of meteorological conditions from available weather reports and forecasts. The shift on duty picked the time at which they began to remove snow off the runway. The purpose of pre-planning was to guarantee the best possible runway conditions at the time of the landing.

Prior to the occurrence Sweepers 1 and 2 had cleared the runway at a width of 33 m. In the landing direction the runway was cleared 15 m to the right of the centre line and 18 m to the left of the centre line. Snow was approximately 10 mm deep at the cleared area and the snow banks were approximately 200–250 mm high. Outside the line of runway edge lights on the runway strip snow was approximately 150 mm deep, rising to ca. 300 mm farther beyond. The deposits were established on the basis of runway observations and photos taken at the time of the occurrence. However, the aircraft was not informed of the height of the critical snow banks prior to the occurrence.

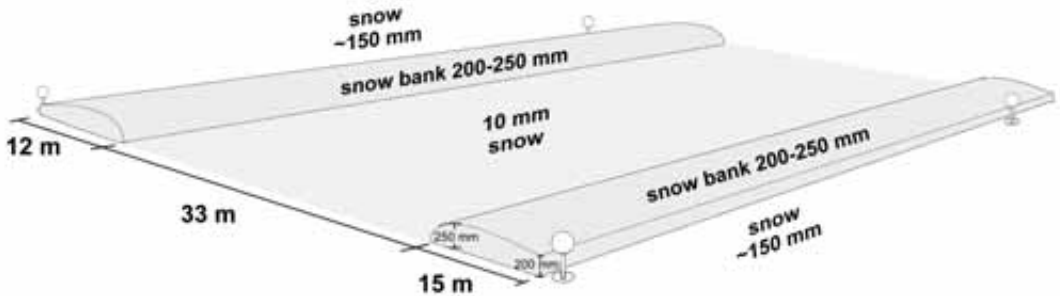

Figure 2. Snow on the runway

1.16.2 Reporting of runway conditions

Airport maintenance personnel are responsible for any required runway maintenance as well as friction measurement. Runway conditions and the results of friction measuring are reported to the airport's Air Traffic Service (ATS) or Aeronautical Information Service (AIS) which, in turn, disseminate the information in the form of a SNOWTAM report via Aeronautical Fixed Service (AFS). This information is also reported on ATS frequencies as well as by means of the Automatic Terminal Information Service (ATIS).

The following runway conditions are to be reported: deposits, extent of contamination, mean depth deposit as well as friction coefficient. Furthermore, the following is to be reported: any possible snow banks, snowdrifts or similar snow deposits on the runway or on the border of cleared and uncleared areas which runway maintenance has yet to remove. Snow banks are considered critical if they exceed 10 mm of slush, 25 mm of wet snow or 100 mm of dry snow. Unless the pilot advises or requires to the contrary, a critical snow bank or other snow deposits on an uncleared section may not exceed approximately 300 mm in height.

Friction is reported to the aircraft in the form of a table, in a measured or calculated friction coefficient, an estimated surface friction or in code:

Friction coefficient	***Estimated surface friction***	***Code***
≥ 0.40	*Good*	*5*
0.39–0.36	*Medium to good*	*4*
0.35–0.30	*Medium*	*3*
0.29–0.26	*Medium to poor*	*2*
≤ 0.25	*Poor*	*1*
Unreliable	*Unreliable*	*9*

Airport maintenance had inspected the movement area earlier that day at 12:50 and written an inspection report. According to the report the runway was damp in its entirety and the estimated friction was good. Later in the evening, when snow began to fall after 18:00 no movement area inspection reports were written. Neither were any SNOWTAM messages disseminated.

Due to time constraints before the occurrence, runway friction was only measured from a short section. At this time the scheduled flight was already approaching Lappeenranta. On the basis of this short measurement braking action was estimated as poor. Surface friction was measured after the occurrence; the friction coefficients were 0.17 / 0.17 / 0.18.

The following day the skiddometer which was being used for friction measurement was inspected and found fully functional. The inspection revealed that the tyre of the skiddometer was unevenly worn.

1.16.3 The landing

On the leg from Helsinki-Vantaa to Lappeenranta the co-pilot was the pilot flying (PF). The captain acted as a monitoring pilot i.e. pilot not flying (PNF) taking also care of radiotelephony. The flight crew informed that they were fit for flight. No factors implying fatigue, illness or the use of pharmaceuticals came up in the investigation. Lappeenranta state local district police performed a breathalyzer test on both pilots. The results for each of them showed zero blood alcohol.

When the aircraft passed over the threshold it was slightly to the right of the centre line. It touched down at approximately 750 m from the threshold and nearly 10 m to the left of the centre line. This was established from the landing gear marks on the runway. After the touchdown the aircraft bore slightly to the left of the centre line. The left main gear ploughed into the snow bank at 150 m of landing run and the right one at 240 m, respectively. Full right rudder was applied, followed by reverse thrust selection after which the right engine failed. This resulted loss of right engine's breaking effect. At first the control column was only pulled partly backwards and then it was pulled fully backwards. Simultaneously, the ailerons were fully deflected to the right. During the roll-out the aircraft gradually turned approximately 25 degrees to the left and skidded off the runway. During the final 20 m of the roll-out it turned a further 75 degrees and came to rest on the runway strip after approximately 500 m of landing run.

After the aircraft came to rest the pilots tried to taxi back to the runway with the still operating engine. However, engine power was insufficient. The left engine still ran for approximately two minutes after this. After they turned off the engine the co-pilot made a passenger address. He explained the situation and added that there was no danger whatsoever. Later the pilots made certain that the right engine, too, was turned off and closed its fuel cock. They radioed the ATC requesting ground transport for the passengers. Later, when they made an external inspection they noticed that the left engine propeller blade tips had been broken when they veered off the runway.

1.16.4 Investigation of the aircraft

Investigation revealed that the left engine propeller blades had broken during the course of the occurrence. A technical examination after the accident found no other damage or malfunction. The engines operated normally during a test run. Neither was there anything out of the ordinary in the operation of the undercarriage.

1.16.5 Communications and flight recorders read out and analysis

On 31.1.2008 AIB Finland had the flight recorders removed from the aircraft. The investigation commission analysed Lappeenranta airport's communications (radio traffic and telephone) recordings as well as the DFDR and CVR recordings. Said information was instrumental in establishing the course of events.

The quality of the CVR recording was extremely poor. However, it was possible to technically enhance the quality so, that it contributed to the investigation.

1.17 Organizational and management information

1.17.1 Fly Lappeenranta

Oy Fly Lappeenranta Ltd is a company providing scheduled traffic between Helsinki-Vantaa and Lappeenranta, including customer service. The company's marketing name is Tango. Shareholders include *Lappeenrannan Kaupunkiyhtiöt Oy* as well as two individual investors. The company has selected the Czech Job Air - Central Connect Airlines s.r.o. to fly the scheduled routes.

In addition to the managing director there are sales personnel and office staff in Lappeenranta. Office personnel were being trained for cabin duties at the time of the occurrence. Ground services at Helsinki-Vantaa were procured from a company called Touch'n Go.

1.17.2 Job Air

The Czech Job Air - Central Connect Airlines s.r.o flew the scheduled flights between Helsinki-Vantaa and Lappeenranta with a SAAB 340B turboprop aircraft. The company's principal place of business is Ostrava, Czech Republic. At the time of the occurrence the airline's fleet comprised six SAAB 340 A/B aircraft. The airliner's JAR OPS 1-based Charter as well as Operating Licence no. 13E, issued on 5.12.2007, were valid. The Air Operator Certificate, no. CZ-57, was valid until 31.3.2008. The company had prepared instructions for operations in Finland.

Central Connect Group a.s. owns Job Air Airlines. Moreover, Central Connect Group a.s. owns an aircraft maintenance company, a company that sells spare parts and provides logistics services as well as a company that provides flight and ground crew training services.

The company's line maintenance in Lappeenranta was the responsibility of Central Connect Group's aircraft maintenance subsidiary. The company's PART 145 licence number was cz.145.0030. The company used an airport hangar owned by *Lappeenrannan Kaupunkiyhtiöt Oy* for line maintenance. Together with the Finnish CAA, the Czech aviation authority audited the line maintenance facilities on 26.2.2008.

1.17.3 Lappeenranta airport

Finavia maintains Lappeenranta airport. The airport is responsible for snow clearance, measurements related to prevailing conditions, improving the surface conditions and reporting said information. The goal of airport maintenance is to properly maintain the required width of the runway during the winter.

According to the Finnish aeronautical information publication (AIP) the available runway may be narrower than the declared runway width. Meteorological and runway conditions permitting, the aim is to ensure at least medium friction on the runway in use. Runway conditions are normally improved by ploughing and sweeping. However, runway de-icing agents or sand can also be used when necessary.

In addition to being responsible for maintenance of movement area, airport maintenance is also responsible of fire and rescue services, ground handling of scheduled flights, de-icing of aircraft as well as any other repairs and maintenance related to airport.

2 ANALYSIS

2.1 Runway maintenance

It started to snow in the evening, approximately six hours before the occurrence. Temperature varied between -0 C° and -1 C°. Hence, the snow was fairly wet. Snowfall was heavy at times until the morning, which kept the three maintenance workers on duty busy throughout their shift. All of the available snow clearance equipment was in use.

Sweeper 1 began to clear the runway some 35 minutes before the flight's estimated time of arrival, followed by Sweeper 2 approximately 10 minutes later. The shift foreman was operating the snow plough in the movement area, trying to clear the taxiway which leads to the apron. The sweeper trucks managed to clear a sufficiently wide section of the runway prior to the arrival of the flight.

The shift foreman hurried from the snow plough to the skiddometer so as to measure runway friction. Nevertheless, he did not have the time to measure the friction as per regulations because the aircraft was about to begin its final approach to RWY 06. A short friction measurement approximately halfway down the runway gave the result of 0.10. Judging by this he reported to the ATC that braking action was really poor. The measurement can be considered unreliable because the distance measured was very short. The result may also have been tainted by the very unevenly worn skiddometer tyre.

Once the clearance of movement area was complete, maintenance personnel did not have the time to write a movement area inspection report. The maintenance crew should have reported the depth of snow as well as the height of the snow banks to the ATC by radio. Then again, the air traffic controller could have requested this information. The ATC reported the width of the cleared runway as well as the poor braking action to the aircraft. Then the air traffic controller requested the pilots to acknowledge the poor braking action and to confirm that the width of the cleared runway was satisfactory to them.

The investigators believe that runway maintenance was started little bit too late, being that there was not enough time to complete the snow removal and friction measurement prior to the arrival of the aircraft. Therefore, the airport was unable to report more detailed information pertaining to runway conditions, such as critical snow banks or other runway contaminants. Sometimes the meteorological conditions or the functioning of equipment make it very difficult to correctly estimate when maintenance activities should commence. If maintenance activities are started too early, snow will cover the already cleared areas on the runway. When it comes to the difficult conditions as regards this occurrence, the aircraft could have waited for the completion of runway maintenance by holding in the air.

Runway friction was re-measured approximately one hour after the occurrence. This time the results were 0.17 / 0.17 / 0.18. The maintenance worker's estimate of the braking action prior to the occurrence had been correct. The investigators believe that runway friction at the time of the occurrence was better than at the time of the re-measurement. This is because the wet snowfall probably degraded runway friction. Corresponding friction measurement tests conducted in similar conditions also support this opinion.

2.2 Flight crew action

According to DFDR information the final approach was normal. The aircraft passed the threshold slightly to the right of the centre line. When the aircraft was landing, snowflakes illuminated by the landing lights blew across the runway in the breeze from right to left, which may have confused the pilots with regard to the true course of the aircraft. A further distraction was that runway centre line markings were completely covered by snow. It is possible that the aforementioned factors caused the aircraft to touch down approximately 10 m left of the centre line, bearing slightly to the left in relation to the centre line.

Because the aircraft was heading towards the left, the left main gear ploughed into the snow bank at 150 m into the landing roll and the right main gear after 240 m of roll-out. Right rudder was fully applied so as to correct the track towards the right. Simultaneously, reverse thrust was applied to slow the aircraft down. Once the reverse thrust began, the right engine failed. This was probably caused by ingested snow which was flung from the nose gear when it penetrated the snow bank. This resulted in the loss of the right engine's braking effect. Since the left engine was braking hard, the nose turned to the left and the aircraft skidded off the runway.

The fact that the control column was pulled backwards contributed to the nose turning to the left, making longitudinal direction control more difficult. Furthermore, full right aileron only exacerbated the nose's leftwards motion. As speed rapidly decreased when the aircraft went off the runway, the increasingly stronger effect of reverse thrust turned the aircraft a further 75 degrees leftwards.

After the aircraft finally came to rest the flight crew tried to taxi back onto the runway by using a high power setting on the remaining engine. Then the propeller wash sucked ice clumps and packed snow off the ground which hit the propeller blade tips, damaging them. Afterwards it was ascertained that no runway edge lights were broken; neither were there any foreign objects on the runway which could have caused the damage to the propeller blades.

The conditions at the time of the occurrence were challenging. Things happened rapidly during the landing roll and recordings revealed that there were moments when the pilots were not sure which one of them was actually the pilot flying. It is the opinion of the investigators that, given the prevailing conditions, the captain should have been the PF. After the aircraft came to a halt the flight crew should not have attempted to taxi back to the runway.

As the aircraft stopped the pilots did not inform ATC about the incident. Instead, the air traffic controller asked the pilots what was going on. The engine that was still running was turned off three minutes after the aircraft stopped. Thereafter the passengers were informed of the situation. The cockpit voice recorder (CVR) kept running for almost 30 minutes after the occurrence. Since the CVR in question only records the previous 30 minutes, thereby wiping off previously recorded data, there was a danger of losing the information from the time of the occurrence.

Runway friction was poor at the time of landing. The width of the cleared runway section was 33 m and there was a direct 5 kt crosswind. Despite the challenging conditions, the investigators believe that landing was possible in prevailing conditions. The aircraft had plenty of fuel which would have made it possible for it to hold in the air, waiting for a more thorough runway clearance. Another issue which affected the occurrence may have been the fact that the company had only begun to fly to Lappeenranta 10 days earlier. The pilots had very little experience in winter operations in occasionally challenging conditions, or with the runway winter maintenance procedures in use.

3 CONCLUSIONS

3.1 Findings

1. The certificate of registration and the airworthiness certificate were valid.

2. The pilots had valid licences and the required qualifications.

3. The air traffic controller had a valid licence and the required qualifications.

4. The mass of the aircraft and centre of gravity were within the permissible range.

5. During the occurrence flight the captain was the pilot not flying (PNF) and the co-pilot the pilot flying (PF).

6. The flight was a scheduled flight. Night IMC conditions prevailed at the airport.

7. The cloud base was low. It was snowing and there was a light southerly crosswind.

8. There are no runway centre line lights. Snow covered the centre line markings.

9. The runway was completely covered with fresh snow. The width of the cleared section of the runway was 33 m. Snow was approximately 10 mm deep in the cleared section.

10. Due to time constraints before landing, runway friction was only measured from a short section.

11. The braking action on the runway was estimated pure. The estimation was correct.

12. Airport maintenance did not report the depth of the snow on the runway or the height of the snow banks to the ATC. Neither did the air traffic controller ask for this information.

13. The air traffic controller informed the approaching aircraft that the estimated braking action was poor. He also asked the aircraft to confirm that the conditions were satisfactory for landing.

14. No movement area inspection reports were written during the time of the snowfall.

15. The aircraft passed the threshold at the correct airspeed and height.

16. The aircraft touched down approximately 750 m past the threshold, some 10 m left of the centre line. It bore slightly to the left of the centre line.

17. The left main gear penetrated the snow bank 150 m into the landing roll and the right main gear 240 m into the roll-out, respectively.

18. The right engine failed after reverse thrust was applied.

19. The aircraft turned to the left and skidded off the runway.

20. The aircraft came to rest approximately 1300 m past the threshold outside the line of the left runway edge lights.

21. The cockpit voice recorder (CVR) was not stopped after the engines were turned off.

22. The left engine propeller blade tips were damaged during the course of the incident.

23. No persons were injured in the incident.

24. There was no need to launch a rescue operation.

25. No defects or malfunctions were detected on the aircraft prior to the incident.

26. The quality of the CVR recording was extremely poor.

27. According to ICAO Annex 13 the classification of this occurrence is Serious Incident.

3.2 Probable cause

The incident was caused by the aircraft veering off the cleared section of the runway during the landing roll. The right engine failed after reverse thrust was applied. This caused unsymmetrical braking, resulting in the aircraft turning to the left and skidding off the runway.

Contributing factors:

Snowflakes illuminated by the landing lights blew across the runway in the light wind, which may have confused the pilots with regard to the course of the aircraft in relation to the runway centre line. Centre line markings were completely covered by snow and the pilots were unaware of the snow banks on the runway.

The conditions in snowfall at night were difficult and braking action was poor. The width of the cleared area of the runway was 33 m and there was a direct crosswind.

The pilots had very little experience in local winter operations or with the runway winter maintenance procedures in use.

4 RECOMMENDATIONS

Shortcomings were detected in flight crew action during the landing. The decision to land in the prevailing conditions was made on scant information.

1. The airline shall ensure that the pilots have the proper training and instructions for the challenging winter operations in northern Europe.

After the aircraft came to a halt the pilots tried to taxi back to the runway. The pilots did not turn off the cockpit voice recorder (CVR) after the occurrence.

2. The airline shall ensure that their pilots have the proper training for procedures related to incidents as well as instructions on handling the CVR during incidents.

The critical snow banks or other runway irregularities were not reported.

3. Finavia shall ensure that comprehensive information relating to runway conditions be reported to air traffic at Lappeenranta airport.

Helsinki 7.4.2009

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