Aircraft incident at Turku airport, Finland on 30.12.1997

Micro-summary: **This Douglas DC-9-41 experienced a runway excursion.**

Event Date: **1997-12-30 at 0012 local**

Investigative Body: **Finland Accident Investigation Board (AIB), Finland**

Investigative Body's Web Site: **http://www.onnettomuustutkinta.fi/**

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Aircraft incident Report

B 9/1997 L

Translation of the Finnish original report

Aircraft incident at Turku airport, Finland on 30.12.1997

LN-RLT

DC-9-41

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ABBREVIATIONS

ACC	Area Control Centre
ADF	Automatic Direction Finding equipment
AFM	Aeroplane Flight Manual
AGL	Above Ground Level
AIP	Aeronautical Information Publication
APU	Auxiliary Power Unit
ARWO	Airport Weather Observation Software
ATIS	Automatic Terminal Information Service
CAA	Civil Aviation Authority (Finland)
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
FL	Flight Level
FOM	Flight Operations Manual
ft	feet (1ft= 0,3048 m)
h	hour(s)
hPa	hectopascal
HSL	Havarikommisjonen for Sivil Luftfart (Aircraft Accident Investigation Board/ Norway)
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
kt	knot(s) (1 kt= 1,852 km/h)
METAR	Aviation routine weather report
MOR	Meteorological Optical Range
NDB	Non-Directional radio Beacon
nm	nautical mile (1 nm= 1,852 km)
PAPI	Precision Approach Path Indicator
p/n	part number
QNH	Corrected mean sea level pressure
REC	Regional Emergency Center
RNAV	Area navigation
RWY	Runway
SHK	Board of Accident Investigation, Sweden
SKH	BV-11 Skiddometer friction tester with high pressure tire
s/n	serial number
TWR	Aerodrome control tower or aerodrome control
UTC	Co-ordinated Universal Time (Finnish local time -2 h)
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio range

SYNOPSIS

On Tuesday 30 December, 1997 at 00.12 local time (Finnish local time is used in this report) an aircraft incident took place at Turku airport where a Douglas DC-9-41 aircraft, registered LN-RLT, owned by Det Norske Luftfartselskap A/S and operated by Scandinavian Airlines System ran off the side of runway. The flight number was SK 720. There were 27 passengers and four crewmembers on board. Nobody was injured but the aircraft was slightly damaged.

On 30 December, 1997 the Accident Investigation Board (AIB), Finland appointed an investigation commission by letter B 9/1997 L. Airline pilot (ret.) Mr Jussi Haila was appointed investigator-in-charge and Aircraft accident investigator Mr Esko Lähteenmäki from the AIB was appointed member of the commission. The investigation was conducted in Finnish legislation, International Civil Aviation Organization (ICAO) Annex 13 and Council of European Union Directive 94/56/EC.

AIB Finland was notified of the incident by Tampere Area Control Centre at 05.05 on 30 December, 1997. Chief air accident investigator Mr Seppo Hämäläinen from the AIB and the investigation commission arrived at Turku airport at 11.00 on the same day.

The commission consulted airline pilot, psychologist Mr Matti Sorsa as an expert on the human factors contribution to the incident.

The pilots gave their statements concerning the incident on 30 December, 1997 and additional questions were asked by the expert and the commission on 13 March, 1998.

The Turku air traffic controller gave his statement concerning the incident on 12 April 1999.

The commission had the Digital Flight Data Recorder (DFDR) removed from the aircraft. The data of the DFDR was read out by SAS Flight Analysis in Copenhagen. The commission received the DFDR data on 26 January, 1998.

Havarikommisjonen for Sivil Luftfart (HSL), Aircraft Accident Investigation Board, Norway, was notified of this incident and the investigation on 30 December, 1997. The HSL did not appoint an accredited representative for the investigation.

The commission sent the final draft of this aircraft incident report to the HSL for comments according to ICAO Annex 13 on 10 February, 1999. The draft has also been sent for comments to the Finnish Flight Safety Authority, SHK (Board of Accident Investigation, Sweden) and the airline SAS. The received comments have taken into account in the report and are enclosed as appendices 2-7.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 Flight preparations

The pilots checked in for duty at Stockholm Arlanda airport on 29 December, 1997 at 15.45 (14.45 local time). They first flew to Geneva and back to Arlanda, where they stayed for about one hour and changed aircraft. The pilots went directly to the aircraft departing for Turku because the flight planning had already been done. They had received the weather information for the flight to Turku in Geneva. The calculated block fuel was 5.600 kg, trip fuel 1.600 kg and the alternate airport was Helsinki.

1.1.2 The flight

The aircraft took off from Arlanda runway (RWY) 08 at 23.41. The flight to Turku was uneventful. The pilots contacted Turku aerodrome control tower (TWR) at 23.59 and reported that they were descending to flight level (FL) 70 and had received the Automatic Terminal Information Service (ATIS) information Echo (E). The air traffic controller cleared the aircraft for an ILS approach to RWY 26 and reported the transition level 55 and the barometric pressure QNH 1011 hPa.

Turku TWR reported to the aircraft 12 minutes before landing that the runway had been swept to a width of 50 m, the runway was covered by 2 mm of slush and the braking action measured half an hour earlier had been good but a new measurement would be made before the landing. The TWR also mentioned that the previous landing aircraft had estimated that the braking action was less than reported. One minute later the TWR reported that there was a snow shower at the airport and the visibility was 1.800 m. The TWR notified at 00.04 (eight min before landing) that the visibility was 800 m in snow, runway visual range (RVR) was 1600 m at all measuring points, and according to the new measurement the runway was covered with 2 mm of slush and braking action was 34/32/32.

The Aeronautical Information Publication (AIP) for Finland defines braking action 32-34 as medium.

1.1.3 Approach and landing

The captain acted as piloting pilot during approach and landing and he made a routine approach briefing for ILS approach to RWY 26. He followed the standard approach procedure via LIE beacon and used autopilot coupled to the ILS. The southerly wind was moderate during approach, causing a 12-14° drift in the beginning of the approach, but the wind weakened below 1000 feet (ft) (300 m) and the drift decreased to 8-9°. The wind was quite steady.

According to the speed booklet of the aircraft the approach speed with the landing mass of 37.000 kg using 40° of landing flaps was 125 knots (kt) and the threshold speed 120 kt. The captain decided to use an approach speed of 130 kt because he estimated that there would be no difficulty in stopping the aircraft on the 2500 m long runway despite the slight over speed.

The aircraft reported outer marker inbound at 00.10. The TWR cleared it to land on RWY 26 and reported the wind as 160°/9 kt, variable 6-12 kt and stated that high intensity approach and runway lights were on at 100% intensity. The copilot said: *"Thank you, sir, and 26, Scandinavian 720".* The pilots requested the wind information again when passing 800 ft. The controller reported: *"160°/8 kt".*

The pilots told that the ILS operated normally. Only the glide slope indication was slightly oscillating at about 700 ft altitude and the autopilot nodded the aircraft for a few times. The captain got the approach lights in sight at about 500 ft (150 m) QNH, about 350 ft above ground level (AGL) and the runway lights somewhat later. According to the flight crew the aircraft flight path was correct when they got the approach and runway lights in sight. The captain requested the TWR to dim the high intensity approach and runway lights. The controller dimmed the lights to 10 %. The captain used the wing and nose landing lights during approach. The wing light switch was in EXT ON position (extended and on) and the nose light was at the beginning in DIM position. When the controller dimmed the high intensity lights the captain switched the nose light to BRT (bright) position and lost the approach and runway lights from sight for a few seconds.

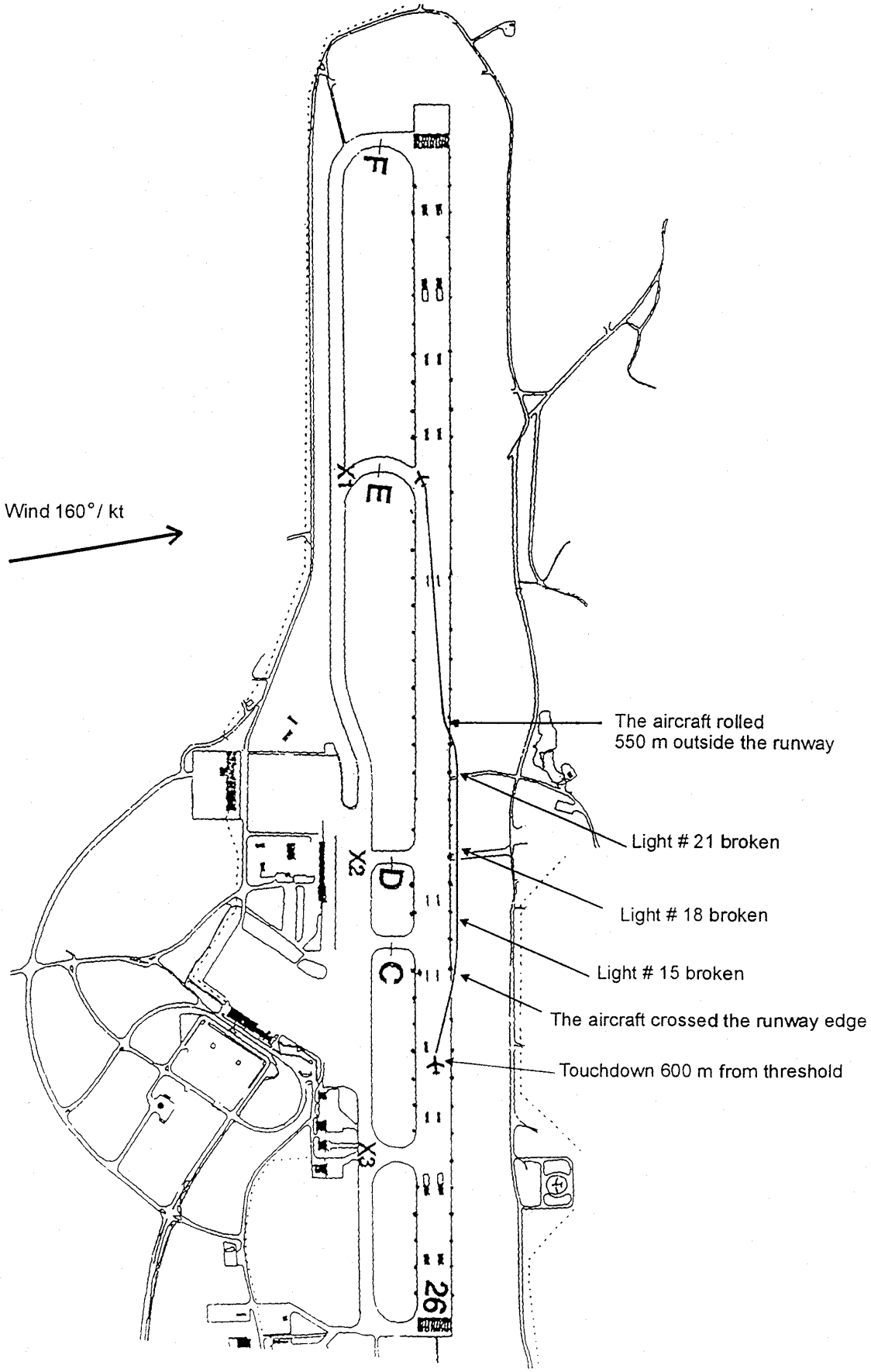
The captain disconnected the autopilot at about 100 ft (30 m), shortly before passing the runway threshold. The side wind component was 8 kt from the left and the wind drifted exceptionally large snow flakes from left to right. The captain told having got an impression that the aircraft was left of the centerline and he decreased the wind correction angle. He also told that he had tried to fly with a slight left bank and had used right rudder control to align the aircraft with the runway.

There were no runway centerline lights installed and the snow cover on the surface was so thick that runway markings were not visible. When the captain disconnected the autopilot the aircraft's heading was 255° (according to the flight recorder, DFDR), but immediately after that it changed 4° to the right to 259° remaining steady until the aircraft ran off the side of runway. The runway direction is 261°. The aircraft passed the threshold with a speed of 130 kt at about 60 ft (18 m).

The aircraft touched down 600 m after the threshold. The right main landing gear wheels were 12 m inside the right runway edge line and the left gear wheels 13 m right of the centerline. The spoilers extended normally decreasing the lift of the wings. The aircraft touched down with a slight right bank and ran off the right edge of the runway 200 m after touchdown. The tracks of the main wheels could be seen on the snow covered runway and strip. No side slipping could be noticed. The nose wheel track began outside the runway edge.

The aircraft fuselage was on touchdown almost along to the runway centerline but the aircraft mass moved to the right off the runway direction. The runway had been swept to

SK-720 TRACKS AT TURKU AIRPORT ON 30.12.1997



the width of 40 m 45 min before landing and the edges had been swept 35 min before landing so that the width of the swept area was 50 m, when the aircraft landed. The right main landing gear wheels were 7 m and the left main landing gear wheels 12 m from the edge of the swept area on touchdown. The right gear wheels ran off the swept area about one second after touchdown and the left gear wheels about one second later. The aircraft fuselage crossed the runway edge three seconds after touchdown. On the runway outside the swept area was about 2-3 cm thick layer of snow and slush and outside the runway was 10-20 cm thick layer of wet snow and slush.

The first officer reported: *"We are drifting to the right".* The flight crew could not remember afterwards at which stage this report was made. The captain did not anyway respond to the first officers report and did not correct the aircraft's flight path. The commander had not seen that the CVR recording had been secured for investigation of this serious incident. The commission could for this reason not determine the exact time for the first officers call out.

The captain did not perceive that the aircraft was running off side the runway before it was crossing the runway edge lights. He did not use the controls for keeping the aircraft on the runway. He did not either lower the nose wheel before the aircraft ran outside the runway edge lights.

The captain told that he first selected engine reverse thrust. When he realized that the aircraft had run out of runway he decreased the thrust to idle or possibly selected forward idle. He tried to get the aircraft back to the runway by using rudder control, but his feeling was that the rudder did not respond. He tried to use left wheel brake but even it had no effect, which after the captain selected reverse thrust again. When the speed decreased he was able to get the aircraft back to the runway by using nose wheel steering. The aircraft ran outside the runway for 550 m.

A drawing of the aircraft's track during landing roll can be seen in figure 1.

The left main wheels and nose wheels ran on asphalt all the time but the right main wheels ran partly on grass. The aircraft stopped on the runway 1800 m after the threshold, at taxiway E intersection. The strip outside the runway was covered by 10-20 cm of wet snow and slush. The slush spray damaged the aircraft slightly.

When the aircraft had stopped on the runway the captain decided that there was no need to evacuate. The cockpit crew had not noticed any warnings or abnormal instrument readings in the aircraft systems. The right engine high pressure fuel lever had stuck and the captain could not shut down the engine. When a mechanic came to the site he shut the lever by using some force.

The captain informed the passengers and the air traffic control about the situation and requested bus to be sent at the site for taking the passengers to the terminal building. Passengers disembarked via the forward entrance door and they were taken to the terminal in three groups by a CAA minibus.

The aircraft was later on towed from the runway to the apron.

1.2 Injuries to persons

There were 27 passengers and four crewmembers on board. No one was injured.

1.3 Damage to aircraft

The aircraft was damaged slightly. The airline technical personnel made a technical inspection, which after the aircraft was ferry flown by the company pilots to maintenance base.

1.4 Other damage

Three runway edge lights were damaged.

1.5 Personnel information

1.5.1 Captain

Captain:	Male, 51 years
Licences:	Airline transport pilot's licence 1990, valid until 31 December, 1997
Licence remarks:	Correcting lenses
Ratings:	Synthetic flight instructor, class single engine land, class multi engine land
Type ratings:	DC-9
Last check flight:	31 October, 1997
Last medical examination:	In December 1997 as notified by the airline
Rest period before the flight:	More than 24 h

Flying experience	**All types**	**DC-9**
Last 24 h	about 5 h	about 5 h
Last 30 days	21 h	21 h
Last 6 months	153 h	153 h
Last 12 months	365 h	365 h
Total experience	7.689 h	7.592

The captain received his basic flight training in the Swedish Airforce where he served from 1966 to 1978 and flew military aircraft for 1700 h. He was hired by SAS in 1980 and had flown the whole of his airline pilot career on DC-9 aircraft, from 1990 as captain.

1.5.2 First officer

First officer	Male, 29 years
Licences:	Airline transport pilot's licence, temporary, issued 17 December, 1997, valid until 17 March, 1998
Type ratings:	DC-9
Last check flight:	December 1997
Last medical examination:	30 July, 1997
Rest period before the flight:	18 h

The first officers flying experience on air transport category aircraft and on DC-9 was 20 h.

The first officer received his basic flight training in 1989 in USA, where he had also acted as a flight instructor for some time. In Norway he had flown light piston and turbo-prop twins and had recently completed airline pilot training given by SAS. He had just started his line flying under supervision.

1.5.3 Cabin crew

There were two flight attendants, which was the number required by the company Aeroplane Flight Manual (AFM) for the flight in question. The cabin attendants had the licences required for their duties.

1.5.4 Air traffic controller

Turku air traffic controller:	Male, 52 years
Licences:	Air traffic controller, valid until 21 March 1998
Licence remarks:	Correcting lenses
Ratings:	EFTU Aerodrome and Approach control

The controller acted also as head of the Turku air traffic control unit.

1.6 Aircraft information

The aircraft was a twin-engine commercial jet aircraft with a passenger seat configuration of 105 seats.

Nationality and registration:	Norwegian, LN-RLT
Owner:	Det Norske Luftfartselskap A/S
Operator:	Scandinavian Airlines System
Manufacturer:	McDonnell Douglas Corporation, USA
Type and model:	Douglas DC-9-41
Serial number:	47626
Year of manufacture:	1974
Engines	
Manufacturer:	Pratt & Whitney Ltd, USA
Type and model:	JT8D-11
Fuel used:	JET A-1

1.7 Meteorological information

There was a cloud area over southern Finland with occasional showers of rain and snow and the ground temperature was around freezing point. Wind at 5000 ft was southwesterly 25 kt, weakening at lower altitude and backing to southerly.

Turku weather forecast valid from 29.12. 23.00 to 30.12. 08.00:

- wind 190°/6 kt, visibility 4000 m, clouds overcast 400 ft, temporarily from 23.00 to 08.00 visibility 7000 m, snow, clouds broken 700 ft.

Turku weather forecast valid from 29.12. 20.00 to 30.12. 14.00:

- wind 170°/7 kt, visibility 8000 m, snow, clouds overcast 500 ft, temporarily from 20.00 to 05.00 visibility 2000 m, rain and snow, clouds overcast 200 ft, forecasted temperature at 20.00 +1°C, at 14.00 -1°C.

Actual weather at Turku airport:

- 23.20: wind 160°/7 kt, visibility 3 km rain and snow, clouds; few 200 ft, broken 300 ft, temperature +1 °C, dew point +1 °C, QNH 1011 hPa

- 23.50: wind 170°/8 kt variable 140-210°, visibility 1800 m, clouds; few 200 ft, broken 300 ft, temperature +1 °C, dew point 0 °C, QNH 1011 hPa

- 00.20: wind 160°/8 kt variable 130-190°, visibility 1200 m, runway visual range 1200 m/1500 m/1500 m, clouds; few 200 ft, broken 300 ft, temperature 0 °C, dew point 0 °C, QNH 1011 hPa.

The Turku aerodrome forecast (TAF), which the pilots had available ended at 23.00. They had only a forecast for time from 29.12. 20.00 to 30.12. 14.00 and a METAR from time 15.20 and Turku SNOWTAM from time 10.39 in the morning.

It was midnight and dark when the aircraft landed.

1.8 Aids to navigation

Two NDB approach beacons, VOR-DME, ILS for RWY 26 and high intensity approach, runway and PAPI lights for both runways were operational at Turku airport.

The aircraft had ADF, VOR-DME, ILS and RNAV equipment, all operating normally. The crew had SAS Route Manuals in their use.

1.9 Communications

The radio communications were listened to from the recording of Turku TWR. The first officer acted as monitoring pilot and handled the radio communications.

Turku TWR radio communications transcript is enclosed as an Appendix.

1.10 Airport information

Turku airport is administrated by the CAA, Finland. The aircraft landed on RWY 26, which is 2500 m long and 60 m wide. The coordinates of Turku airport reference point are 60° 30’ 52” N, 22° 15’ 42” E and the elevation is 161 ft (49 m). The elevation of runway mid part is 160 ft (49 m), RWY 26 threshold 141 ft (43 m) and RWY 08 threshold 131 ft (40 m). The first half of RWY 26 is uphill and the second half is downhill.

Airport maintenance had swept the runway during the evening. The width of the swept area was 40 m at 23.25 and the runway was swept to width of 50 m between times 23.31 and 23.38. The snow showers were intensifying at the same time, 45 min before the aircraft landed but the runway was not swept although two aircraft which landed at 23.30 and 23.56 complained the braking action. The maintenance did not sweep the runway after time 23.38 and the middle of the runway was swept before time 23.25.

The maintenance measured braking action with BV-11 Skiddometer (SKH) at 00.04. The obtained values were 34/32/32 (first part/ second part/ last part). The air traffic controller reported that there was 2 mm of slush on the runway. The slush and snow layer was growing due to heavy snowfall and the surface of the runway was totally white when the

aircraft landed. The airport maintenance personnel told in the hearing that the falling snowflakes were exceptionally large and thickness of the slush and snow layer was 5 mm after the aircraft had landed.

1.11 Flight recorders

The aircraft was equipped with an Allied Signal Avionics Inc. Digital Flight Data Recorder (DFDR, p/n 980-4100-HQUN, s/n 10792). The recorder runs when at least one high pressure fuel lever is open and the parking brake is released. DFDR recorded six parameters: standard pressure altitude, indicated airspeed, magnetic heading, two vertical acceleration values and radio transmission keying.

The data of the DFDR was read out by SAS Flight Analysis in Copenhagen, Denmark.

The aircraft was equipped with an Allied Signal Avionics Inc. Cockpit Voice Recorder (CVR, p/n 980-6005-076, s/n 13144) which provided a continuous four channel recording for 30 minutes when the aircraft electrical power was on.

The instructions on saving the DFDR and CVR recordings were given in the airline Flight Operations Manual (FOM) para 3.2.1.11. According to the given instructions *the Commander shall see to it that in the event of occurance of a serious nature (accident or major incident) both the flight recorder and the voice recorder be removed and secured for the subsequent investigation. To preserve the CVR recording, it is necessary to pull its circuit breaker immediately after parking.* In this case the CVR circuit breaker had not been pulled, the electrical power had been on for over 30 min and the recordings from the approach and landing were lost.

1.12 Description of the incident site and aircraft inspection

1.12.1 Description of the incident site

The airport personnel took photograps of the aircraft tracks about 10 min after landing. The quality of the photos was modest because only a small pocket camera was used and its capacity was insufficient for this purpose. Also the snowfall had covered somewhat the tracks. The airport personnel measured the tracks and made a drawing about 30 min after landing before next sweeping.

The tracks of the main landing gear wheels began 600 m after threshold. Outside the runway edge there is a 5 m wide asphalt strip. The wheels of the left main landing gear and nose wheels ran on this strip. The right landing gear wheels had touched the runway 12 m inside the runway right edge line, 7 m inside the edge of the swept area. The left landing gear wheels had touched the runway 13 m right of the runway centerline. The track gauge is 5.0 m. The tracks of the left main gear began 10 m later than the tracks of the right gear. The runway surface is slanting at this point 1.5° to the right. The tracks of the main gear wheels ran directly 4° right from the runway direction and led out of the runway edge about 200 m after touchdown point, which after the tracks continued parallel with the runway. There were no signs of side slipping. The nose wheel track be-

gan outside the runway right edge. The aircraft left the runway near light assembly no 13, (counting from RWY 26 threshold), which remained intact. The distance between the light assemblies is 60 m. The wheels of the left main gear and nose gear ran on the strip outside the runway, while the wheels of the right main gear ran partly on the asphalt strip partly on the frozen grass

The aircraft ran outside the runway for 550 m. The left landing gear damaged three runway edge lights (nos 15,18 and 21 from threshold 26). The aircraft came back to the runway between light assemblies no 22 and no 23. Outside the runway there was 10-20 cm of wet snow and slush.

1.12.2 External inspection of the aircraft

The commission inspected the aircraft in the afternoon on 30 December 1997. The aircraft was inspected visually on the apron for possible damage caused by wet snow and slush. Wet snow had split the glass of the right nose light and filled the wheel wells. It had also caused small dents on the right wing leading edge and landing flap. Most of the wet snow had already been removed or had melted from the wheel wells and the rear cargo compartment by the time of the inspection.

A spray of wet snow from the right main landing gear had hit the inward-opening rear cargo compartment door and broken the counterparts of the lock pins and opened the door. The skin plate of the door had been bent outwards at the edges. After the door had opened, wet snow had sprayed in to the cargo compartment, damaged the structures behind the compartment bulkhead and caused the jamming of the right high pressure fuel lever wire. The snow spray had also bent the water guide plates of the APU (Auxiliary Power Unit) turbine air intake on the underside of the fuselage.

The airline technical personnel made the airworthiness inspection for the ferry flight.

1.13 Medical information

No medical tests were made.

1.14 Fire

There was no fire. The landing fuel was about 4.000 kg.

1.15 Survival aspects

1.15.1 Notifications of the incident

The air traffic controller did not alerted the airport rescue unit or the Regional Emergency Center (REC). He should have followed the Turku airport alerting instructions when the aircraft had run off the side of runway.

The controller informed Tampere Area Control Centre (ACC) about the incident at 00.23. The ACC controller who received the information wrote it down but the note remained on the watch supervisor's desk for about 4 ½ h because he had, according to the practice followed at the ACC, gone to another building to sleep at the time of the incident and found the note after he had woken up at about 05.00. According to an entry in the ACC logbook the information about the incident had been received *"at about 00.30".*

1.15.2 Operation of the rescue organization

The rescue organization was not alerted but one member of the rescue unit decided himself to remain on stand-by in the vicinity of a fire truck until it became certain that no alarm was given.

1.15.3 Survival aspects

No strong deceleration forces occurred during landing roll and there was no fire. The aircraft was not evacuated. The passengers disembarked the aircraft on the runway via the forward entrance door using the aircraft stairway.

1.16 Tests and research

1.16.1 General

The investigation material consisted of incident reports made by the captain and the air traffic controller, flight documents, crew and aircraft information, extracts from air traffic control logs , statements of the persons involved, radiotelephone and telephone transcripts and DFDR recordings, information obtained from company manuals, documents, instructions and from the damage report of the aircraft. The material also included weather information from Turku airport at the time of the incident and recorded runway braking action values.

The material was sufficient for the commission to form a detailed view of the course of events.

1.16.2 Flight Data Recorder information

The DFDR was intact and had functioned properly. The recorded six parameters were useful when investigating the events during final approach and landing. The DFDR records neither the data of the flight path, navigation aids, radio altimeter or engines, nor the positions of flight controls and high lift devices. These would have been useful when analysing the progress of the approach and landing.

1.16.3 Cockpit Voice Recorder information

As mentioned in para 1.11, the CVR data concerning the incident was lost.

1.17 Organizational and management information

1.17.1 General

Scandinavian Airlines System (SAS), which is owned by three states: Denmark, Norway and Sweden, operates in domestic and international air traffic. The head office and operational management are in Stockholm. The airline uses its own Flight Operation Manual (FOM), DC-9 Aeroplane Flight Manual (AFM) and Route Manual (RM).

1.17.2 Flight Operations Manual

Provisions and instructions for the airline flight operations were given in the FOM.

In para 3.1.10 Flight Performance-Landing:

3. Ground fog, blowing snow or sand

Precipitation or drifting snow or sand in crosswind conditions may create a false impression of the aircraft movement and thus the pilot may get an impression of no drift when in fact there is a considerable drift present.

There is no definite rule on how to handle this problem, but here are some recommended procedures:

- Make yourself aware of the existing situation.

- Do not use landing lights.

- Look well in front of the aircraft during touchdown and landing roll. Use runway lights for reference.

4. Landing lights

When landing in reduced visibility, the use of landing lights may cause reduced forward visibility due to blinding effect and also lead to disorientation. In conditions of precipitation and crosswind, false impressions of drift can occur as stated in 3 above. The use of landing lights during landing in the above mentioned conditions is therefore not recommended.

6. Runway alignment

Every effort shall be made to ensure a landing along the runway center as this gives the best margin for correction in case of unforeseen alignment difficulties after touchdown.

1.17.3 DC-9 Aeroplane Flight Manual

Orders and instructions on the use, restrictions and performance of the aircraft type were given in part II of DC-9 AFM.

AFM para 2.4.6 gave detailed landing instructions for the pilots.

> ***2.3. Disorientation:***
>
> *Precipitation or drifting snow or sand in crosswind conditions may create a false impression of aircraft drift, especially if landing lights are on. Thus the pilots may:*
>
> *- Get an impression of no drift, when in fact there is a considerable drift present, ending up off the runway on the leeward side.*
>
> *- Get an impression of drift which will cause him to delay his removal of side slip during flare and touchdown and land off the runway on the windward side.*
>
> *There is no definite rule how to handle this problem, but here are some recommendations:*
>
> *- Make yourself aware of the existing situation*
>
> *- Do not use nose wheel landing or taxi lights and, if necessary, also switch off the wing landing lights.*
>
> *- Look well in front of the aircraft during touchdown and landing roll. Use runway lights for reference.*

1.17.4 Route Manual

The Route Manual contained the navigational, approach and landing charts required in flight operations and the other flight information needed. In part *Meteorology,* item 2.3, instructions for estimating runway conditions in difficult weather circumstances were given as follows:

> ***2.3 Reliability of reported friction coefficient on standing water, slush and wet snow***
>
> *According to FOM 3.3.1§3.2:*
>
> *The reported friction coefficient should be regarded as unreliable when "airport temperatures are close to zero and there is standing water, slush or wet snow on the runway".*

However, there is one exception:

When the measuring is made by BV11 Skiddometer or SAAB/ Surface Friction tester the reported friction coefficient may be used also under the above runway conditions.

1.17.5 Braking action measurement

According to AIP Finland, para 2.3.1, the measurement of braking action should be made by towing the BV11 Skiddometer trailer with a speed of 65 km/h.

According to the Aviation Regulation BCL-F 3.2 (Bestämmelser för Civil Luftfart) of Luftfartsverket Sweden, para 8.2.7, the braking action measured with BV11 Skiddometer can be misleading if the runway is covered by wet snow or slush and the measuring speed is less than 95 km/h.

When the matter was discussed with the manufacturer of the friction tester, he stated to AIB Finland that the only *"correct measuring speed is 65 km/h"*, which is also the instructed speed in Norway.

The braking action had been measured in Turku with a speed of 65 km/h. According to the instructions given in AIP Finland para 2.3.1 *the measurement is made along the runway 5-10 m on either side of the runway centerline.* In this case the braking action was measured by towing the tester to only one direction. The BV-11 Skiddometer friction tester was taken out of use after the incident and the functioning of the equipment was tested by means of a calibration weight on 31 December, 1997. The friction tester was functioning normally and the test results corresponded to the calibration markings.

1.18 Additional information

A continuous automatic weather measurement system was in use at Turku airport. The recorded parameters are: wind direction and speed, Meteorological Optical Range (MOR) and Runway Visual Range (RVR). The MOR corresponds to meteorological visibility (VIS). The measured values are processed in the ARWO (Airport Weather Observation Software) unit. The METARs (Aviation routine weather report) are supervised and, where necessary, corrected by a weather observer. The automatically obtained weather information is recorded at 20 min intervals. The wind data contains the mean wind during last 10 min and the maximum and minimum values of wind direction and speed. The visibility data reports the runway in use, VIS and three runway visual range (RVR) values, (first, mid and last part of the runway), at 20 min intervals. Turku Airport had decided on the recording system used and chosen the 20 min recording interval, but rapid variations often occur in rain and snow showers, thunderstorms and some fog conditions. It is possible that this kind of deterioration is not included in the recorded information. When investigating accidents and incidents a more frequent weather recording would be useful.

According to the statement of the senior meteorologist of CAA Finland, the above-mentioned recording practice is sufficient and fulfills the requirements of ICAO Annex 3.

In this case at 00.00 the recorded visibility values were: VIS 3600 m and RVR 2000-2500 m. At 00.01 the air traffic controller reported to the approaching SK-720 VIS 1800 m in snow and three minutes later, at 00.04 VIS 800 m and RVR 1600 m. The recording at 00.20, 16 min after the controller's last reported visibility, indicates VIS 1300 m and RVR 2000 m, which is misleading compared to the actual conditions during landing. The Turku METAR at 00.20 reports VIS 1200 m and RVR 1200m/1500m/1500m.

2 ANALYSIS

2.1 Runway conditions

Snow showers had occurred during the evening of 29 December at Turku airport and the maintenance personnel had swept the runway several times. The swept area was 40 m wide at 23.25, the edges were swept between 23.31 and 23.38 and the swept area was 50 wide when the aircraft landed. The braking action was measured on the runway centerline at 23.18. The obtained result 46/44/57 were never transmitted to ATIS-information. The snowfall intensified about 45 min before landing but the runway was not swept despite the fact that the aircraft, which landed at 23.30 and at 23.56, complained the braking action. The captain of the last landed aircraft estimated the braking action to be 25 and partly less. The airport maintenance did not sweep the runway after time 23.38 and there was no discussion between the maintenance and the air traffic controller of need of the runway sweeping. The airport ATIS reported braking action 69/72/64. A new braking action was measured at 00.04. The measurement was made by towing the friction tester, against the instructions, to only one direction. Eight minutes before landing the air traffic controller reported a new braking action 34/32/32, told that there was 2 mm of slush on the runway, that the visibility had deteriorated from 1800 m to 800 m and that the RVR was 1600m. Airport maintenance personnel estimated that there was a 5 mm thick layer of wet snow on the runway after the aircraft had landed. The thickness of the layer increased to 10 mm before the aircraft was towed away from the runway.

A new braking action measurement was not made after the aircraft had landed. The next braking action was measured after the runway had been swept.

A Vaisala Icecast system has been installed at Turku airport. The system includes six permanent temperature measuring elements on the runway surface. They are automatically measuring eight parameters at five minute intervals, including the runway surface temperatures. Runway temperatures between -0.4°C and +0.4°C were recorded at 22.00-24.00. No ice melting chemicals had been used on the runway. There was a thin layer of slush on the surface after sweeping, but the snow did not melt notably and the runway surface was white when the aircraft landed.

The slush and snow layer on the runway surface had increased all the time and at 00.12, when the aircraft landed, the braking action was somewhat less than the 34/32/32 measured with BV11 Skiddometer. This should have been known to the pilots because of reported visibility of 800 m in snowfall. The braking action was sufficient to stop the aircraft on the 2500 m long runway and the crosswind component was according to the company DC-9 AFM within allowable limits even with a braking action of 22. The slippery runway is not considered a cause of the incident. The fact that no side slipping could be noticed in the wheel tracks and the nose wheel track did not start until outside the runway also support this conclusion.

There was a 2-3 cm thick layer of slush and snow outside the swept area on the runway and just outside the runway edge lights 20 cm thick bank of wet snow. The strip outside of this bank, was covered by a 10 cm thick layer of wet snow. The left main gear ran in the snow bank which increased the drag of the left wheels and helped in steering the aircraft back to the runway. The grass area outside the asphalt strip was smooth and frozen, which prevented more serious damage to the aircraft.

2.2 Human factors

The flight crew started the approach in good mental and physical alertness. No signs of tiredness, illness or medication were found in the investigation.

The captain, a DC-9 instructor, who had 18 years of experience on the type, piloted the aircraft. The first officer, who was in training, was inexperienced as an airline pilot. The situation set extra demands on cockpit co-operation, because with this kind of crew combination it cannot be assumed that the monitoring pilot, the first officer, would have a high ability to deal with unexpected situations.

A routine approach briefing was made. On the basis of available information, the captain supposed that no problems would be expected with regard to the weather and braking action. During approach the captain found out that the visibility was actually somewhat better than he had expected. The approach was normal in every way, with the autopilot coupled to the ILS until slightly below 100 ft. The first officer did good monitoring work during the approach.

The captain got the approach lights in sight at about 500 ft (150 m) QNH, about 100 m above runway level, and the runway lights somewhat later. The decision altitude was 350 ft on QNH. *(The decision altitude is the height above sea level, where for a precision instrument approach, a missed approach procedure must, at the latest, be initiated unless the visual reference to the approach lights, the runway lights or the runway has been established, permitting a continued approach to land, FOM 1.3.1*). The high intensity lights felt blinding bright and the captain requested the lights to be dimmed. At the same time he switched the aircraft nose landing light from dim to bright position and was blinded for a few seconds when the light was reflected from the snow flakes. At this time he lost the runway lights from sight. When the captain got the runway lights in sight again, it created a false impression of the aircraft flight path to him. He flew the aircraft manually in the final stage and his impression was that the aircraft was slightly left of centerline and he corrected the flight path to the right, which after the heading, according to the DFDR, remained steady until the aircraft ran off the side of runway.

The first officer called out: *"We are drifting to the right"*, but the captain did not respond to first officers report and did not try by controls to correct the aircraft flight path. The aircraft fuselage was almost along the runway centerline, but the mass moved 4° to the right from runway direction. The captain was not aware of the aircraft's realistic movement direction. He did not try to keep the aircraft on runway by controls and he held the nose wheel up until the aircraft crossed the runway edge light line. His action on touchdown and immediately after that indicates that he experienced the landing normal.

The captain told that at touchdown, he had used aileron control slightly to the left and rudder control to the right. He found the effect of the wind to be weak. The touchdown was normal and the spoilers extended normally, whereupon the lift of the wing decreased. The captain selected engine reverse thrust immediately after touchdown but did not see the need to start wheel braking immediately after nose wheel contact. During the hearing the captain and the first officer remembered that the first officer had said that the aircraft was drifting to the right, but they could not remember the exact time for the call out.

According to the available information the decision to initiate the approach was correct and the approach was performed according to the principles of good airmanship until the dimming of the high intensity lights. At that point the captain made a mistake when he selected the nose landing light to the bright position and maintained it bright although he was immediately blinded. For a few seconds the captain lost the runway from sight. The wind drifted exceptionally large snow flakes from left to right, which together with the blinding effect of the landing lights caused an illusion of movement to the left. The captain unconsciously developed a wrong mental picture of the aircraft's direction of movement with respect to the runway centerline and he therefore decreased the wind correction angle, which after the aircraft did not move along the runway centerline but 4° to the right. The captain did not land on the runway centerline. The touchdown was 15 m right of centerline and 600 m after the threshold. The normal touchdown point is 300 m after threshold on runway centerline.

On touchdown the right main landing gear was 7 m from the edge of the swept area and ran one second after touchdown outside the swept area. The left landing gear was 12 m from the edge of the swept area and ran two seconds after touchdown outside the swept area. According to the manufacturers FCOM (Flight Crew Operating Manual) the spoiler extension takes normally 0.8 second. Some delay may occur on reduced friction conditions. The right landing gear ran outside the swept area at the same time when the spoilers reached their full extension and the left landing gear one second later, which after the main wheels ran on a thick slush and snow layer. Even the aircraft fuselage was along the runway on touchdown the main wheel tires had not got firm grip on the runway surface before the aircraft ran on a thick snow and slush covered surface where the tires were probably slush planing. As the captain held the aircraft nose up had the wings, despite of spoiler extension, some lift which reduced the main wheel weight on the runway. For these reasons the aircraft movement continued until outside the runway edge.

The company DC-9 cockpit procedures did not require the monitoring pilot to call out the radio altimeter readings after decision or minimum altitude. This call out procedure would help the piloting pilot in determining the aircraft height above runway surface particularly when the surface is not easily distinguished

The braking action would have been sufficient to stop the aircraft on the runway if the aircraft had moved along the runway centerline at touchdown. The aircraft did not skid notably sideways. This means that an essential factor in the incident was insufficient wind correction before touchdown. This was caused by incorrect use of the landing

lights and wrong impression of the aircraft flight path caused by snowfall. The captain had a feeling that he banked the aircraft to the left at touchdown. However it appeared from the wheel tracks that the aircraft was actually banked slightly to the right. The captain told that he had used rudder control to the right at touchdown. These factors together have increased the aircraft's drift to the right.

As shown in paragraph 1.17, the company has given instructions for this kind of situations both in the FOM and the AFM. The instructions can be considered good and they correspond very well to the common practice in the industry. This case is a typical example of what can happen if these instructions are not followed. The aircraft's drift and position with respect to the runway was more difficult to determine than usual because there were no runway centerline lights and the runway markings were covered by snow. These facts should have been known to the flight crew.

The two pilots in the cockpit form a team and the operation of the aircraft is a result of this teamwork. One pilot, in this case the captain, flies the aircraft and the other handles the radiotelephone communications, reads the checklists and monitors the piloting pilot's performance. In the final stage of an instrument approach when the runway or runway lights are in sight, the piloting pilot looks out and compares the aircraft flight path to the runway or lights and forms an idea of the aircraft's position and flight path with respect to the runway. The monitoring pilot monitors the aircraft's flight path and speed by means of the instruments. The monitoring pilot should interfere in the piloting pilot's performance if he makes a mistake which might compromise safety. If in this case the monitoring pilot had been an experienced copilot, he could have called the captains attention to the correct use of landing lights and the aircraft flight path before touchdown or he could have advised the captain to discontinue the approach and to make a go-around and a new approach. Any of these actions alone could have prevented the aircraft from running off the side of runway.

2.3 The captain's flying routine

The captain also acted in the airline as a simulator and route instructor. During the last month he had flown DC-9 aircraft only 21 h and during the six last months on an average 25 h per month. This flight time can be considered low for an airline pilot. When acting as a route instructor he had probably concentrated on the training, and it is thus possible that his own feel for piloting the aircraft could have, in spite of long type experience, declined due to infrequent flying. The action as simulator instructor had not maintained the captain's own flying routine.

During the hearings it appeared that the captains knowledge of the company AFM and FOM was partly incomplete.

2.4 Operation of the air traffic control

2.4.1 Turku aerodrome control

The Turku air traffic controller acted also in position of leadership in the control unit. He told in the hearing that alarming is so simple matter that no special instructions is needed and for this reason he did not follow the Turku airport alerting instructions when the aircraft ran off the side of runway. Use of the instructions had been useful as he did not alarm the airport rescue unit or the Regional Emergency Center (REC) even the instructions required alarming. He did not either call police in the site to examine the state of the flight crew, to decide need of medical examinations and to make investigations in site. He did not inform AIB. This item in the Turku airport alerting instructions was not up-to-date. He neither ordered a new braking action measurement immediately after the incident, which had helped investigation. The controller did not take measures to send a NOTAM for informing that Turku airport was closed before Helsinki-Vantaa briefing asked it when the airport had been closed about 30 min. It appears from the Turku TWR telephone transcript that when the controller informed others about the incident he seemed to understate the event and was laughing. For this reason the persons who received the message could have got a wrong impression of the seriousness of the event.

The commission sees that it is always a serious situation when an aircraft runs off the runway. The landing speed, the mass of an airliner and the remaining fuel always cause a high risk of structural damage and fire when an aircraft runs off runway. According to ICAO Annex 13, attachment D, overrunning or running off the side of runway is a serious incident. In Aviation Regulation GEN M 1-4, on the notification of an accident, damage or incident, running off the side of runway is as an example of a serious incident. The commission considers it peculiar that the air traffic controller did not understand that the situation was serious.

The head of Turku airport stated that he did not know the recurrent training given to the air traffic controllers. He presumed that CAA orders the training and told that the air traffic control unit had taken care of the training matters selfishly.

According to the head of training at Turku air traffic control, the controllers had familiarized themselves by self-study with the revisions of given regulations and orders. The airport management had not organized any training concerning the regulations, orders or their revisions in the recent years.

2.4.2 Tampere area control

The personnel working in Tampere ACC during the night in question consisted of a watch supervisor, two controllers, one trainee and one assistant. According to the head of the ACC the controllers are allowed to rest by turns during the night shift. In this case the supervisor had gone to sleep in another building before the information about the incident was received in ACC at 00.23. The controller who received the message at his working station wrote it on a piece of paper which he left on the supervisor’s desk. The

supervisor found the note after waking up at 05.00. According to the given instructions, the controller should have woken up the supervisor after receiving the information about the incident. The time of the incident was entered in the logbook as *"about 22.30 UTC"*. The starting and ending times of the night shift had not been marked in the ACC logbook as required by the instructions.

When the ACC controller was informed about the incident by the controller at Turku TWR, he became concerned about a flight, which had departed from Helsinki and was bound for Turku, as the runway in Turku was closed. The discussion then turned to this flight.

The commission assumes that the incident information was left on the supervisor's desk without informing him about the incident at 0023 because the ACC controller had got a wrong impression of the event. As the Turku controller reported the incident unconcerned and laughing, the area controller did not understand how serious the incident was and did not immediately relay this information to the supervisor.

3 CONCLUSIONS

3.1 Findings

1. The cockpit crew had valid licences and they were qualified for the flight.

2. The registration and airworthiness certificates of the aircraft were valid.

3. No defect or malfunction was found in the aircraft before the incident.

4. The captain acted on the flight as route instructor and piloting pilot. He also acted as simulator instructor in the airline and had flown with DC-9 aircraft during the last month only 21 h and during the last six months on an average 25 h per month. This flight time can be considered low for an airline pilot. The action as simulator instructor had not maintained the captain's own flying routine.

5. The first officer had recently completed airline pilot training given by SAS. The flight was one of his first line flights under supervision. His total flight experience on an airliner and on DC-9 was 20 h.

6. During the evening of 29 December snow showers had occurred at Turku airport and the runway had been swept several times. The reported braking action was 69/72/64. Two aircraft which landed at 23.30 and 23.56 complained the braking action. The captain of the last landed aircraft estimated the braking action to be 25 and partly less. Despite of pilots reports the runway was not swept.

7. At 00.04 (eight minutes before landing) the controller reported to SK 720 a new braking action 34/32/32, stating that there was 2 mm of slush on the runway, that the visibility had deteriorated from 1800 m to 800 m and that the RVR was

1600 m. The braking action measurement was not made according to the instructions given in AIP Finland para 2.3.1.

8. According to the statements of the airport maintenance personnel there was a 5 mm thick layer of wet snow on the runway after the aircraft had landed.

9. The captain got the approach lights in sight at about 500 ft (150 m) QNH, about 100 m above runway level, and the runway lights somewhat later.

10. The captain disengaged the autopilot at about 100 ft (30 m).

11. The captain used wing and nose landing lights during the approach. The wing landing lights were in EXT ON position (extended and on) and the nose landing light at the beginning on DIM position. When the controller dimmed the high intensity lights on the pilots' request, the captain switched the nose landing light to BRT (bright) position. He was blinded for a few seconds when the light was reflected from the snow flakes. At this time he lost the runway lights from sight. When he got the runway lights in sight again, it created a false impression of the aircraft flight path to him.

12. When the captain disengaged the autopilot the aircraft heading was 255° (according to the DFDR), but changed immediately after that 4° to the right to 259°, remaining steady until the aircraft ran off the side of runway. The runway direction is 261°.

13. The captain told that his impression was that the aircraft was left of the centerline and he decreased the wind correction angle.

14. The left side wind component was 8 kt. According to the company DC-9 AFM it was within allowable limits even with a braking action of 22.

15. There were no runway centerline lights installed at Turku airport and the snow covered the runway markings.

16. The aircraft passed the runway threshold with a speed of 130 kt at about 60 ft (18 m) altitude. According to the speed booklet of the aircraft, the approach speed with the actual landing mass was 125 kt and the threshold speed 120 kt. The instructed threshold altitude is 50 ft (15 m).

17. The aircraft landed with a slight right bank 600 m after the threshold, 15 m right of the runway centerline. The direction of the mass was 4° to the right of the runway direction.

18. The first officer called out: *"We are drifting to the right"*, but the captain did not respond to first officers report and did not try by controls to correct the aircraft flight path.

19. The captain was not aware of the aircraft realistic movement direction. He did not try to keep the aircraft on runway by controls and he held the nosewheel up until the aircraft crossed the runway edge light line. His action on touchdown and immediately after that indicates that he experienced the landing normal.

20. The right landing gear ran outside the swept area at the same time when the spoilers reached their full extension and the left landing gear one second later, which after the main wheels ran on a thick slush and snow layer. Even the aircraft fuselage was along the runway on touchdown the main wheel tires had not got a firm grip on the runway surface before the aircraft ran on a thick snow and slush covered surface where the tires were probably slush planing. As the captain held the aircraft nose up had the wings, despite of spoiler extension, some lift which reduced the main wheel weight on the runway. For these reasons the aircraft movement continued until outside the runway edge.

21. The aircraft ran outside the runway for 550 m. The left main wheels and nose wheels ran on the asphalt strip but the right main wheels ran partly on grass. There was a 20 cm thick bank of wet snow just outside the runway edge lights. The strip outside of this bank was covered by a 10 cm thick layer of wet snow.

22. The aircraft stopped finally on the runway 1800 m after threshold.

23. According to the company FOM, the CVR circuit breaker should be pulled out to save the recordings. In this case the instructions had not been followed and the recordings were lost.

24. The air traffic controller did not follow Turku airport alerting instructions when the aircraft ran off the side of runway. He only informed Tampere ACC about the event.

25. The air traffic controller did not alarm the airport rescue unit or the Regional Emergency Center (REC) even the instructions required alarming. He did not either call police in the site to examine the state of the flight crew, to decide need of medical examinations and to make investigations in site.

26. The air traffic controller did not inform AIB. This item in the Turku airport alerting instructions was not up-to-date.

27. The air traffic controller did not order a new braking action measurement immediately after the incident, which had helped investigation.

28. The air traffic controller did not take measures to send a NOTAM for informing that Turku airport was closed before Helsinki-Vantaa briefing asked it when the airport had been closed about 30 min.

29. The ACC watch supervisor had gone to sleep in another building before the information about the incident was received in ACC at 00.23. He found a written note about the incident on his desk after waking up at 05.00. According to the current instructions the controller who received the message should have woken up the supervisor.

30. Turku airport weather information was recorded at 20 min intervals. When investigating accidents and incidents a more frequent weather recording would be useful.

3.2 Probable cause

The probable cause of the incident was the captain's wrong impression of the aircraft flight path during final approach and landing. The illusion was caused by incorrect use of landing lights and the snowfall which drifted snowflakes from left to right. Recognition of the impression was hampered by the missing runway centerline lights and the snow which covered the runway markings.

Because of low experience of the monitoring pilot, a first officer in training, it was difficult for him to intervene in the progress of the events during final approach and landing.

4 RECOMMENDATIONS

1. The airline shall make sure that the instructors have good knowledge of the company manuals.

2. The airline shall establish in DC-9 aircraft a cockpit procedure where the monitoring pilot calls out radio altimeter readings below decision altitude/ minimum altitude.

3. The Civil Aviation Administration, Finland shall look after:

   - that the air traffic controllers commit themselves to the given norms assimilate in the norms as part of their professional competence
   - that the attitudes of the air traffic controllers are appropriate for their duties at the service of international airline traffic.

Helsinki 11.5.1999

Jussi Haila Esko Lähteenmäki

APPENDIX 1

Radio communications on Turku TWR frequency 118.3 Mhz

TWR is Turku aerodrome control
SK 720 is Scandinavian Airlines System flight SK 720
FIN 926 is Finnair flight FIN 926 (MD-82)

From	To	Time (local)	Transmission
SK 720	TWR	23.59	Turku, good evening, Scandinavian 720, we are descending to flight level 70, information Echo
TWR	SK 720		Scandinavian 720, Turku tower good evening, you are cleared ILS approach runway 26, transition level 55, QNH 1011
SK 720	TWR		Cleared ILS approach runway 26, (unreadable), 720
TWR	SK 720		Turku tower
TWR	FIN 926		Finnair 926, what was your estimate of the braking action?
FIN 926	TWR		I say 25, may be partly more slippery
TWR	?		Jep
TWR	SK 720	00.00	Scandinavian 720, we have two millimeters (unreadable) slush and runway is brushed 50 meters wide and about half an hour ago measured coefficients were good, but we take a new measurement before your landing
SK 720	TWR		Okay, thank you, 720
TWR	SK 720		Because the estimates by the landing planes have been more poor
SK 720	TWR		(acknowledge by pressing push to talk button)
TWR	SK 720	00.01	Scandinavian 720, we have a shower of snow going on, visibility 1800 meters right now
SK 720	TWR		Copy that, 720
TWR	SK 720	00.04	Scandinavian 720, visibility in snow is now 800 meters and runway visual range 1600 meters in all positions and measured coefficients are 34, 32, 32. Presently two millimeters of slush on runway
SK 720	TWR		Thank you very much, Scandinavian 720
SK 720	TWR	00.06	And tower, Scandinavian 720 just passed Lieto outbound
TWR	SK 720		Scandinavian 720
SK 720	TWR	00.08	(unreadable) established localizer niner miles, Scandinavian 720
TWR	SK 720		Roger, report outer marker
SK 720	TWR		Wilco, 720
SK 720	TWR	00.10	We are outer marker inbound now, Scandinavian 720
TWR	SK 720		Roger, cleared to land runway 26, wind 160 degrees 9 knots, minimum 6, maximum 12 and 100 per cent high intensity lights on

From	To	Time (local)	Transmission
SK 720	TWR		Thank you sir, and 26, Scandinavian 720
SK 720	TWR	00.11	Wind check
TWR	SK 720		160 degrees eight knots
SK 720	TWR		Lights (unreadable)
TWR	SK 720	00.12	Lights 10 per cent now
TWR	SK 720		Scandinavian 720, stand number seven
SK 720	TWR		Aaa...tower, Scandinavian 720, we went off the runway to the right because there were no braking action at all, and we are holding here now
TWR	SK 720	00.13	All right, can you explain if you need help?
SK 720	TWR		We can taxi in
TWR	SK 720		All right
TWR	SK 720		Are you out of concrete or on concrete?
SK 720	TWR		We are on the concrete now and gears are holding
TWR	SK 720		Jep
---	---	---	---
SK 720	TWR	00.15	And tower, Scandinavian 720, we also need a tractor, be towed to the apron after investigation if we have (unreadable) main gear
TWR	SK 720		All right, would you like to have Finnair mechanics to come and check it?
SK 720	TWR		Thank you

Aircraft Accident Investigation Board, Norway
HSL

APPENDIX 2

ACCIDENT INVESTIGATION BOARD
Yrjönkatu 36 A
FIN-00100 Helsinki
FINLAND

Handled by
Finn Heimdal, +47 64 84 57 80
Our date
09.03.1999
Our reference
HSL/194/99/FH
Your date
10 Februar 1999
Your reference
LN-RLT

FINAL DRAFT REPORT - LN-RLT - 30TH DECEMBER 1997

We have reviewed the draft report and find it very thorough and well written. We have no further comments to the content of the report.

Yours sincerely

Finn Heimdal

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1999-03-15

APPENDIX 3

Accident Investigation Board
Yrjönkatu 36
FIN-00100 Helsinki
FINLAND

Re Final Draft Incident Report A/C LN-RLT 30 December, 1997

Thank you for availing us the opportunity to comment on the above draft. We do not have any comments but to congratulate you to a well elaborated report.

Yours sincerely,

S-E Sigfridsson

Deputy Director General

Statens haverikommission SHK *Board of Accident Investigation*

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ILMAILULAITOS
CIVIL AVIATION ADMINISTRATION
LENTOTURVALLISUUSHALLINTO
FLIGHT SAFETY AUTHORITY

Päivämäärä Date 10.3.1999

Onro 3/02/99

APPENDIX 4

Onnettomuustutkintakeskus
Yrjönkatu 36 A
00100 Helsinki

Viite Ref Lausuntopyyntönne 10.2.1999

a Subject LENTOTURVALLISUUSHALLINNON LAUSUNTO TUTKINTASELOSTUKSEEN B 9/1997 L

Lentoturvallisuushallinnolla ei ole lausuttavaa mainitun tutkintaselostuksen luonnoksesta.

Lentoturvallisuushallinto lähettää oheisen Ilmailulaitoksen lennonvarmistus-osaston asiasta antaman lausunnon tutkintalautakunnalle tiedoksi.

Lopuksi lentoturvallisuushallinto toteaa, että mahdollisista toimenpiteistä tullaan päättämään erikseen.

Ylijohtajan po.
apulaisjohtaja Reijo Lamberg

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APPENDIX 5

COMMENTS OF SAS ACCIDENT INVESTIGATION

I thank you for our interesting meeting where we openly could discuss the draft. As to our arguments of what finally was leading to the runway excursion here are our arguments as were discussed on our meeting.

#) RUNWAY CONTAMINATION
The runway was reported covered by 2 mm of slush. According to ICAO Technical Airworthiness manual and JAR OPS this is not considered as a contamination. This observation was probably made shortly after the runway was swept. The fact that the runway was white is leading us to the conclusion that the runway was covered by wet snow, (slush with a density of 0.5 or less but still with a high content of water). According to the definition of contamination, the was covered by at least 10 mm of wet snow. A runway contaminated by 5 mm of wet snow is per ICAO definition not contaminated and would have been covered by slush and appear greyish

As we agreed upon, the reliability of the BA measurement should be considered poor under the prevailing conditions at the time of the incident. In conditions of possible hydroplaning,as in this case, the measuring speed of the friction tester is highly critical. A low speed, 65km/h, as in this case requires a friction tester tire with a lower pressure to satisfy the mathematical aquaplaning formula. Measuring BA in slush conditions at 65 km/h with a high pressure tire will probably not simulate aircraft tire aquaplaning speeds. This is particurlarly important in this case as the relative aircraft velocity was above the aircraft tire aquaplaning speed upon touch down.

#) THE FLARE AND TOUCH DOWN
We do agree with you that the aircraft was sideslipping to the right during the flare. Howevr, upon touch down a measured runway friction or BA of 34 32 32 and even 25 as reported by the preceding aircraft must be considered sufficient to stop the lateral movement of the aircraft after touch down. We believe that the sideslipping movement of the aircraft on touch down in connection with a runway friction (BA) too low to stop the lateral movement of the aircraft after touch down combined with a crosswind in excess of max allowable under the pravailing poor friction is the reason why the aircraft left the runway. It is also a possibility that the crosswind could have peaked to 12 knots during the landing maneouvre. The sideways velocity movement of the aircraft, the cornering effect on the tires, will also have reduced the effective BA even further.

We also agreed that the heading of the aircraft during the roll out and before leaving the runway was along or to the left of centerline.The aircraft tire tracks could not have appeared as skidding marks as a lateral or cornering movement would show as rolling wheel tracks.

As you mentioned, dynamic hydroplaning is a very likely cause of the poor friction and a major possible cause for the aircraft to leave the runway. Even if ground spoilers were deployed as a result of wheel spin up, we know that the wheel spin up speed as sensed by wheel rotation, is lower than the aircraft velocity which must be considered as reference speed for aircraft tire slip ratio. The hydro-mechanics phenomenon will allow the wheel to spin down and be unable to ragain a fully rotational state even after full initial wheel spin up.

If any of the statements or arguments should be clearified any further, pls let me know.

best regards
Bjørn Langnes

ILMAILULAITOS
Lennonvarmistusosasto

LAUSUNTO

10.3.1999

Dnro:

9/510/99

Lentoturvallisuushallinto

APPENDIX 6

Viite: Tutkintoselostus B 9/1997 L

VAARATILANNE TURUN LENTOASEMALLA 30.12.1997

Lennonvarmistusosasto lausuu viitteen tutkintaselostusluonnoksesta ja sen turvallisuussuosituksista seuraavaa:

1. Tutkintaselostuksen kohdassa 4 Turvallisuussuositukset alakohdassa 4.3 todetaan, että *Ilmailulaitoksen tulee huolehtia siitä, että:*

   - *lennonjohtajat sitoutuvat annettuihin normeihin ja omaksuvat ne osaksi ammattitaitoaan*

   - *lennonjohtajat asennoituvat työtehtäviinsä kansainvälisen lentoliikenteen hoitamisen edellyttämällä tavalla*

   Lennonjohtajan käsikirja määrittelee ilmaliikennepalvelun antamiseen liittyvät vastuut ja normit. Lennonjohtajan koulutusohjelmissa nämä perusarvot käydään läpi ja ne tulevat toistuvasti lennonjohtajan työuran aikana kerratuiksi. Lennonjohtajien sitoutuminen normeihin ja työtehtäviin asennoituminen on perinteisesti Suomessa ollut erittäin korkealla tasolla. Tämä on todettu myös useiden ulkopuolisten tahojen toimesta tehtyjen tutkimusten yhteydessä. Lennonjohtajien toiminnasta tehdyt johtopäätökset (22 ja 23) eivät oikeuta yleistävään kielteiseen arviointiin sitoutumisesta tai asennoitumisesta.

2. Tutkintaselostuksen mukaan sääolosuhteet näkyvyyden osin olivat tapahtumahetkellä hyvin rajoittuneet. Näkyvyys tornista ei mahdollistanut tapahtuman havaitsemista. Radiopuhelinliikenne ei myöskään tuonut esille tapahtuman vakavuutta. Päinvastoin koneen ilmoitus tilanteesta oli rauhallinen, eikä edellyttänyt erityistoimia. Koska lennonjohtaja ei voinut havaita tapahtunutta, eikä saanut lentäjiltä sellaista tietoa, joka edellyttäisi onnettomuuteen liittyviä toimepiteitä, ei hänen myöskään voida edellyttävän toimivan toisin, kuin hän tapauksen yhteydessä oli asiallisesti toiminut. Lisäksi tutkijalautakunnan tulkinta tilanteen omituisuudesta on perustelematon.

3. Tutkintaselostuksen kohdassa 2.4.1 todetaan vuorossa olleen lennonjohtajan olleen lennonjohtoyksikön päällikkö. Tällä seikalla ei pitäisi olla tutkinnan

kannalta merkitystä ja se pitäisikin tutkintaselostusten yleisten periaatteiden mukaisesti poistaa.

4. Tutkintaselostuksen kohdassa 2.4.1 esitetty väite, että lentoaseman johto ei ole järjestänyt viime vuosina lennonjohtajille ohjeita ja määryksiä sekä niiden muutoksia koskevia koulutustilaisuuksia tulisi ehdottomasti selvittää todenmukaisesti lentoaseman kanssa. Muussa tapauksessa tulisi väite poistaa tutkintaselostuksesta.

Turun lentoasema tulee antamaan lausuntonsa luonnoksesta 15.3.99 mennessä. Asiaa koskeviin kysymyksiin vastaa apulaisjohtaja Jorma Alakoski, p. 2270.

Johtaja Jussi Myllärniemi

TIEDOKSI: Turun lentoasema, Etelä-Suomen lennonvarmistuskeskus

ILMAILULAITOS
TURUN LENTOASEMA

APPENDIX 7

16.03.99

Onnettomuustutkintakeskus
Lentoturvallisuushallinto

74/72-99

viite: Onnettomuustutkintaselostus B 9/97 L

Turun lentoaseman lausunto

Turun lentoasema on tutustunut Onnettomuustutkintakeskuksen selostukseen ja kuullut lennonjohdon päälliköä asiassa. Turun lentoasema yhtyy lennonjohdon pääällikön lausunnossa esitettyihin kommentteihin.

Antero Mero, lentoaseman päällikkö

Liitteet: lennonjohdon päällikön lausunto

Tiedoksi: Myllärniemi

YL/yl

Postiosoite
PL 162
20101 Turku

puh. 02-271 4600
fax. 02-271 4699

ILMAILULAITOS
TURUN LENTOASEMA

16.03.99

Onnettomuustutkintakeskus
Lentoturvallisuushallinto

viite: Onnettomuustutkintaselostus B 9/97 L

Turun lennonjohdon päällikön lausunto

Tutustuttuani tutkijalautakunnan selostukseen, haluan tuoda esiin seuraavaa (***kursiivilla painetut kohdat ovat sitaatteja tutkijalautakunnan selostuksesta***. Muu teksti on allekirjoittaneen kommentteja kyseisiin kohtiin) :

kohta 1.15.1 sivu 14

"lennonjohto ei hälyttänyt lentoaseman pelastusyksikköä eikä aluehälytyskeskusta lentokoneen mentyä ulos kiitotieltä. Hänen olisi tullut noudattaa Turun lentoaseman pelastuspalveluohjetta vaaratilanteen edellyttämällä tavalla."

kohta 1.15.2 sivu 15

"Pelastuspalvelua ei hälytetty, mutta yksi palomies lentoaseman pelastusyksiköstä jäi oma-aloitteisesti päivystämään paloauton läheisyyteen, kunnes varmistui, että hälytystä ei anneta"

Pelastuspalveluohjeen noudattamisessa ei olisi ollut mitään epäselvää, mikäli lennonjohtajana toiminut lennonjohdon päällikkö olisi saanut tiedon koneen ajautumisesta kiitotien ulkopuolelle silloin, kun tilanne oli akuutti. Syy siihen, miksi kiitotieltä ulos ajautumista ei havaittu, on selkeästi esitetty lennonjohtajana työskennelleen lennonjohdon päällikön tapauksesta laatimassa alustavassa selvityksessä, joka on tiettävästi erikoisasiantuntijoidenkin käytössä. Siinä on kerrottu, etteivät sen paremmin lennonjohtaja, kuin omista tiloistaan laskukiitoa seurannut kunnossapidon henkilöstökään, havainneet mitään poikkeavaa koneen laskeutumisessa, vaikka molemmat yksiköt näkivätkin laskeutuvan koneen lumisateen läpi. Syy siihen oli tapahtumahetkellä suurten lumihiutaleitten aiheuttama voimakas häiritsevä "vipellys" katsojan lähikentässä sijainneessa kirkkaassa asematasovalaistuksessa pimeää taustaa vasten.

Nämä tutkinnan alkuvaiheessa esiin tuodut tekijät ovat jääneet tutkijalautakunnalta kokonaan huomioimatta.

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PL 167
20101 Turku

Mistähän palomiehelle varmistui, että hälytystä ei anneta? Se, että hälytystä ei vallitsevien tietojen perusteella annettu, ei tarkoittane, ettei hälytystä aiota suorittaa, mikäli aihetta ilmenee.

kohta 2.4.1 sivu 24, 1. kappale

"Lennonjohtoyksikön päällikkö toimi tapahtumahetkellä Turun lähilennonjohdossa lennonjohtajana. Hänen olisi tullut noudattaa Turun lentoaseman hälytyspalveluohjetta, kun lentokone meni ulos kiitotieltä, mutta hän ei hälyttänyt lentoaseman pelastusyksikköä eikä aluehälytyskeskusta"

Lennonjohtajana toiminut lennonjohtoyksikön päällikkö pitää omituisena, että erikoisasiantuntijoiksi itsekin itseään tituleeraavat tutkijat eivät käytössään olevasta aineistosta ole kyenneet päättelemään sen vertaa, ettei lennonjohtajana toiminut lennonjohdon päällikkö havainnut koneen ajautuneen kiitotien ulkopuolelle laskukiidon aikana. Vasta sen jälkeen, kun kone oli jo palannut ja pysähtynyt kiitotielle, koneen miehistö ilmoitti käväisseensä kiitotien ulkopuolella. Lennonjohdon tiedusteluun, onko kone jonkinlaisessa avun tarpeessa, miehistö vastasi kieltävästi ja ilmoitti rullaavansa asematasolle.

Koska kone näytti olevan kiitotiellä ja miehistö vahvisti niin olevankin ja ilmoitti itse rullaavansa asematasolle allekirjoittanut oletti, että kyseessä ei ollut varsinainen vaaratilanne, vaan mahdollisesti vähäinen reuna-alueen hipaisu. Parin minuutin kuluttua miehistölle tuli mielenmuutos. He pyysivät hinausapua *"just in case"* ja matkustajille kuljetusta terminaaliin. Tällöin laskeutumisesta oli kulunut jo suht. pitkä aika, eikä viitteitä vaaratilanteesta silloinkaan ilmaistu. Kunnossapidon ajoneuvot siirtyivät tällöin kiitotielle koneen lähettyville tilannetta seuraamaan. Paikalle ajoi myös Finnairin mekaanikko, joka ei myöskään aluksi ilmoittanut havainneensa mitään hälyttävää. Hinausavun pyynnön oletettiin johtuvan siitä, että kone oli rullannut niin lähelle kiitotien eteläreunaa, ettei koneen kääntäminen ilman hinausapua olisi onnistunut reunavaloja rikkomatta.

Myöhemmin, kun matkustajat oli jo siirretty terminaaliin, kävi ilmi, että kone oli kulkenut osittain kiitotien ulkopuolella suurimman osan laskukiidostaan, ja kyseessä olikin vakavampi vaaratilanne, kuin tapahtumahetkellä osattiin olettaa. Tässä vaiheessa hälytyksen antaminen olisi ollut perusteetonta.

Allekirjoittanut, keskusteli myöhemmin yöllä puhelimessa koneen miehistön nuoremman edustajan kanssa. Hän suhtautui vielä siinä vaiheessa asiaan naureskellen.

kohta 2.4.1 sivu 24, 3. kappale

Turun lennonjohtajien koulutusvastaavan lausunnon mukaan lennonjohtajat ovat perehtyneet omatoimisesti annettuihin määräyksiin ja ohjeisiin. Lentoaseman johto ei ole järjestänyt viime vuosina lennonjohtajille ohjeita ja määräyksiä sekä niiden muutoksia koskevia koulutustilaisuuksia.

Turun lentoaseman lennonjohtajille on järjestetty hälytyspalvelun kertauskoulutusta tarpeen mukaan ajoittain lennonjohtajien työpaikkakokouksissa, jotka ovat samalla koulutustilaisuuksia. Lisäksi Turun lennonjohtajat ovat osallistuneet ILL:n järjestämiin SAR-koulutustilaisuuksiin tarjonnan mukaan. Annettua koulutuksen määrää voidaan pitää riittävänä huomioiden lähilennonjohdon hälytyspalvelun periaatteiden selkeys ja yksinkertaisuus.

Kohta 3.1-8

Kiitotien jarrutustehoa ei mitattu heti laskeutumisen jälkeen...

Jarrutustehojen mittaus suoritetaan Turun lentoasemalla tavallisesti ohjeen mukaisesti siten, että sekä keski- että reunakaistat mitataan erikseen. Usein kuitenkin nopeampia mittauksia on suoritettu vain sen varmistamiseksi, onko kiitotien kunnossa tapahtunut toimenpiteitä vaativia muutoksia. Ajoittain Turun lentoaseman ajoittain vilkkaasta liikenteestä ja usein ilma-alusten miehistön pyynnöistä johtuen ei ole ollut mahdollista suorittaa mittausta täydellisenä.

Huomautettakoo, että mikäli vakava vaara olisi havaittu ajoissa ja onnettomuusvaarahälytys olisi annettu, ei kitkamaittausta olisi voitu missään nimessä suorittaa välittömästi laskeutumisen jälkeen, koska kunnossapidon henkilöstö olisi ollut sidottu hälytyksen edellyttämiin tehtäviin, joihin ei sisälly kitkan mittaus.

Kohta 4.3

Ilmailulaitoksen tulee huolehtia, että...

Molemmat turvallisuussuositukset ovat yleispäteviä ja hyviä ohjenuoria lennonjohtotyössä. Toisen suosituksen sanamuotoa tulisi hieman tarkentaa. Ei kai lausuman tarkoitus ole antaa ymmärtää, että kotimaan liikenteen hoidossa olisi löysemmät normit, kuin kansainvälisen liikenteen hoidossa.

Lennonjohdossa lennonjohtajana työskennelleen lennonjohtoyksikön päällikön lausunto onnettomuustutkintakeskuksen luonnoksesta

Edellä kerrotun perusteella näyttää siltä, että tutkijalautakunta ei ole paneutunut aiheeseen riittävällä vakavuudella, vaan näyttää suhtautuvan työhönsä ilmeisen vähätellen ja naureskellen, ja teksti haiskahtaa hieman asenteelliseltakin. Tapahtuman aikana lennonjohdossa lennonjohtajana työskennelleen lennonjohtoyksikön päällikön mainitseminen toistamiseen tekstin eri kohdissa siinä muodossa, että asianosainen on siitä kaikkien tunnistettavissa, ei varmaankaan ole rutiininomaisesti sanamuotoihin tarkkaan tarrautuvien, pilkkuja viilaamaan tottuneiden erityisasiantuntijoiden pelkkä lipsahdus, ja on siksi tuomittavaa.

Huomautettakoon, että erityiset asiantuntijat eivät ole lainkaan kuulleet allekirjoittanutta lukuun ottamatta yhtä satunnaista parin minuutin mittaista puhelinkeskustelua, jossa tapahtumien kulkua ei käsitelty. Se ei ole hyväksyttävää huomioon ottaen lautakunnan allekirjoittaneen toimintaan suuntaaman kritiikin ja sen väärät tulkinnat. Oikeusvaltion periaatteisiin kuulunee edelleenkin asianosaisten kuuleminen ennen tuomion julistamista. Senhän tietänee oikeusministeriökin.

Tutkijoiden moralisoivat huomautukset allekirjoittaneen naureskelevasta ja vähättelevästä asenteesta vakavaan vaaratilanteeseen katson asiattomiksi ja ne sallittanee jättää omaan arvoonsa. Sellaisesta asenteesta ei kohdallani ole ollut kysymys, vaan tutkijoiden jälkiviisastelusta. Olen kyllä vitsaillut tilannetta puhelinkeskustelussa Tampereen aluelennonjohdon kanssa, mutta en suinkaan olisi menetellyt niin, mikäli olisin havainnut vakavan vaaran uhanneen ilma-alusta ja sen matkustajia tilanteen ollessa akuutti. Korostan vielä kerran, että tilanteen vakavuusaste selvisi minulle niin myöhään, että siinä vaiheessa haudanvakavaksi heittäytyminen olisi osoittanut hermoheikkoutta. Vuosikausia lennonjohdossa työskennelleenä olen todennut, että syvä vakavuus ei yleensäkään leimaa lennonjohtojen työympäristöä, eikä paheksumastanne tyylistä sinänsä ole tietääkseni aiheutunut riskiä lentoturvallisuudelle. Olisiko minun tutkijoiden mielestä pitänyt alkaa itkemään? Tunnen kyllä moniakin ihmisiä, jotka ovat vakavia alinomaa, vaikka mitään vaaraa ei olisikaan tiedossa. Itse en kuulu siihen ihmisryhmään, ja toivon, että sellainen imago on sallittua edelleenkin ilmailussa?

Suosituksenі tutkijoille

Suosittelen, että onnettomuustutkintakeskus omasta puolestaan toteuttaa lausunnon kohteena olevaan tutkintakertomukseen ja ainakin tätä tapausta käsitelleen tutkijalautakunnan työskentelytapoihin seuraavat muutokset:

- Tutkintakertomuksen ne kohdat, joissa allekirjoittanut mainitaan tunnistettavasti lennonjohdossa tapahtumahetkellä työskennelleenä lennonjohtoyksikön päällikkönä on muutettava yksilön intimiteettisuojaa loukkaavina.

- Tutkijoiden moralisoivat huomautukset allekirjoittaneen asenteesta vakavaan vaaratilanteeseen on poistettava asiattomina,

- Lautakunnan kommentti siitä, että Turun lentoaseman johto ei ole järjestänyt mitään hälytyspalvelukoulutusta lennonjohtajille tulee poistaa paikkansa pitämättömänä

- Tutkijalautakunta kuulee kaikkia osapuolia, joiden toimia selostuksessa käsitellään

- Haittaa ei varmaankaan aiheuttaisi tutkijoiden herääminen huolellisempaan työskentelytapaan näin vakavien asioiden hoidossa. Epäloogiset olettamukset ja johtopäätökset ovat omiaan hämärtämään tutkinnan sinänsä hyviä päämääriä ja kyseenalaistavat tutkinnan luotettavuutta.

Erittäin kunnioittavasti

Yrjö Lähdesmäki, lennonjohdon päällikkö

YL/yl

Tiedoksi: Myllärniemi