Runway overrun, Incident involving Aircraft N-263US, 12 November 1996 at Örebro Airport, T county, Sweden

Micro-summary: **This Boeing 727 overran the end of this icy, slicky runway**

Event Date: **1996-11-12 at 1939 UTC**

Investigative Body: **Swedish Accident Investigation Board (AIB), Sweden**

Investigative Body's Web Site: **http://www.havkom.se/**

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Report C 1997:36

Incident involving Aircraft N-263US
12 November 1996 at Örebro Airport,
T county, Sweden

Case L-108/96

1997-10-29 L-108/96

Swedish Civil Aviation
Administration

601 79 NORRKÖPING

Report C 1997:36

The Swedish Board of Accident Investigation (Statens haverikommission, SHK) has investigated an incident which occurred on 12 November 1996 at Örebro airport, T county, Sweden.

In accordance with section 14 of the Ordinance on the Investigation of Accidents (1990:717) the Board submits herewith a final report of the investigation..

Olle Lundström

Monica J Wismar Henrik Elinder

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APPENDICES

1 **Not applicable in this English version**

2 **Flight recorder readout**

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Report finalised 1997-10-20

Aircraft: registration and type	**N-263US, Boeing 727-251**
Owner	Express One International Inc, 3890 West Northwest Hwy, Suite 700, Dallas, Texas 75220, USA
Time of incident	12-11-1996, 2039 hours in darkness *Note:* All times in the report are given in Swedish normal time (SNT) = UTC + 1 hour
Place	Örebro airport, T county, Sweden (pos 5914N 1503E; 187 ft (57 m) above sea level)
Type of flight	Scheduled cargo
Weather	METAR Örebro 2020 hrs: Wind 020°/10 kts, visibility 1 000 m in snow, clouds 8/8 300 ft, temp/dp ±0/±0°C, QNH 1001 hPa
Numbers on board: crew	3
passengers	-
Personal injury	None
Damage to aircraft	None
Other damage	Minor ground damage
Captain´s age and licence	33 yrs, Airline Transport Pilot´s Licence
Captain´s total flying hours	3 172 hrs, of which 1 323 hrs on the type
Copilot´s age and licence	29 yrs, Commercial Pilot´s Licence
Copilot´s total flying hours	1 500 hrs, of which 140 hrs on the type

The Board of Accident Investigation (SHK) was notified on 12 November 1996 that an incident with an aircraft registered N-263US had occurred at Örebro airport, T county, on the same day at 2039 hrs.

The incident has been investigated by the Board represented by Olof Forssberg, chairman up to 26 May 1997, Olle Lundström thereafter, Monica J Wismar, chief investigator flight operations (aviation) and Henrik Elinder, chief technical investigator (aviation).

The Board has been assisted by Max Danielsson, also representing the Swedish Civil Aviation Administration, as operational expert, and also by Baltzar Skogman as expert on airport service.

The purpose of the investigations performed by the Board of Accident Investigation is solely to prevent accidents and incidents in the future.

SUMMARY

After a flight from Arlanda airport (ESSA) the aircraft approached Örebro (ESOE) for landing. The crew received the following weather information from the TWR: Wind 020°/9 knots, visibility 1 000 m in snow, broken clouds at 4-500 ft, temp/-dewpoint ±0/±0°C, QNH 1002 hPa, friction on runway 01 ”good to medium” on

the first two thirds and ”good” on the last part. The runway friction test was performed 21 minutes before the landing.
The approach and touchdown on runway 19 were normal according to the crew. After the captain had unreversed the engines he intended to taxi to the runway end, turn around and taxi back to the terminal building. He did not, however, manage to stop the aircraft on the runway. It slid past the far runway end and stopped first after 76 m on the levelled area south of the threshold.

The incident was caused by the fact that the captain, in adverse meteorological conditions, touched down too far from the landing threshold and thereafter released the brakes too early. Contributing to the incident was the fact that the actual runway friction was lower than that reported.

During the investigation the Board of Accident Investigation has found that current regulations for measuring and reporting friction values, among other things, lack necessary requirements for maintenance and calibration of approved measuring equipment.

Recommendations

The Swedish Civil Aviation Administration is recommended

- to draw up requirements on maintenance and calibration of friction measuring equipment similar to those specified for measuring equipment and tools used in the maintenance of aircraft and air material, and

- to consider the need for the person who has performed the friction test to sign the recording slip.

1 FACTUAL INFORMATION

1.1 History of the flight

On 12 November 1996 at 2005 hrs the scheduled cargo flight BCS 2912, a Boeing 727-251 registered N-263US and belonging to Express One International Inc, took off from Stockholm/Arlanda airport (ESSA) to Örebro airport (ESOE). The captain piloted the aircraft. The flight was cleared at flight level 60 (FL60) to the Non Directional Beacon (NDB) EN immediately north of ESOE.

Approximately 15 minutes after take-off the crew called Örebro tower and received the following weather information: wind 020°/9 kts, visibility 1 000 m in snow, broken cloud at 4-500 ft, temp/dewpoint ±0/±0°C, QNH 1002 hPa, friction on runway 01 ”good to medium” on the first two thirds and ”good” on the last part. When they asked the crew received confirmation that runway 01 was in use because of the wind direction, but that it had no Instrument Landing system (ILS). The crew finally decided to use runway 19 and the aircraft was radar-vectored to an 11 NM final.

The approach and touchdown were normal according to the crew. After the captain had unreversed engines he intended to taxi to the end of the runway, turn around and taxi back to the terminal building. He did not, however, manage to stop the aircraft on the runway. It slid off the end of the runway and stopped after 76 m on the levelled area south of the threshold. The crew have stated that the actual friction of the runway seemed to be considerably lower than what had been reported before the landing.

None of the crew members were injured. The aircraft was undamaged and the day after the incident was towed back onto the tarmac.

The incident occurred in position 5914N 1503E, 187 ft (57m) above sea level.

1.2 Personal injuries

	Crew	*Passengers*	*Other*	***Total***
Fatal	-	-	-	-
Seriously injured	-	-	-	-
Slightly injured	-	-	-	-
No injuries	3	-	-	3
Total	**3**	**-**	**-**	**3**

1.3 Damage to the aircraft

None.

1.4 Other damage

Minor ground damage.

1.5 The crew

The captain was 33 years old at the time and had a valid Airline Transport Pilot´s Licence.

Flying hours, total
All types 3 172
This type 1 323
Latest PFT (periodic flight training) was performed in August 1996 on Boeing 727.

The copilot was 29 years old at the time and had a valid Commercial Pilot´s Licence.

Flying hours, total
All types 1 500
This type 140

1.6 The aircraft

Owner:	Express One International, Inc 3890 West Northwest Hwy, Suite 700 Dallas, Texas 75220, USA		
Type:	Boeing 727-251		
Serial number:	19 982		
Year of manufacture:	1969		
Gross weight:	Max. permissible 78 245 (172 500 lbs) current 57 631 (127 055 lbs)		
Centre of gravity:	Limits 9-37 % MAC, current 23,5 % MAC		
Engine manufacture:	Pratt & Whitney		
Engine model:	JT8D-7B		
Number of engines:	3		
Fuel loaded:	Jet A-1		
Aircraft flying time:	56 751 hrs		
Aircraft cycles:	46 553		
Operating time since latest periodic check:	1 hour		
Engines operating time:			
Engine #	1	2	3
Serial number	65 4497	65 4486	64 9496
Hours	41 816	41 015	52 977
Cycles	53 850	28 763	38 491

The aircraft had a valid Certificate of Airworthiness.

1.7 Meteorological information

METAR ESOE 2020 hrs:
Wind 020°/10 kts, visibility 1 000 m in snow, clouds 8/8 300 ft, temp/dewpoint ±0°/0°C , QNH 1001 hPa.

Weather information from ESOE

Time	2019	2025(approx)	2030(approx)	2035(approx
To aircraft	BCS 2912	ditto	SK 816	ditto
Wind	020°/9 kt	020°/8 kt	020°/9 kt	ditto
Visibility	1 000 m snow	1 500 m snow	1 800 m snow	ditto
Cloud	BKN[1] 4-500 ft	BKN 400 ft	ditto	ditto
Temp/dewpt	±0/±0°C	ditto	ditto	ditto
QNH	1002 hPa	l001 hPa	ditto	ditto
B/A[2] rwy 01	G/M[3],G/M,G[4]	ditto		
B/A rwy 19			G,G/M,G/M	ditto

SMHI (Statens Meteorologiska och Hydrologiska Institut)
According to SMHI the airport official measurements were well in agreement with the SMHI automatic recording at the airport.

1.8 Navigational aids

ESOE runway 19 is equipped with ILS/DME. The ILS receivers of the aircraft had initial difficulties in locking on to the signals. After the ILS antennas on the ground had been cleaned, locking occurred and an ILS approach could be performed.

1.9 Radio communications

Radio communications between the aircraft and the tower were normal. Two weather reports were transmitted to the flight according to 1.7 above.

1.10 Airport data

ESOE status according to AIP Sweden.

1.11 Flight and sound recorders

The flight recorder, P/N 980-4100-GOUS, was removed from the aircraft after the incident and sent to NTSB for decoding.

The result is graphically presented in appendix #2. Also presented is the ground speed of the aircraft, which has been derived from the longitudinal acceleration.

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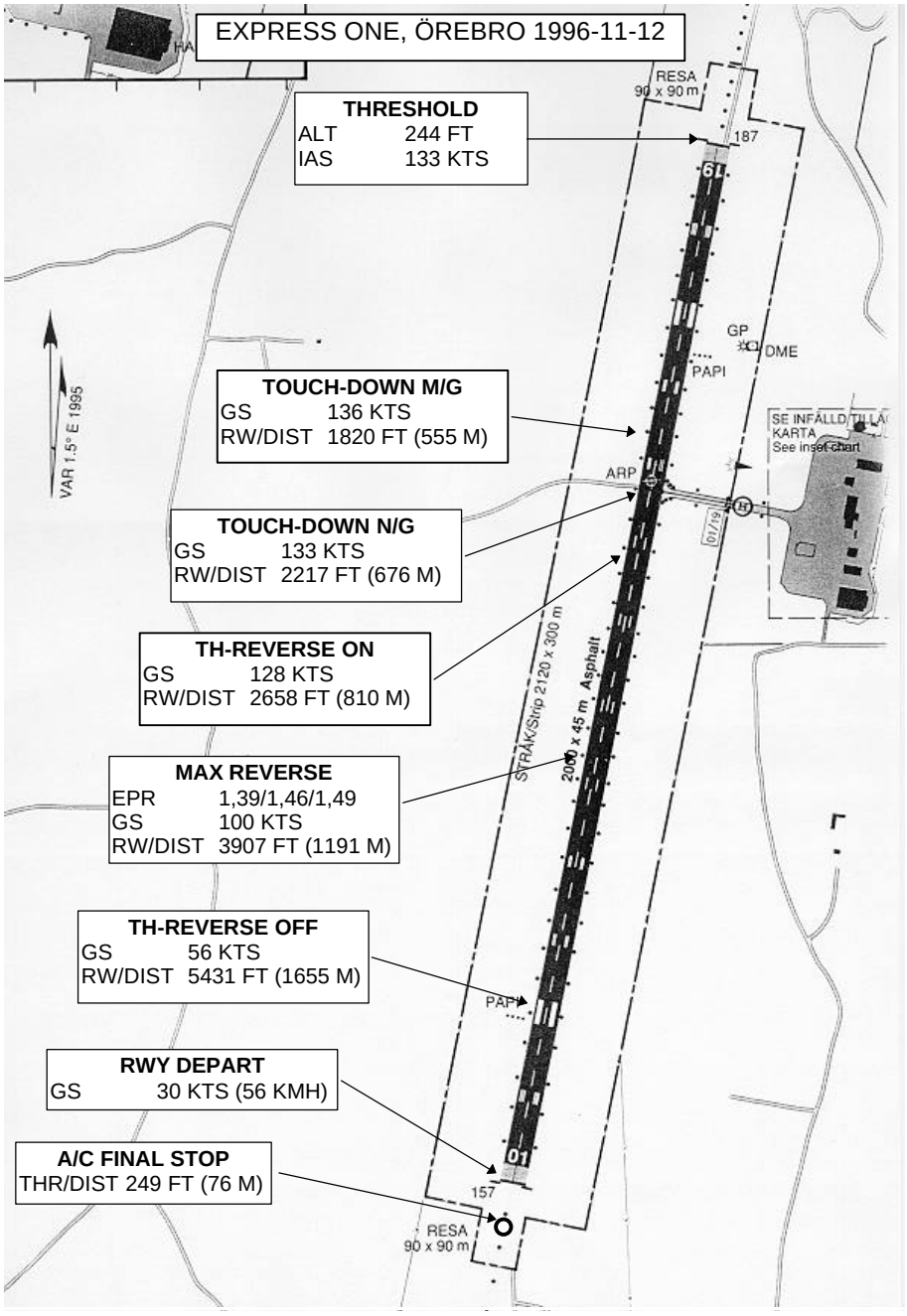
[1] Broken
[2] Braking Action
[3] Good to medium
[4] Good

In drawing below essential positions along the runway have been pointed out.



The sound recorder, P/N 93-A-100-800, contained no information from the landing due to over-cycling.

1.12 Site of incident and aircraft

1.12.1 *Site of incident*

The aircraft came to a stop 76 m beyond the end of the runway. The ground consisted of approximately 5 cm snow-covered till.

1.12.2 *The aircraft*

The aircraft was not damaged.

1.13 Medical information

Nothing indicates otherwise than that the crew were in good physical and mental condition

1.14 Fire

There was no fire.

1.15 Survival aspects

The deceleration was gentle and the ELT did not activate.

1.16 Special tests and investigations

Not applicable

1.17 The company's organisation and management

The American company Express One International Inc. Head office is located in Dallas, Texas. An operational and technical base exists in Brussels, Belgium, for the company's European activity.

1.18 Other information

1.18.1 *Runway conditions at Örebro airport*

1.18.1.1 *Snow clearance*

On the occasion there was heavy snowfall in the area and the runway was being swept continuously up to the moment the flight was about to land.

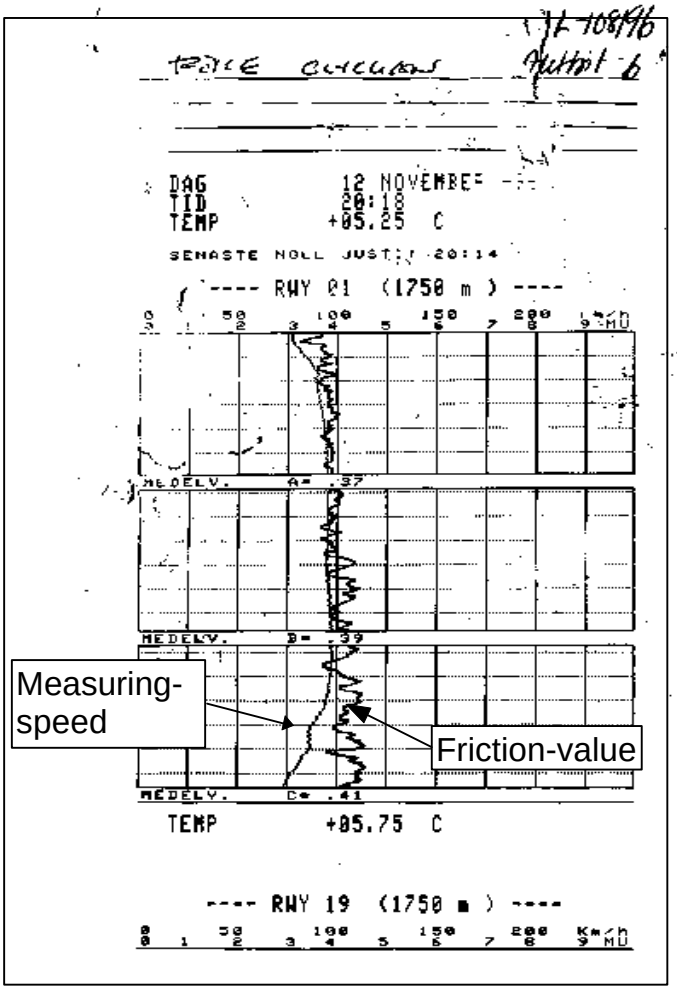
Each sweeping cycle started with two vehicles simultaneously sweeping a width of 6 m, driving along the runway centreline and moving the snow outwards toward the edges. To sweep the whole runway the vehicles had to perform three cycles, which totally took between 15 and 20 minutes. A strip of snow along each runway edge was left to be removed later by snow-thrower.

The aircraft landed shortly after the sweeping was completed.

1.18.1.2 *Measurement and reporting of runway friction*

Runway friction at Örebro airport is measured with a Skiddometer Friction Tester, BV11, towed behind a car. The last measurement before the landing in question was performed during a snowfall and was completed 21 minutes before the landing. The test run was performed in one direction, along runway 19, 5 - 8 m from the centreline. The run followed in the tracks of the snowplough vehicles at a speed slightly below 95 km/h.

The following friction values were reported to the tower: 0.37, 0.39, 0.41 corresponding to braking action ”good to medium”, ”good to medium” and ”good”. The test equipment computer was wrongly programmed and gave the result as being obtained on runway 01.



Recording slip of test before the incident (one direction)

A complete friction test on runway 19 was performed eight minutes after the incident and gave the following values: 0.36, 0.34, 0.36.

1.18.2 *Measuring and reporting of runway friction in general*

1.18.2.1 *General*

During the investigation of this incident and of similar incidents where runway conditions and friction values may have influenced the course of events, the Board has found reason to study measurement equipment and routines more closely. Several independent commercial aviation companies operating at airports coded 3 and 4 (e.g. Örebro with runway length > 1 200 m) have expressed the opinion that the reliability of reported friction values varies considerably between airports.

1.18.2.2 *Regulations*

Sections F 3.1 and 3.2 of the Swedish *Bestämmelser för Civil Luftfart* (BCL: Rules and Regulations for Aviation) include the following provisions:

- the snow clearance team leader is responsible for measuring and reporting runway friction,
- local regulations shall govern the activities,
- friction values shall be measured according to methods approved by the Aviation Safety Department of the Swedish CAA,
- friction values at airports coded 3 and 4 must be measured at least four times every 24 hours except when the friction value is certainly 0.40 or higher,
- measuring shall be performed as soon as there is reason to believe that the friction value of any section of the runway has changed more than 0.05, and
- measured values shall be reported as uncertain if obtained e.g. on a runway covered by slush and at a vehicle speed below 95 km/h.

1.18.2.3 *Equipment*

According to BCL-F2.4 and the Aviation Safety Department publication listing approved equipment (TU), the following measuring equipment is approved for use on runways coded 3 and 4: Skiddometer BV11, Surface Friction Tester and Safegate Friction Tester (the two latter are derived from SAAB Friction Tester).

All approved equipment simulates the friction values generated by an aircraft on takeoff and landing, and consist of a mechanical part and an electronic part. On the Skiddometer BV11 the mechanical part is housed in a trailer towed by a car containing the electronic equipment. Both the Surface and Safegate Friction Testers have the electronic and the mechanical parts together built into a Saab car.

SAAB Friction Tester

BV 11

The friction is measured by a wheel caused to rotate on the runway at a speed lower than that of the vehicle wheels. The resulting torque is measured and represents the friction against the runway. The result is computed and presented on a

slip (1.18.1.2) containing instantaneous values as well as mean values for the whole runway and for every third part of the runway. Before use the computer must be calibrated and programmed.

The user´s manuals contain maintenance procedures for ensuring the accuracy of the results obtained. The Board has been unable to find strict procedures laid down in BCL regarding maintenance and calibration of the test equipment.

1.18.2.4 *Measuring*

To achieve a complete metering of runway friction one run in each direction, 5 - 10 m from the centreline, is needed. The measuring speed must be at least 95 km/h over an as much as possible part of the runway length. It provided in BCL-F 3.1 that staff supervising or personally making measurements of friction shall hold a certificate of competence after completed training.

1.18.2.5 *Reporting*

Friction values are normally reported by the snow clearance crew chief by radio to the air traffic services. If a full report on the runway conditions is needed this should be in writing (”SNOTAM”). The friction value first reported shall be that for lowest-numbered runway.

1.18.2.6 *Measuring of the friction value in practice*

The Board has noted the following:

- The main airports have special staff with friction measuring as a main task and who are well trained for this. At smaller airports the measuring staff divide their time between different tasks. This may sometimes lead to a situation when measuring cannot be performed before an estimated landing - even though the weather requires this - because the person responsible for this is also responsible for baggage handling.
- There are cases where personnel are obviously are not qualified for the task. Measuring is performed in a faulty manner, the result is wrongly interpreted, the result is not reported correctly, important and supplementary runway information is not reported etc.
- There are great variations in the status of maintenance and calibration of the measuring equipment.

2 ANALYSIS

2.1 The runway condition

The friction report given to the aircraft was based on a test performed 21 minutes before the landing, near the centreline and along a section that had just been swept. As the heavy snowfall persisted during the continued cleaning, which was terminated just before the landing, the real friction values must have been lower than those reported. This was also confirmed 8 minutes after the landing when it was found that the friction values had deteriorated by 0.01 on the first third and by 0.05 on the last two thirds of the active runway.

Also, the test before the landing was performed only in one direction and at an average speed below the recommended 95 km/h, which rendered the test result less reliable.

It must have been obvious to the snow clearing team chief and to the air traffic controller that the friction values at the time of touchdown would be lower than

those reported. According to BCL-F 3.2 the values given should therefore have been reported as ”unreliable” and additional information about the actual conditions given.

Runway friction values shall be given starting with the first third of the runway with the lowest designation. The air traffic controller thus understood the reported values given to him as being for runway 01 - not 19 - and forwarded this to the aircraft. It is difficult to judge if this circumstance had any influence on the course of events.

2.2 The incident

The crew chose runway 19 with 8 knots tailwind which was reasonable considering the lack of ILS on the opposite runway. The ILS approach seemed normal according to the flight recorder and the Board’s appraisal. The touchdown, however,was 250 m beyond the normal touchdown zone. The tailwind may have contributed to this.

The captain used reversing and wheel braking normally down to a ground speed of 56 kts (103 km/h) at which speed he unreversed only 345 m remained of the runway length. The captain has stated that braking was normal until the speed had been reduced to taxiing speed and that he thereafter intended to continue to the runway end to turn around there. The ground speed when the aircraft skidded off the runway was 30 kts(56 km/h), however, which indicates that the captain underestimated the ground speed and unreversed the engines and released the brakes too early. Contributing to this misjudgement may have been a visual perception of low ground speed due to the snowflakes moving in the same direction due to the tailwind.

When the captain was to perform the final braking before the 180° turn at the end of the runway, the ground speed was thus too high in relation to the actual runway friction. The main wheels lost their grip and the aircraft skidded uncontrollably over the runway and additionally 76 m into the overrun area.

Had the crew been aware that the runway was snow-covered and that the reported friction values should be regarded as uncertain, the captain may have been more aware of the risk of being unable to brake effectively and may consequently have used another landing technique.

2.3 Equipment and routines for measuring friction

2.3.1 *General*

Correct information about runway friction and other runway conditions is of great importance for aircrews. The information may be vital in deciding whether or how a takeoff or landing should be performed. An over-optimistic report may end up with a takeoff or landing not being cancelled in time or being performed in an unsuitable manner, with an incident or accident as a consequence.

2.3.2 *Method/equipment*

BCL-F 2.4 and BCL-F 3.1 and 3.2 clearly state responsibility, methods, equipment, reporting routines etc. for measuring and reporting runway friction.

However the Board has been unable to find sufficiently strict rules regarding maintenance and calibration of the approved measuring equipment. This equipment is complicated and a prerequisite for reliable test results is a qualified staff to perform the maintenance and calibration following the manufacturer's instructions.

As possible sources of error can be mentioned:
- Mechanical wear, loose and sticking movable parts
- Wrong diameter/air pressure in the metering wheel
- Wrong quality/temperature of the metering wheel
- Wrong metering wheel pressure on the runway
- Faulty torque metering system
- Faulty zero reset
- Computer fault

Considering the important flight safety impact of correct friction values, the Board therefore considers that the Civil Aviation Administration should lay down similar and specified requirements for the maintenance and calibration of friction measuring equipment as are specified for measuring equipment and tools used in aircraft and air material maintenance.

This requires:
- Qualified staff
- Special tools
- Calibration equipment
- Technical documentation
- Systems for following-up of maintenance and calibration.

Regarding the incident which is the subject of this report, nothing has been found to indicate that a fault in the measuring equipment at Örebro airport influenced the course of events.

2.3.3 *Measurement of runway friction in practice*

The Board is aware that great differences may exist between the country's airports in terms of routines for friction metering. It has nevertheless tried to form an opinion of how the work is performed in practice. The findings in 1.18.2.6 give the Board reason to believe that the differing accuracy of the measurements may also be because the measuring of runway friction does not always receive the priority demanded by this qualified measuring operation. One impression is that the task is sometimes has the same status as runway snowploughing, sweeping etc., which the Board considers an unsatisfactory state of affairs. One way to raise the sense of responsibility for the task may be to require that all test slips be signed by the person who has taken the measurements.

To sum up: it should be a self-evident requirement that the reliability of reported friction values and runway condition is equally good for all airports coded 3 and 4 and having regular commercial air traffic.

3 CONCLUSIONS

3.1 Findings

a) The crew were qualified to perform the flight.
b) The aircraft was airworthy.
c) The landing was performed in tailwind.
d) The aircraft touched down slightly more than 250 m beyond the touchdown zone.
e) The friction values were not measured according to the rules laid down in BCL.
f) The friction values on the runway were lower than what was reported before the landing of the flight.
g) The ground speed of the aircraft at the end of the runway was 30 kts (56 km/h).
h) There were deficiencies concerning reporting of runway condition and friction value.

3.2 Causes of the incident

The incident was caused by the fact that the captain, in adverse meteorological conditions, touched down too far from the landing threshold and thereafter released the brakes too early. Contributing to the incident was the fact that the actual runway friction was lower than that reported.

4 RECOMMENDATIONS

The Swedish Civil Aviation Administration is recommended

- to draw up requirements on maintenance and calibration of friction measuring equipment similar to those specified for measuring equipment and tools used in the maintenance of aircraft and air material, and

- to consider the need for the person who has performed the friction test to sign the recording slip.