Aircraft incident to LN-RLF at the Växjö/Kronoberg airport, G County, Sweden On June 23, 1999

Micro-summary: **An omission of arming the spoilers results in anti-skid failure and a runway overrun.**

Event Date: **1999-06-23 at 1655 UTC**

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

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

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Report RL 2000:38e

Aircraft incident to LN-RLF
At the Växjö/Kronoberg airport,
G County, Sweden
On June 23, 1999

Case L54/99

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

Translated by Bob Arnesen.

From the original Swedish 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.

F20 Rapport L_eng

2000-11-02 L-54/99

Swedish Civil Aviation Administration

601 79 NORRKÖPING

Report RL 2000: 38e

The Board of Accident Investigation (Statens haverikommission, SHK) has investigated an aircraft incident that occurred on June 23 1999 at the Växjö/Kronoberg airport, G County, Sweden, involving an aircraft with registration LN-RLF.

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

Rune Lundin Henrik Elinder

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Report RL 2000:38e

L-54/99
Report finalised 2000-11-02

Aircraft: registration, type		**SE-RLF,** Douglas DC-9-82 (MD82)
Owner/Operator		SAS Norge ASA, 1330 Fornebu, Norge
Date and time		1999-06-23, 1855 hours in daylight *Note*: All times in the report in Swedish summer time (SST) = UTC + 2 hours
Place of occurrence		Växjö/Kronoberg airport, G County, pos 5655N 1443E, 186 m above sea level)
Type of flight		Scheduled flight
Weather		Metar Växjö at 1850 hrs: Wind 330° at 5 knots, Visibility +10 km, Cloud base 2500 ft, temp 13°C/dew point 11°C, QNH 1018 hPa. Rain showers in the area.
Persons on board:	*crew*	2/4
	passengers	119
Injuries to persons		None
Damage to aircraft		No damage
Other damage		None
Commander:		
age, certificate		49 years, ATPL
total flying time		6775 hours, of which 3500 hours on type
First Officer:		
age, certificate		57 years, ATPL
total flying time		17000 hours, of which 7000 hours on type

The Board of Accident Investigation (SHK) was notified on June 23, 1999 that an aircraft with registration LN-RLF had an incident at 1855 hrs on that day at the Växjö/Kronoberg airport, G County, Sweden.

The incident has been investigated by SHK represented by Olle Lundström, Chairman, and Rune Lundin, Chief investigator flight operations and Henrik Elinder, Chief technical investigator aviation.

The investigation was followed by Max Danielsson, Swedish Civil Aviation Administration and by SAS's own Internal Investigation Team (SAINT), represented by Lars Deremo and Thomas Krave.

Summary

An SAS MD-82 aircraft departed the Stockholm/Arlanda airport on June 23, 1999 on a scheduled passenger flight to the Växjö/Kronoberg airport. The weather was good however the runway was reported wet from a previous rain shower. The commander, who was the flying pilot sitting in the left pilot seat, chose to perform an ILS[1] approach to runway 19, selected the ABS[2] to medium and planned to use engine reverse.

The touchdown was normal and engine reverse was selected. Deceleration appeared normal in the beginning however the commander felt that the aircraft did not continue to properly decelerate. He re-checked the ABS

[1] ILS – Instrument Landing System
[2] ABS – Automatic Brake System

position several times, increased reverse thrust, selected position maximum on the ABS, and finally increased engine reverse to maximum. The aircraft then began to decelerate much better but however it went off the runway end with a speed of about 10-20 knots. The aircraft came to a halt with the tail 41 m. outside the runway edge. Nobody onboard was injured.

The first officer stated that he touched the brake discs shortly after the incident and determined that they were cold.

SHK was able to determine with the help of the aircraft recorders that a normal landing had occurred and that the speed reduced to about 60 knots, when engine reverse increased to maximum thrust. The read out revealed that the landing spoilers had not deployed and that no wheel braking had taken place.

The aircraft's ABS system measures the amount of retardation during the rollout and regulates braking according to the deceleration rate selected on the ABS switch. The ABS is however not activated until the spoilers are deployed. The arming of the spoilers for automatic deployment upon landing is checklist item performed by the pilot in the left seat and is to be confirmed by the right seat pilot during the reading of the checklist. This checklist item is read when landing flaps are selected and the flying pilot orders completion of the landing checklist. It was not possible to determine whether this checklist had been read or not as a recording was not available from the CVR[3].

Unlike the takeoff phase, there is no indication during landing that the ABS is not working due to failures such as the spoilers not being activated. It is the duty of the non-flying pilot to visually confirm automatic deployment of the spoilers after touchdown and to verbally communicate this to the flying pilot. Should this not occur automatically then they must be manually deployed.

No technical fault was found with the aircraft braking system after investigation by SHK.

The commander felt certain that the spoilers had been armed for automatic deployment upon landing which would enable the ABS system to function correctly. The data on the flight recorder however does not indicate that this was the case. The statements given by both pilots to SHK support all the data registered on the flight recorder except that the activation of the spoilers for automatic deployment and the confirmation of this must have been forgotten. If this mistake had been discovered during the landing rollout then the commander could have instead used normal manual braking and the aircraft would in most probability stayed on the runway. The non-flying pilot must have also forgotten to verbally confirm automatic spoiler deployment after touchdown.

SHK considers that the present aircraft design that warns the pilot against failure to activate the automatic spoiler deployment system before takeoff but not for landing is not logical. A pilot performed procedure has instead compensated for this design fault.

The incident was most probably caused through the failure to apply good Crew Resource Management (CRM) techniques after ordering the final landing flap setting, resulting in the spoilers not being armed. The first officer also failed to report that the spoilers had not automatically deployed after touchdown. As the spoilers had not been armed to deploy the automatic braking system was never activated. Engine reverse was the only stopping aid used after touchdown, this being insufficient to stop the aircraft before the end of the runway.

[3] CVR – Cockpit Voice Recorder

The incident occurred with two commanders making up the cockpit crew, with the more experienced acting as the first officer. Experience has shown that this composition has certain risk factors attached to it.

1 FACTUAL INFORMATION

1.1 History of the flight

Aircraft LN-RLF, an SAS owned MD82 operating as a regular passenger flight with call sign SK 1159, departed the Stockholm/Arlanda airport on June 23 1999 bound for the Växjö/Kronoberg airport. The crew requested the latest actual weather report prior to commencing the approach to runway 19, which indicated a tailwind of about five knots, that rain showers were in the area and that the runway was wet from previous rainfall. Otherwise favourable weather conditions prevailed. The commander, who was the flying pilot in the left seat, chose to fly an ILS approach. He selected the ABS switch to the medium position prior to landing and had planned to use engine reversing after touchdown.

Both pilots have stated that the approach was normal, the flight breaking out below cloud at around 5000 ft. When the crew had visual contact with the runway a visual approach with landing flaps selected to position 40° was carried out. The touchdown was made close to the threshold at a speed of 121 knots, where after engine reverse thrust was set to 1.4 EPR[4]. During the first part of the rollout the pilots felt that the aircraft decelerated normally. However the commander felt that the deceleration became worse which cased him to first visually recheck and confirm that the ABS switch was in the desired position and then increase the reverse thrust to 1.8 EPR. At this point he began to suspect that the reported tailwind could have in fact been substantially more than reported and once again rechecked and confirmed the position of the ABS switch. As the aircraft began to approach the end of the runway the commander ordered the ABS switch to be positioned to Maximum and engine reverse thrust was increased to maximum. Deceleration improved at that point however insufficient to stop the aircraft from going off the runway end with a speed of about 10-20 knots. The commander then discontinued the use of engine reverse and steered to the right to miss an obstacle, the aircraft coming to a stop with the tail 41 m beyond the runway end.

When the aircraft had come to a stop the commander informed the passengers of what had happened, instructed them to remain calm and that a normal evacuation of the aircraft would take place. All passengers were later reunited outside the aircraft by the left wing where the commander with the help of a megaphone explained in more detail exactly what had happened, where after they walked the approximately three hundred meters to the terminal building.

The first officer stated that he felt the brake discs with his hand shortly after the incident and determined that they were cold.

1.2 Injuries to persons

	Crew	*Passengers*	*Others*	*Total*
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	–	–	–	–

[4] EPR – Exhaust Pressure Ratio, engine thrust

None	6	119	–	125
Total	6	119	–	125

1.3 Damage to aircraft

No damage. By using maximum reverse thrust the maximum allowed RPM for both engines was exceeded and both were sent for inspection at the maintenance base at the Arlanda airport. No faults were found.

1.4 Other damage

None.

1.5 Personnel information

The commander was 49 years old at the time and had a valid ATPL Licence.

Flying hours previous	*24 hours*	*Total*
All types	1	6775
This type	1	3500

Flight training on type concluded in 1987. Latest periodic flight training (PFT) carried out in 1999-02-19 on MD-80. The actual duty period was the first day of a five-day duty block and the flight was the first for the day.

The first officer was 57 years old at the time and had a valid ATPL Licence.

Flying hours previous	*24 hours*	*Total*
All types	5	17000
This type	5	7000

Flight training on type concluded in 1987. Latest periodic flight training (PFT) carried out in 1999-04-09 on MD-80. The actual duty period was the last day of a five-day duty block. He had originally been scheduled only as available for duty for the actual day however had been rescheduled for the flight the previous day.

The cabin crew consisted of a Purser (AP) and three flight attendants (AH). All were properly certified.

1.6 Aircraft information

1.6.1 General

AIRCRAFT:

Owner:	SAS Norge ASA, 1330 Fornebu, Norge
Type:	Douglas DC-9-82
Serial number:	49383
Gross weight:	Max authorised landing weight 58967 kg, actual 53000 kg
Centre of gravity:	Within allowable limits

The aircraft had a valid Certificate of Airworthiness.

1.6.2 The aircraft automatic braking system

The aircraft has an automatic braking system (ABS) that can be armed for use upon landing using three settings, minimum, medium and maximum. The system works automatically upon landing decelerating the aircraft at the selected level using an antiskid system.

The system senses the aircrafts actual deceleration rate during the rollout and regulates the desired level of braking as pre-selected. If the braking action limits the retardation rate because of skidding then the antiskid system acts to reduce the amount of braking.

The ABS is not activated until the aircraft spoilers are deployed after touchdown. Arming of the spoilers for automatic deployment is performed in the air by the left seat pilot and always verified by the right seat pilot when the item is read on the landing checklist. Upon touchdown automatic spoiler deployment shall be visually confirmed by the pilot reading the checklist using the phrase "spoilers". Conversely should they fail to deploy automatically then this fact will be confirmed using the phrase "no spoilers".

There is no warning to tell the pilots that the ABS has not been activated should the spoilers not deploy or something similar happen during the landing phase. Prior to take off however the pilots are warned if the spoilers or ABS is not properly armed. Proper arming allows for optimum stopping performance during an aborted take off. The ABS and the spoilers are automatically activated to brake the aircraft during an aborted take off when the throttles are retarded to idle and the engine reversers are extended.

A technical investigation of the aircraft that SHK performed revealed no faults.

1.7 Meteorological information

The actual weather at the airport as reported in the Metar from 1850 hrs: wind 330° at 5 knots, varying between 330° and 020°, visibility more than 10 km, rain showers in the vicinity, base of isolated Cb[5] clouds 2500 ft. and an overcast cloud base at 5500 ft, temperature 13°C, dew point 11°C, QNH 1018 hPa. A warning that the runway was wet at the southern end was relayed to the flight. The tower air traffic controller stated that a rain shower passed over the field around 1700 hrs and at the time of the incident a Cb cloud with associated heavy rain showers was 10-15 km north of the airport.

1.8 Aids to navigation

The airport was equipped with standard navigation aids as described in the Swedish AIP. The aircraft was equipped to use all these aids.

1.9 Communications

Normal radio communication was carried out between the aircraft and the Växjö air traffic control tower.

[5] Cb - Cumulonimbus

1.10 Aerodrome information

The airport is situated 610 ft above mean sea level. Runway 19 was in use at the time of the incident. The runway is of asphalt measuring 2103 m long and 45 m wide.

1.11 Flight recorders

The aircraft was equipped with the necessary recorders in the form of a Flight Data Recorder (FDR) and a Quick Access Recorder (QAR) to record flight parameters and a Cockpit Voice Recorder (CVR) to record all sound.

Due to the fact that the aircraft was left parked with the power on after the incident, the CVR continued to record for quite some time causing the recording from the landing to disappear.

It is stated in the SAS Flight Operations Manual (FOM 3.2.1) that the commander shall, when an event of a serious nature has occurred, make sure that the FDR and CVR recordings are saved and secured. Should an accident occur, the CVR information would be saved when the crew performs the "On Ground Emergency" checklist (Aircraft Operating Manual MD-80 2.13/4). The same text also refers to the need for the commander to pull the CVR circuit breaker once on the ground and make a note of this fact the aircraft log, should he in any other situation deem it necessary to save the recording after an event. Normally the CVR is turned off when the aircraft is parked after a flight.

In this case the commander did not consider any special procedure needed to be followed as the crew and the passengers left the aircraft in a normal fashion.

1.12 Accident site

The incident occurred at the end of runway 19 and the aircraft came to a stop with the tail 41 m from the runway end at position 5655N 1443E.

1.13 Medical information

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

1.14 Fire

There was no fire.

1.15 Survival aspects

Not applicable.

1.16 Tests and research

With the help of SAS, SHK has been able to get readout of the QAR. As the CVR remained powered for the duration of the tapes maximum recording period of 30 minutes after the incident, no voice readout was available.

As seen in the QAR readout the aircraft landed at 1655 hrs. with a speed of 121 knots. Thereafter during a period of 14 seconds the speed reduced

to about 60 knots, when the engine reverse effect is increased from 1.5 EPR (approx. 80% N1) to 2.1 EPR (approx. 102% N1). The readout also shows that the spoilers did not extend after touchdown and that no wheel braking took place.

1.17 Organisational and management information

MD-80 pilots at SAS are assigned duty blocks, either in a fixed continually alternating schedule of five days on duty and four days off or a variable type duty schedule where the length of on/off duty periods alternate more randomly.

Both pilots worked part time and had variable duty schedules.

A commander at SAS has full authority to perform right seat duties as a first officer. When a commander is called out on short notice as in a stand-by situation, he shall always assume the duties of the pilot he was called to replace, even if this entails flying as first officer to a commander with less seniority. Such was the case on this flight.

Should it become apparent that there is a lack of both commander and first officers at the planning stage then two commanders can be scheduled for the same flight, the one with the highest seniority serving as commander. The practice of using commanders for first officer duty is not contrary to regulations.

1.18 Additional information

In accordance with the MD-80 landing checklist, items 1-10, they shall be read from the checklist up to the extension of the landing gear. The checklist is to be read out loud by the pilot-not-flying (PNF) when ordered by the pilot–flying (PF). Each checklist item is read in a challenge and response fashion and any item to be performed by PF shall be correctly responded to prior to the next item being read.

Upon ordering the final flap setting the PF shall order the remaining landing checklist items 11-15 to be read, which are performed from memory without the use of the checklist. These items entail the landing gear to be checked down and locked (item 11), the spoilers to be armed (item 12), the rudder to be functioning properly (item 13), the auto brake switch to be set to the desired position (item 14) and the "Checklist Complete" (item 15). As stated in the checklist the left seat pilot (in this case also PF) shall arm the spoilers. The SAS Flight Operations Manual (FOM) states that all checklist items shall be verified. After touch-down the PNF shall visually check the spoiler handle for proper automatic deployment and state "Spoilers", or should they not deploy, "No Spoilers", where after they shall be deployed manually.

The commander stated to SHK that he had established routines to check the arming of the spoilers. He maintained that such was the case even this time and could not recall anything that could have interrupted his normal routine. The only non-normal aspect of the flight was having an older and more senior commander in the right seat.

He also stated that he never thought to recheck for proper spoiler deployment when he became aware of the slow retardation.

The commander acting as first officer for the flight stated that he felt uncomfortable sitting in the right seat, which he had last done in April 1999.

2 ANALYSIS

The investigation has not found any fault with the aircraft.

According to the commanders statement he was convinced that the spoilers were properly armed and that they should have automatically deployed upon touchdown. The QAR readout however shows this not to be the case. Braking during the roll out, which was in a light tail wind, was performed using engine reverse only.

The investigation has been unable to establish why landing checklist item 12, arming of the spoilers, was not performed. A CVR readout has not been available. Both pilots have provided information to SHK that confirm the registered flight data, with the exception of the arming of the spoilers and then verifying their deployment after touchdown. No aural confirmation of spoiler activation in accordance with established procedure was given after touchdown either.

When the commander felt that the retardation during the roll out was slower than normal he rechecked the position of the ABS switch several time but never thought to check the spoilers for proper deployment. Had he done that then he could have manually deployed the spoilers or reverted to manual wheel braking, where-by the aircraft could have been stopped within the confines of the runway.

The reason for the commander not suspecting proper spoiler deployment or reverting to manual wheel braking was most probably due to his assumption that reduced retardation was due to the tail wind being stronger than reported or the runway being more slippery after the earlier rain shower. According to the MD-80 Aircraft Operating Manual (AOM) Bulletin no. 108, the best braking results on a slippery runway are obtained using the ABS, as opposed to using manual braking. The commander was aware of this characteristic.

As engine reverse is most effective at high speeds, it gives good retardation only at the beginning of the braking phase. As the aircraft slows proper wheel braking becomes essential. The reason for this, as shown in section 1.6.2, is that an activated ABS gives a constant retardation rate. This can result in the pilots becoming aware of insufficient retardation at a late stage.

SHK maintains that the aircraft's design, with a spoiler warning system for take off but not for landing, is not logical. No proper explanation has been provided as to why a proper warning system for landing does not exist. It is SHK's opinion that the installation of a proper system to warn the pilots that the spoilers are not properly armed for landing is sufficiently motivated. The absence of a proper system has in this case been compensated for by the introduction of a pilot procedure.

The incident occurred with two commanders in the cockpit crew, the more experienced serving as first officer. Experience has shown that certain latent risk factors are involved with this cockpit composition.

SHK determined, as has happened in previous events, that the crew failed to save the CVR recording from the incident through pulling the circuit breaker to stop further recording. Based on what is contained in both the FOM and the AOM this should have been done. The text in the relevant sections of these manuals should be clarified in the future to prevent further

misunderstanding. This procedure should also be briefed and practiced during normal periodic flight training in the simulator.

SHK deems it worthy to note that Part D of the ICAO Conventions Annex 13 classifies overrunning the runway end as a serious incident.

SAS's internal investigation group (SAINT) intends to recommend in its report to the company that it investigates the possibility of including a warning for spoilers even after touchdown. If the investigation should find it not possible to install such a warning device, then better procedures should be implemented for confirming proper activation or failure of the ABS after touchdown. It is further suggested that a simulator scenario be introduced to train crews in the proper procedures to be followed in stopping the CVR to save the recording after an incident.

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 was found with the aircraft.
d) The aircraft spoilers were not armed.
e) No wheel braking took place as the spoilers failed to deploy.
f) The aircraft slowed using engine reverse only.
g) The aircraft CVR was not stopped after the incident.

3.2 Causes

The incident was most probably caused by a breakdown in Crew Resource Management (CRM) after the landing flaps had been selected. As a result of this the spoilers were never armed. Neither did the first officer report the failure of the spoilers to automatically deploy after touchdown, which the commander believed them to be. This caused the ABS not to function at all. This resulted in the braking of the aircraft through use of the engine reversers only, which was not enough to keep the aircraft from overrunning the runway end.

4 RECOMMENDATIONS

None.