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Report RL 2000:18e

Aircraft accident to SE-DYB
at the Östersund/Frösön F4 Airport,
Z county, Sweden,
on 03 September 1999

Case L-85/99

SHK investigates accidents and incidents with regard to safety. The sole objective of the investigations is the prevention of similar occurrences in the future. It is not the purpose of this activity to apportion blame or liability.

The report is also available on our Web site: www.havkom.se

Translated by Bob Arnesen

From the original Swedish report at the request of the Board of Accident Investigation. In case of discrepancies between the English and the Swedish texts, the Swedish text is to be considered the authoritative version.

2000-05-26 L-85/99

Swedish Civil Aviation Administration

601 79 NORRKÖPING

Report RL 2000: 18e

The Board of Accident Investigation (Statens haverikommission, SHK) has investigated an aircraft accident that occurred on 03 September 1999 at the Östersund/Frösön F4 airport, Z county, Sweden, involving an aircraft with registration SE-DYB.

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

Olle Lundström

Monica J Wismar Henrik Elinder

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APPENDICES

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Aircraft: registration, type		**SE-DYB,** Dassault Mystere Falcon 10
Class/airworthiness		Normal, airworthy
Owner/Operator		Andersson Business Jet AB, Vetevägen 16, 187 69 Täby
Date and time		1999-09-03, 1712 hours in daylight *Note*: All times in the report in Swedish summer time (SST) = UTC + 2 hours
Place of occurrence		Östersund/Frösön F4 airport, Z county, (pos 6311N 1430E, 376 m above sea level)
Type of flight		Non scheduled flight/ Private Charter
Weather		Actual Weather as reported at 1705 hours: Wind 220° at 30 km/h, Visibility more than 10 km, High clouds only (CAVOK), temperature 23° C/dewpoint 13° C, QNH 1007 hPa
Persons on board:	*crew*	2
	passengers	4
Injuries to persons		None
Damage to aircraft		Substantially damaged
Other damage		None
Commander:		
age, certificate		54 years, Air Transport Pilot Licence (ATPL)
total flying time		7441 hours, of which 675 hours on type
flying hours previous 90 days		129 hours , all on type
number of landings previous 90 days		83 , all on type
Co-pilot:		
age, certificate		31 years, Commercial with instrument rating (I/R)
total flying time		1616 hours, of which 1173 hours on type
flying hours previous 90 days		89 hours, all on type
number of landings previous 90 days		69 , all on type

The Board of Accident Investigation (SHK) was notified on 03 September 1999 that an aircraft with registration SE-DYB had had an accident at 1712 hrs that day at the Östersund/Frösön F4 airport, Z county, Sweden.

The accident has been investigated by SHK represented by Olle Lundström, Chairman, Monica J Wismar, Chief investigator flight operations and Henrik Elinder, Chief technical investigator aviation.

The Board was assisted by Leif Wahlund as operational expert.

The investigation was followed by Max Danielsson, from the Swedish Civil Aviation Administration (Luftfartsverket/LFV).

Summary

The aircraft departed the Stockholm/Bromma airport for a flight to the Östersund/Frösön F4 airport. The co-pilot was the flying pilot. As the aircraft approached Östersund the crew was cleared to continue directly towards the airport to carry out a visual approach to runway 30.

The tower reported the surface wind to be 220 degrees at 23 knots (approx. 42 km/h) and then gave them landing clearance.

The crew experienced considerable turbulence on final and noted on their instruments that the wind was from the south-west at 50 knots. The wind decreased as they approached the threshold however the turbulence persisted. At touchdown the aircraft bounced and the co-pilot pushed the control column forward to lower the nose. At about the same time the aircraft began to roll to the right causing the co-pilot to correct with a left aileron. The commander felt that the aircraft bounced once again but this time only on the right main gear. The aircraft started to roll abruptly to the left and when it then touched down on the left main gear the crew experienced that the aircraft also began to swerve to the left. The commander, who was now also on the controls, extended the airbrakes at this time.

When the crew disembarked the aircraft after parking at the terminal they observed that the left wing tip and aileron had received substantial damage through contact with the runway during landing.

The accident was caused by the flying pilot not beeing able to correct for the strong and gusty crosswind and turbulence associated with the landing and touchdown. A contributing factor can be that the air brakes were extended when the aircraft was not on the ground.

Recommendations

It is recommended that the Swedish CAA, in addition to the present rules for reporting the landing wind, consider implementing a system for reporting wind variations that are less than ± 10 knots, but at the same time can be considered significant enough for the pilot to be made aware of. *(RL 2000:18 R1)*

1 FACTUAL INFORMATION

1.1 History of the flight

The aircraft departed the Stockholm/Bromma airport for a flight to the Östersund/Frösön F4 airport. The co-pilot was the flying pilot. As the aircraft approached Östersund the commander contacted Frösö control and received clearance to descend to Flight Level (FL) 70 (approx. 2150 meters height), to continue towards the airports VOR/DME[1]- navigational aid, identified as OSS, and to expect a visual approach to runway 30. The actual weather at the airport was reported as : Wind 220 degrees at 30 km/h (approx. 13 Kt), CAVOK[2], temperature 23° C, dewpoint 13° C, air pressure 1007 hPa. Shortly thereafter the aircraft was instructed to descend to 4000 ft (approx. 1200 m)

During the approach the pilots discussed the reported wind in relation to the runway direction and that the runway threshold was displaced (see appendix 2). They determined that the crosswind would be 80 degrees off to the left. They increased the Vref[3]- speed by 8 knots to 127 knots. They later reported that they had the field in sight and were cleared by Frösön tower to carry out a visual approach to runway 30. The wind was reported as being 220° at 23 knots when they were cleared to land.

The crew experienced considerable turbulence on final and noted on their instruments that the wind was from the south-west at 50 knots. The wind decreased as they approached the runway threshold but the turbulence persisted. The aircraft bounced upon landing and the co-pilot pushed the control column forward to lower the aircraft nose. At the same time the aircraft began to roll to the right causing him to apply left aileron to correct. The commander felt that the aircraft bounced once again, this time on the right main gear. The aircraft then started to roll abruptly to the left. When it touched down again on the left main gear the pilots felt the aircraft swerve to the left. The commander, who was now helping on the controls, extended the airbrakes (see 1.6.2) and was then given control of the aircraft by the co-pilot.

The pilots felt that the whole sequence of events on touch down happened very quickly and were unsure about what exactly happened. After disembarking the aircraft at the terminal they observed that the left wing tip and aileron had been substantially damaged through contact with the runway.

The accident occurred at position 6311N 1430E; 376 m above sea level.

1.2 Injuries to persons

	Crew	*Passengers*	*Others*	*Total*
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	–	–	–	–
None	2	4	–	6
Total	2	4	–	6

[1] VOR/DME – Very high frequency Omnidirectional Radio range/ Distance measuring equipment

[2] CAVOK – Visibility more than 10 km, no clouds below 5000 ft., no thunderstorms within 15 km or other weather within 8 km of the airport

[3] Vref – Minimum speed when crossing over runway threshold

1.3 Damage to aircraft

Substantially damaged.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 Commander

The commander was 54 years old at the time and had a valid ATPL Licence.

Flying hours previous	*24 hours*	*90 days*	*Total*
All types	3	129	7441
This type	3	129	675

Number of landings this type previous 90 days: 83.
Flight training on type concluded in march 1998.
Latest periodic flight training (PFT) carried out in 1999-02-18 on Dassault Mystere Falcon 10.

1.5.2 Co-pilot

The co-pilot was 31 years old at the time and had a valid Commercial Licence with an instrument rating.

Flying hours previous	*24 hours*	*90 days*	*Total*
All types	3	89	1616
This type	3	89	1173

Number of landings this type previous 90 days: 69.
Flight training on type concluded in July 1996.
Latest PFT carried out in 1999-04-28 on Dassault Mystere Falcon 10.

1.5.3 Pilots previous schedule

During the week prior to the accident the pilots had had the following schedule:

1999-08-28	Free
1999-08-29	Free
1999-08-30	Free
1999-08-31	7 hours and 30 minutes
1999-09-01	Stand-by
1999-09-02	8 hours and 30 minutes
1999-09-03	3 hours and 30 minutes

1.6 Aircraft information

1.6.1 General

AIRCRAFT:

Manufacturer:	Dassault
Type:	Falcon 10
Serial number:	216
Year of manufacture:	1988
Gross weight:	Max authorised landing weight 17640 lbs., actual landing weight 17280 lbs.
Centre of gravity:	Within limits
Total flying time:	2416 hrs
Number of cycles:	2597
Flying time since latest inspection:	30 hrs
Fuel loaded before event:	Jet A1

ENGINE:

Manufacture:	Garret	
Model:	TFE 731#2-K	
Number of engines:	2	
	No 1	*No 2*
Total operating time, hrs	2416	2416
Cycles after overhaul	2597	2597

The aircraft is a low wing type and the wingtip height above ground with the aircraft standing on the undercarriage is approximately one meter.

The aircraft had a valid Certificate of Airworthiness.

1.6.2 Airbrakes

The aircraft type is equipped with four hydraulically operated airbrakes, two on the upper surface of each wing (inboard and outboard airbrakes respectively). They are activated from the cockpit through a handle on the centre console between the pilots. According to the manufacturer the time required to extend and retract the airbrakes is:

	Extend	Retract
Inboard Airbrakes	3.0 ± 0.2 seconds	5.2 ± 0.2 seconds
Outboard Airbrakes	2.8 ± 0.1 seconds	5.2 ± 0.2 seconds

1.7 Meteorological information

At the time of the accident a large low pressure area over the Norwegian Sea gave strong south-westerly winds over much of northern Sweden.

The actual weather reported at the Östersund/Frösön F4 airport at 1720 hrs.: Wind 220° 17 knots, no gusts, visibility more than 10 km, temperature 24° C, dewpoint 13° C, Qnh 1007 hPa.

The wind for runway 12 was registered as follows:

Time	Direction	Average velocity/2 minutes	Average velocity/ 5 seconds
1610	205 degrees	19 knots	21 knots
1620	210	17	19
1630	205	15	17
1640	215	18	17
1650	212	18	21
1700	228	17	20
1710	222	19	17
1720	222	18	16
1730	225	19	20
1740	215	20	20
1750	208	21	19
1800	205	22	18

The instrument used to measure the wind for runway 30 was at the time unserviceable due to the construction work in progress on the first part of the runway. The pilots were not informed of this fact.

According to the airport meteorologist the wind direction and velocity experienced that day was very unusual, due to the position of the Ovik Mountains, with the wind generally blowing more from the west or the south. The wind can also increase in strength as it passes between hilltops and hangars (see 1.10), giving gusts with changes in both direction and velocity. At the time of the accident construction work had been in progress during a shorter period on the first part of runway 30. This left the wind registering equipment unserviceable and the meteorologist unable to determine how the actual wind conditions affected aircraft landing at the displaced threshold. It was well known that downdrafts near the threshold of runway 12 could occur do to a house situated to the south of the runway.

1.8 Aids to navigation

The aircraft was equipped for instrument flight. Runway 30 is normally equipped with ILS[4], VOR and NDB[5], however the ILS was turned off due to the construction work. The approach was done under VMC[6].

1.9 Communications

The communication between the pilots and Air Traffic Control was normal (see appendix 3).

1.10 Aerodrome information

All airport information was contained in the Air Information Publication (AIP) for Sweden. As previously stated there was at the time construction

[4] ILS – Instrument Landing System
[5] NDB – Non Directional Beacon
[6] VMC – Visual Meteorological Conditions

work in progress on the first part of runway 30, leaving 1800 meters of available runway. Runway 30 has a 0.5 % downward slope.
South-west of runway 30 there is first a 50 meter high ridge covered with trees and then at about midpoint an area with several military hangars. Between these two features there is an open space (see appendix 2).

1.11 Flight recorders

1.11.1 Flight Data Recorder (FDR)

The aircraft was equipped with an F800 FDR, P/N 17M703-274 and S/N 5173. It was sent to Scandinavian Avionics A/S after the accident for analysis of the available data. The FDR had a capacity for registering 10 parameters at a rate of one reading per second. For some unknown reason the only data made available on the readout was speed (IAS), altitude (ALT) and heading (HDG). Analysis of the readout has been limited due to the poor precision between recording intervals. The readout however does support the crews statements concerning turbulence on final and that the aircraft did swerve abruptly to the left a few seconds after the first contact with the runway.

1.11.2 Cockpit Voice Recorder (CVR)

The aircraft was equipped with an AV557C CVR, P/N 980-6005-076 and S/N 9946. It was sent to Muirhead Avionics in England for play back. The CVR records on three channels, one for each of the pilots plus a third area microphone, centrally located in the cockpit, that picks up all the surrounding sound. The CVR tape had 33 minutes of recorded data, of which 16 minutes were from a time after the accident, when the aircraft power was later reapplied. The company has since implemented a new policy of pulling the circuit breaker for the CVR after landing when a significant event has occurred. As the tape only has approximately 30 minute capacity this procedure eliminates the risk for accidentally erasing valuable information after the fact.

A copy of the play back tape was sent to Magnic AB in Sweden for readout and analysis. A transcription was made of the pilots conversation (see appendix 3) and a diagram was also done, showing when conversation was made in relation to time during the course of events (se appendix 4).

It is evident from the information contained in the appendixes that the sequence of events during the landing happened quite quickly and took the pilots by surprise. Time "zero" has been set to when the aircraft first contacted the runway. About 1.7 seconds later the co-pilot is heard to remark "Jesus". At about 3.6 seconds a clicking sound is heard (see 1.11.3), that in all probability is the airbrakes handle being applied to extend them. At the same time the commander says "I'm extending these", where after the co-pilot replies "Yah, do that" at 4.5 seconds.

Between 6 and 10 seconds after first contact with the runway sound is heard resembling six different touchdowns. This could very well indicate a significant bounce from 0 to 6 seconds, followed by a number of smaller ones afterwards. It is possible that contact was made after 4 seconds however the sound is hard to hear due to other sources interfering. Correct interpretation of the sound is uncertain as it can not be heard on the reference recording (se 1.11.3). After about 8 seconds the co-pilot remarks "Jesus! What happened" and at about 10 seconds says "Your controls" whereby the commander replies "My controls".

It has been difficult to determine when the wingtip made contact with the runway as no sound from the wing contacting the runway has been recorded.

1.11.3 Additional reference information

In an effort to be able to better identify the different sounds heard on the CVR tape, a recording was made at a later date on the same type of aircraft where different cockpit sounds where recorded and then later used as a comparison.

1.12 Accident site and aircraft wreckage

1.12.1 Accident site

Runway 30 at the Östersund/Frösön F4 airport.

1.12.2 Aircraft wreckage

The aircraft sustained damage to the left wingtip, the left aileron and the leading edge slat.

1.13 Medical information

Nothing indicates that the mental and physical condition of the crew had been impaired before or during the flight.

1.14 Fire

There was no fire.

1.15 Survival aspects

The Emergency Locator Transmitter (ELT) of type Dorne Marboline DMN 8.1 was not activated in the accident.

1.16 Tests and research

After the accident a check was performed on the aircraft's flight controls, flaps, slats and airbrakes and nothing out of the ordinary was observed. The following observation times were measured for the airbrakes:

	Extension	Retraction
Inboard airbrakes L/R	3/3 seconds	6/6 seconds
Outboard airbrakes L/R	3/3 seconds	6/6 seconds

All these systems where also later checked during flight and nothing unusual was found.

1.17 Organisational and management information

1.17.1 General

The company is certified to perform commercial flights on a non-regular basis. The company is registered in Stockholm and has its base at the Stockholm/Bromma airport. The company operate three Falcon 10 aircraft and had eight permanently employed pilots.

1.17.2 Flight Operations Manual (FOM)

Chapter 6.4 of the FOM covers the use of checklists and standard phraseology to be used onboard. Amongst other things all checklists shall be read out loud. Checklist items shall first be carried out and then confirmed properly performed in a challenge-and-response fashion. To avoid any misunderstanding English is used in all operation of the aircraft using standard terminology. It is stated in chapter 7.1 that Swedish may be used during radio transmissions to the air traffic controllers at Swedish military bases.

1.17.3 Aircraft Flight Manual (AFM)

In chapter 6 of the AFM reference is made to how the Threshold speed Vref shall be corrected for the winds speed, direction and gusts. The calculated Vref of 119 knots shall be corrected upwards with half the headwind component and the whole gust component, up to a maximum correction of 20 knots.

1.17.4 Operational Instruction Manual (OIM)

In the manufacturers OIM it is stated regarding the use of airbrakes:
"After touch down, airbrakes ..... EXT".
"Extend the airbrakes after contact with the runway and as soon as the nose wheel has touched down".

The Falcon 10's maximum demonstrated crosswind component for landing on a dry runway is 25 knots.

1.17.5 Transition and Recurrent Training

Transition training for company pilots on Falcon 10 is performed on a simulator at Simuflite in the USA. PFT's are performed in the simulator every second year for commanders and every fourth year for co-pilots. These PFT's are also done at Simuflite in the USA, using Simuflites own personnel and internal checklists. These PFT's are seldom done with two pilots from the company at the same time. All other PFT's are done in the aircraft.

1.18 Additional information

1.18.1 Crosswind landings

There are generally speaking two methods to compensate for a crosswind on landing. The first method is called "crabbing", where on final approach the nose of the aircraft is pointed just enough into the crosswind to keep the aircraft flying on the runway centreline. Just prior to landing the nose and undercarriage are lined up with the centreline using rudder and opposite

aileron is applied into the wind to prevent lateral drift. The second method is to apply the correction used just prior to landing, mentioned in the first method, at an early stage during the final approach, using aileron to lean into the wind and opposite rudder to counteract the turn. This early correction is held all the way to touch down.

During a crosswind landing the pilot must also consider the presence of both vertical and horizontal changes in the wind. The greater these changes are the greater the demands placed on the pilot to successfully make a smooth and controlled landing or avoid dragging a wingtip on the runway.

1.18.2 Wind measurement and reporting at airports

The wind at an airport is affected by several factors such as local topography, the terrain and its relative position to the runway. An airport situated in the middle of an open field experiences winds quite different from one that is surrounded by hilly terrain, forest and large trees. Larger airports often have wind measuring equipment at several points along the runway for just this reason. The measurements are usually taken at a height of about six to ten meters above ground

The average period for a wind observation is two minutes. Temporary changes are reported to the pilot if the total variation in wind direction is more than 60 degrees and /or the wind velocity varies more than 10 knots from the average value over a ten minute period.

According to the regulations governing Air Traffic Control Services, section O chapter 2.5.2, an air traffic controller shall normally use the unit knots to report wind velocity to civilian aircraft. If the wind information is taken from a QAM[7] or a MET REPORT[8], the units used in the report shall be relayed. Conversion is only done at the request of the pilot.

The pilot determines which language is to be used at a military aerodrome when making his first contact with ATC. The weather given upon initial contact will be from a QAM and the wind velocity will be reported in km/h. During the approach and landing the wind will be reported in knots as it is read directly from his instrument in the tower.

1.18.3 Crew Resource Management (CRM)

During the investigation of accidents and incidents around the world in the past years, poor co-operation and communication between crew members has been found to be a major cause or a contributing factor. This has given rise to programs to improve these deficiencies, better known as Crew Resource Management or CRM.

CRM promotes the optimum use of all available crew resources to achieve maximum safety, effectiveness and comfort. In CRM emphasis is placed on achieving good communication between crewmembers and creating a co-operative "team" atmosphere, both in and out of the aircraft.

A large number of airlines around the world educate their crews in the effective use of CRM. Training is normally carried out by attending an introductory course, later followed by recurrent CRM training in connection with periodic flight training.

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[7] QAM – Military meteorological report – actual weather
[8] MET REPORT – Civil Meteorological report – actual weather

2 ANALYSIS

2.1 The Approach

The flight from Stockholm was routine and the weather permitted a visual approach and landing. During the approach the surface wind was reported to be 220 degrees at 30 km/h and the pilots discussed both the advantages and disadvantages of landing on runway 30. They were aware of the fact that the landing would take place in a very strong crosswind and that the runway sloped downwards. The commander therefore even considered landing on runway 12. Based on the CVR-readout the discussion of runway choice was unstructured and did not contain any standard phraseology. The use of checklists seems to have been sporadic.

These departures from standard procedure can have contributed to the improper correction of the final Vref speed for wind prior to landing. The latest reported wind was 220 degrees at 23 knots with no gusts. This meant that the wind was 80 degrees off the runway, which gives a headwind component of 4 knots and a crosswind component of 22.5 knots. The Vref speed should have been in this case increased by 2 knots to 121 knots. The pilots chose to increase by 8 knots but it is unsure if this played any part in the sequence of events.

It is unfortunate that the pilots received a wind, first reported in km/h during the approach, and then later in knots on final. This can in all likelihood cause planning mistakes to be made.

As stated above the wind was reported as 220 degrees at 23 knots when the flight was on final. After landing it had changed to 220 degrees at 17 knots, which would support the pilots view that there were great variations in the wind. They also reported to the tower after landing, "Yeah tower, as you saw there was quite a bit of turbulence across the runway over there, so please warn other aircraft".

In accordance with existing regulations wind variations that are less than ±10 knots from the average wind over a ten minute period are not reported. This means that the momentary wind can vary between 1 and 19 knots, if the average wind is 10 knots and not reported as gusting. In this case the pilots would have been helped if variations had been reported, even if they officially could not be classed as gusts. The evidence would support the idea of instituting a procedure for reporting wind variations that are less than ±10 knots from the average but can be considered significant enough to pass on to landing aircraft.

As shown in 1.18.2 regarding wind measurement and reporting, there are a number considerations a crew must look at during takeoff and landing, such as the type of report, when the measurement was made, the location for the measuring equipment, the effect of surrounding terrain, etc. In this case there were several unfortunate circumstances. The wind was blowing from the left, almost ninety degrees off. On the left side of the runway there was first a 50 meter high ridge, followed by an open space and then a number of hangars. It is very possible that mechanical turbulence existed in the leeward side of these obstacles on the left hand side, resulting in great variations in wind velocity and direction across the runway.

2.2 The landing

As indicated in paragraph 2.1 the conditions existing prior to touch down were not so favourable. The CVR-readout supports the pilots statement that the aircraft bounced on the first contact with the runway and then swerved

to the left. The landing sequence for several seconds after that was dramatic and somewhat uncontrolled. The air brakes were extended 3.6 seconds after the first runway contact. The readout has not been able to determine if this was done while the aircraft was in the air after the first bounce or on the ground after a new bounce. It is still uncertain at what point the aircraft wingtip actually came in contact with the runway, however most of the evidence indicates that this occurred between 4 and 9 seconds after the first contact, as the aircraft successively touched firmly on the runway. During this sequence the co-pilot also gave the commander the control of the aircraft.

No technical fault has been found with the aircraft, other than a very small deviation from the manufacturers prescribed extend and retract times for the air brakes, which can be considered to have played no part in the outcome. It is evident that both pilots were surprised by the initial bounce and later swerving of the aircraft upon touch down. Much of the evidence points to a combination of wind variation and it's associated turbulence and manoeuvring of the aircraft as the most probable cause for the accident. As the distance between the wingtip and the ground on the actual type is only about one meter there is little margin for corrections in the roll plane. If the air brakes were extended while airborne then this can also have contributed to the outcome.

Taking into consideration that the aircraft is sensitive to gusty cross-winds during takeoff and landing and that it is of the utmost importance that the air brakes be extended when the aircraft is on the ground, these facts should be reviewed during transition training and during PFT's.

2.3 Operational procedures

SHK has found after reviewing the CVR-readout that the crew did not follow company procedures for the use of checklists and phraseology as laid down in the FOM. This is surprising considering the level of commercial transport the company is engaged in and how basic these procedures are for maintaining a high level of safety.

The readout also indicates that the crew only had one set of landing charts for the Östersund airport onboard. This can be seen as inadequate as a two-pilot system is built on the one pilot flying and the other assisting, necessitating both pilots having correct and immediate access to all information in front of them about an approach or departure.

In a small airline with so few pilots employed and who regularly fly with each other, there is always a risk for familiarity with colleagues leading to complacency. A significant contributing factor is that the transition training and certain PFT's are performed not using the company's own procedures and checklists, and that PFT's performed in the simulator are seldom done with two pilots from the company at the same time. It becomes evident that all these aspects together have a negative effect on the level of daily CRM-training, which is essential to keep operations on a high level of safety. In the end it is the Chief Pilot who must ensure that the company's established procedures are followed.

3 CONCLUSIONS

3.1 Findings

a) The pilots were qualified to perform the flight.
b) The aircraft had a valid Certificate of Airworthiness.
c) No technical fault affecting the outcome of the accident was found.
d) The threshold for runway 30 was displaced 500 meters.
e) The wind measuring equipment for runway 30 was unserviceable.
f) The landing was performed in a turbulent crosswind.
g) The correction for wind to the Vref speed made by the pilots was incorrect.
h) Deviations were made from company procedure concerning the use of checklists and phraseology.
i) Only one set of landing charts was available onboard.

3.2 Causes

The accident was caused by the flying pilot not beeing able to correct for the strong and gusty crosswind and turbulence associated with the landing and touchdown. A contributing factor can be that the air brakes were extended when the aircraft was not on the ground.

4 RECOMMENDATIONS

It is recommended that the Swedish CAA , as a complement to established procedure, consider the possibility of implementing a system for reporting wind variations that are less than ±10 knots from the average wind, but at the same time can be considered significant enough to inform the pilot about. *(RL 2000:18 R1)*