Statens haverikommission
Swedish Accident Investigation Board

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Report RL 2006:14e

Aircraft accident involving SE-DYX at Stockholm-Arlanda Airport, AB county, Sweden, on 1 December 2004

Case L-50/04

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 Björn Brink from the original Swedish at the request of the Swedish Accident Investigation Board.

In case of discrepancies between the English and the Swedish texts, the Swedish text is to be considered the authoritative version.

Statens haverikommission (SHK) Swedish Accident Investigation Board

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2006-05-24 L-50/04

Swedish Civil Aviation Authority

601 73 NORRKÖPING

Report RL 2006:14e

The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an aircraft accident that occurred on 1 December 2004 at Stockholm-Arlanda Airport, AB County, involving an aircraft with registration SE-DYX.

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.

The Board will be grateful to receive, by 24 November 2006 at the latest, particulars of how the recommendations included in this report are being followed up.

Åsa Kastman Heuman

Stefan Christensen Henrik Elinder

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APPENDICES

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Report finalized 2006-05-24

Aircraft; registration and type	SE-DYX, Cessna 560 XL
Class/airworthiness	Normal, Valid Certificate of Airworthiness
Owner/Operator	Greenfield AB/EFS European Flight Service AB
Time of occurrence	2004-12-01, 20.48 hours, during darkness *Note:* All times are given in Swedish standard time (UTC + 1 hr)
Place	Stockholm-Arlanda airport, AB County (pos. 5939N 01755E, 42 m above sea level)
Type of flight	Commercial Air Transport
Weather	According to SMHI:s[1] analysis: Wind 250°/8 kts, visibility 6 km, cloud base 600 ft, temp./dp +3/+2 °C, QNH 1007 hPa.
Persons on board:	6
crew members	2
passengers	4
Injuries to persons	None
Damage to aircraft	Substantially damaged
Other damage	None
Commander:	
Sex, age, licence	Male, 46 years, ATPL
Total flying time	4421 hours, of which 431 hours on type
Flying hours previous 90 days	53, all on type
Number of landings previous 90 days	56
First Officer	
Sex	Male, 38 years, CPL
Total flying time	4556 hours, of which 456 hours on type
Flying hours previous 90 days	56, all on type
Number of landings previous 90 days	56

The Swedish Accident Investigation Board (SHK) was notified on 1 December 2004 that an aircraft with registration SE-DYX had an accident at Stockholm-Arlanda airport, AB County the same day at 20.48 hrs.

The accident has been investigated by SHK represented by Åsa Kastman Heuman, Chairperson, and Mats Öfverstedt, Chief investigator flight operations until 15 August 2005, Stefan Christensen from 15 August 2005 and Henrik Elinder, Chief technical investigator aviation.

The investigation was followed by Max Danielsson, Swedish Civil Aviation Authority.

Summary

The aircraft departed from Stockholm-Bromma airport in the morning with destination Plovdiv in Bulgaria. The task was a taxi-flight and the return flight was scheduled to the evening the same day.

[1] SMHI = Swedish Meteorological and Hydrological Institute

On short final during approach to Plovdiv the crew noticed that the runway consisted of concrete blocks and had a rough appearance. The crew considered the landing and the roll out to be very severe for the aircraft.

No damages or faults could be found on the aircraft after the landing and neither at the check before take-off which was done before the return flight to Stockholm.

When the landing gear was retracted after take off, a warning was displayed that the nose gear wasn't retracted. The Commander decided to continue the flight to Stockholm. During the approach the landing gear was extended according to normal procedures, but the green light which indicates that the nose gear is down and locked did not come on.

The landing took place on runway 26 at Arlanda. At around 50 knots the nose touched the runway. The aircraft was sliding on the nose for about 200 meters before it came to a complete stop.

At the investigation after the accident it was established that the nose gear strut didn't spring out at extension, which caused the nose gear to get stuck between the hinge arms of the landing gear doors. After the accident the nose gear was dismounted and was sent for investigation under the supervision by SHK. At the tests it appeared that leakage of nitrogen gas under some circumstances could occur. The leakage was located to a defect o-ring in the lower landing gear strut.

Everything points to the fact that the found pressure loss in the nose gear was caused by the defective o-ring. It is likely that most part of the leakage came up due to the violent vibrations and stress the aircraft was exposed to on the runway.

The accident likely occurred because the aircraft was operated on a very rough runway, which caused the damage on the nose wheel. The damages caused the nose wheel to get stuck in a partly retracted position, causing an emergency landing. Contributing has been an unsuccessful design of the nose gear retraction mechanism on the aircraft type.

Recommendations

The Swedish Civil Aviation Authorities is recommended:

- In the international air safety work, see to that a suitable classification is introduced regarding quality and condition concerning surface and smoothness on runways (*RL 2006:14e R1*).

- See to that information about the real surface covering is issued as standard on landing chart in Route Manuals (*RL 2006:14e R2*).

- Investigate whether there is a need for special regulations concerning low fly-by passes and if such a need is identified, to issue such regulations. *(RL 2006:14e R3).*
  (Compare with the SHK document in item A-41/06 in Appendix 3 of this report.)

1 FACTUAL INFORMATION

1.1 History of the flight

1.1.1 The flight before the accident flight

The pilots departed on 1 December 2004 at 07.04 from Bromma airport to perform a taxi-flight to and from Plovdiv airport in Bulgaria (LBPD) with the Commander as the flying pilot (PF) at the first sector. Onboard the aircraft there were four passengers and the return flight to Sweden should take place in the evening the same day.

None of the pilots had landed at Plovdiv airport before. Information about the airport was collected from both SAS and Jeppesen Route manuals. Additional information and current status about the airport was collected via NOTAM[2] from Arlanda, respective EFS (European Flight Service AB).

NOTAM concerning LBPD contained information partly about continuing diggings east from the apron and taxiway E, partly that MSSR (secondary radar type monopulse), was out of service at the airport the actual day.

The flight to Plovdiv took about three hours and went on without problems. During the final approach, when the aircraft was on short final to runway 30, the pilots noticed that the runway consisted of blocks of concrete and looked bumpy. In connection with the landing and the roll out on the runway the pilots realized that the runway was very bumpy and in a bad condition. The Commander said that the landing and the roll out was “the worst he had ever experienced through his career”, and that he was worried about that “something had broken on the aircraft”. However, the pilots couldn’t see any visible damages after landing.

1.1.2 The accident flight

Before takeoff at the return flight to Bromma, the pilots made the normal inspection of the aircraft (PFC Pre flight Check), as prescribed in the flight manual. The Inspection Checklist states, among other things, that landing gear, landing gear doors, wheels and tires shall be controlled in consideration to condition and/or possible damages. The crew has according to their own statement performed the checklist and found the airplane to be without remarks. Therefore the crew did not hesitate to carry out the return flight, but decided that during the taxiing try to find the least uneven part off the runway to use for take off.

During taxiing to runway 30 for take off, which was performed on the runway, the pilots observed that the runway was evidently uneven. They therefore decided that the commander should bee flying pilot PF during take off on the return flight. At take off the commander has stated that he could experience the characteristic ”bow” by the nose in connection with the take off. To make the shortest possible take off roll the take off was performed as a “static take off “i.e. the airplane was held on the brakes during application off power, where after the brakes were released.

During the beginning of the acceleration before lift off the pilots experienced the runway bumps strongly which decreased successively as the speed increased. After being airborne, when the airplane was on about 400 feet altitude, the landing gear and the flaps were retracted.

Shortly after the warning light on the instrument panel for the Stabilizer trim “STAB MISS” illuminated (see 1.6.4.). The pilots also observed that the warning light for landing gear “UNLOCK” did not go out, which is normal when the landing gear is fully retracted.

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[2] NOTAM = Short term aeronautical information

In order to solve the problem the pilots manoeuvred the flaps and the landing gear out and in a couple of times but the fault indications did not go out. The pilots noted during these attempts that the green indication light for the nose wheel did not come on when the landing gear was extended. The pilots also observed that the wind noise in the cockpit was different then under normal circumstances. This, including the indications in cockpit, lead to that the crew in an early phase suspected a technical fault and that normal manoeuvring of the nose gear probably not would be possible. After consultation with the assisting pilot, here called the co-pilot, the Commander decided that they should continue the flight to Sweden despite the indications of fault. Due to the faults the flight continued with limitations of the performance according to the checklist for abnormal procedures.

Disregarding these operative limitations the flight continued without problem. After consultation with responsible technician in Gothenburg via satellite telephone the pilots suspected that a failure hade occurred in the aircraft hydraulic system. When the aircraft entered Swedish air space they informed the Air Traffic Control (ATC) that they wanted to change the destination airport from Bromma to Arlanda. In this phase the ATC was not informed that the aircraft had technical problems.

The reason that the crew preferred Arlanda, was that they should get access to more choices regarding runways if any problem should arise in connection with the landing. All runways at Arlanda are longer than the single runway at Bromma and available rescue service has higher capacity. During approach to Arlanda the crew discussed different alternatives to be able to solve possible problems. They agreed nevertheless that to follow the prescribed procedure for “LANDING GEAR WILL NOT EXTEND”, according Abnormal Checklist of the aircraft manual. Early during the approach to Arlanda the crew reported to ATC that they had problems with the hydraulic onboard, but did not demanded any priority.

During the final approach for landing at Arlanda runway 26 the crew extended the landing gear, initially according to the normal procedures. As suspected they observed that the green indication light for the nose landing gear did not come on. They altered then to the prescribed procedures according to Abnormal Checklist; where alternate extension of the landing gear is described. They followed the list with actions, with exception for “nose yaw”- an action where side forces help extension and locking, to solve the problem. Main purpose of this list is that through activation of a separate air pressure system, instantaneous rise pressure in the system so that the gear is extended. This so-called emergency extension of the landing gear had no effect. As said before the pilots could note that the wind noise was not normal, and therefore concluded that the landing gear was not locked in the extended position.

Before the landing the pilots declared emergency and called MAYDAY, MAYDAY, MAYDAY. The controller at Arlanda tower suggested a low fly past to verify the status of the landing gear. This was declined by the pilots. The reason to this was the present weather situation with 600 feet cloud base, and darkness.

The Commander also took the decision not to ask for any foam on the runway, with consideration to the low attitude of the nose at a gear collapse probably should mean that the front window quickly should become cowered with foam. The airplane manufacturer has not advised any recommendations of any kind regarding foam in connection with landings with known landing gear problems.

When the pilots reduced power before landing the sound warning was activated, indicating that the landing gear was not extended. The touch down on the main landing gear was smooth and with high attitude. The Commander tried during the roll out to keep a high attitude as long as possible, but at about 50 knots the nose dropped down and the underside of

the airplane front touched the runway. The airplane then rolled on the main gear and slid on the nose more than 200 meters before it stopped.

The airport rescue team quickly came to the scenery and took care of the persons onboard who all were safe and able to leave the aircraft on their own.

Location: 5939N 01755E; 42 m above sea level.

1.2 Injuries to persons

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

1.3 Damage to aircraft

Substantially damaged.

1.4 Other damage

None. The accident had no impact on the environment.

1.5 Personnel information

1.5.1 Commander

The commander, male, was 47 years old at the time and had a valid ATPL..

Flying hours			
latest	*24 hours*	*90 days*	*Total*
All types	6,9	53	4421
This type	6,9	53	431

Number of landings this type previous 90 days: 56.
Flight training on type concluded in 2000.
Latest PC (proficiency check) carried out in February 2004.

1.5.2 Co-pilot

The co-pilot, was 38 years old at the time and had a valid CPL.

Flying hours			
previous	*24 hours*	*90 days*	*Total*
All types	6,9	56	4556
This type	6,9	56	456

Number of landings this type previous 90 days: 56.
Flight training on type concluded in 2000.
Latest PC carried out in February 2004.

1.5.3 The crew members duty schedule

According to valid duty time regulations.

1.6 Aircraft information

1.6.1 General

AIRCRAFT		
Manufacturer	Cessna	
Type	C-560XL	
Serial number	560-5029	
Year of manufacture	1999	
Gross mass	Max authorized start/landing mass:9070/8400kg, actual 9000/7200 kg	
Centre of mass	Within limits	
Total flying time	2120 hrs	
Number of cycles	2256	
Flying time since latest inspection	319 hrs	
Fuel loaded before event	2200 liter Jet A1	
ENGINE		
Manufacture	Pratt & Whitney	
Model	545	
Number of engines	2	
Engine	*No 1*	*No 2*
Total operating time, hrs	2120	2120
Operating time since overhaul	2120	2120
Cycles after overhaul	2249	2249

The aircraft had a valid Certificate of Airworthiness.

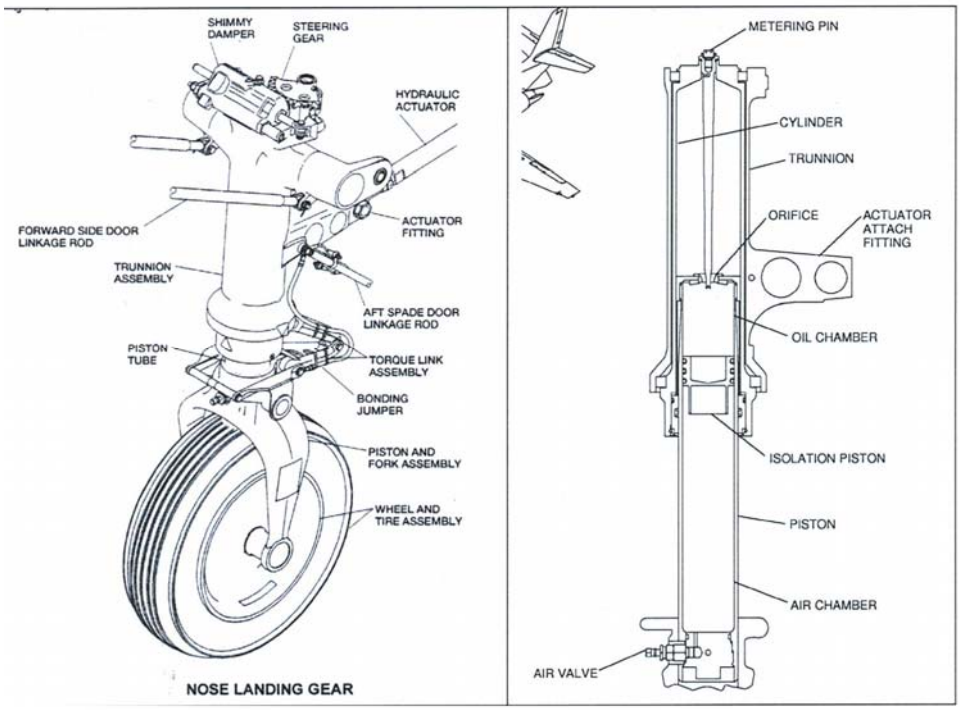
1.6.2 Landing Gear

The aircraft type has a retractable landing gear which is operated by hydraulic power. In the cockpit there is a handle to maneuver the landing gear and four indicating lights. Three green lights indicate that each main landing gear and the nose gear are extended and properly locked. When the landing gear is in transit mode (extending or retracting) a red indication light is on with the text “UNLOCKED”.

1.6.3 Nose gear

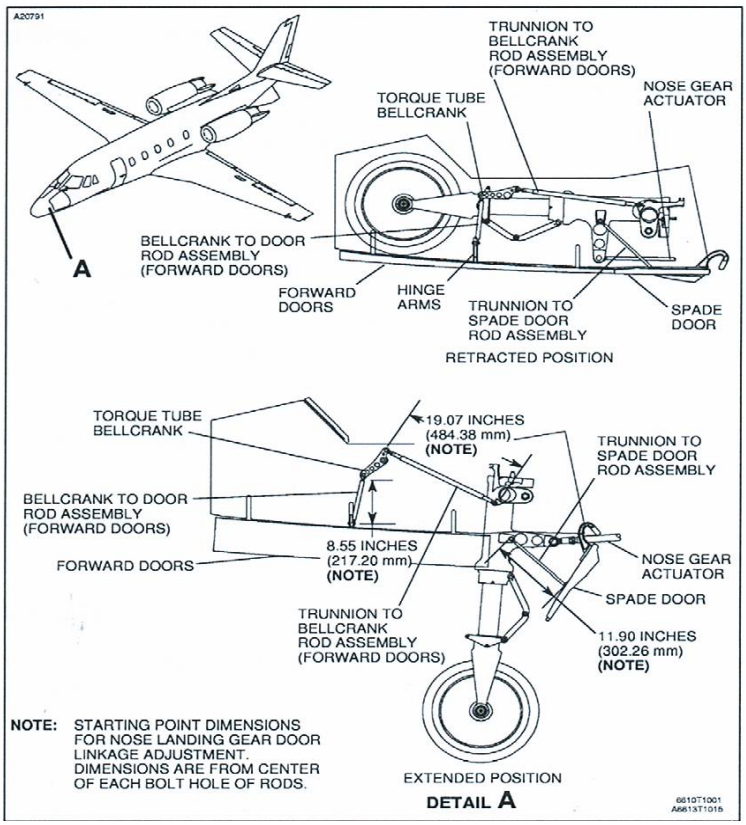
The nose gear has a gas/hydraulic suspension which are built-in in the landing gear strut. Simplified the upper part of the nose landing gear strut function as an outer cylinder and the lower part constitute a piston which moves up and down in the upper part. The space between the upper and the lower part is filled with gas and hydraulic oil. When the lower part is pressed into the upper part the gas is compressed which gives the spring function. The system contains also components implying shock absorber function. One of this is a movable piston (isolation piston) in the lower part of the landing gear strut as separates gas in the upper part of the struts and oil in the lower part of the strut. (See figure below.)

Adjustment of the nose gear spring pressure is performed through drain or refilling of gas which is performed through a nipple in the lower landing gear strut (air valve).



1.6.4 Nose gear retraction mechanism.

Retraction of the nose gear is by forward motion, with use of a hydraulic cylinder. To allow the landing gear and the nose wheel to fit into the nose wheel bay in the aircraft forward part the shock strut must be fully extended which is normal as soon as the nose wheel has left the ground. Mechanically linked to the retraction mechanism are two gear doors (forward doors) which opens respectively closes in connection with the extension and retraction of the landing gear.



1.6.5 Stabilizer trim

The aircraft type is equipped with a system for trimming of the stabilizer. The system aim is to minimize necessary rudder forces in different configurations. On the actual type the whole stabilizer plane is moveable, and changes angle of attack within a limited register.

The system receives signals from sensors at the wing flaps, and changes position within a certain area of the wing flap register. The trim system is hydraulically activated. If any malfunction should occur, causing that the stabilizer trim does not adjust to a certain flap position, a warning is activated on the panel in the cockpit "STAB MISCOMPARE".

In this case the crew got the warning in connection with problems with the landing gear. The reason for this is that the logic in the hydraulic system is giving priority to the most essential systems onboard, in this case landing gear and wing flaps. With a landing gear which is not extended after that the switch is activated, the hydraulic pump works continuously to increase/maintain pressure in order to extend the gear. The system will at the same time reduce the oil pressure to certain secondary users, which the stabilizer is part of.

The consequences of the gear problem therefore implied that the whole flight was done with the stabilizer in displaced position. This did not affect the course of events, but caused the elevator trim of the autopilot to work in the outer range of it's register.

It can be mentioned that the crew via satellite telephone with the company's technical chief, got instructions to switch off power to the hydraulic system with the fuse. They therefore pulled "HYD CONTROL C/B". The reason for this was to avoid continuous running, and by that risk for overheating, of the hydraulic pump during the flight.

1.7 Meteorological information

According to Arlanda ATIS[3], 20.20: Wind 230°/6 knots, visibility 6 km, broken clouds at 600 ft, temp. /dew point +3/+2°C, QNH 1007 hPa. Tempo broken clouds at 400 ft, visibility 4 km. Darkness prevailed.

1.8 Aids to navigation

All navigation aids both on the ground and in the aircraft worked without remarks. The approach to runway 26 was performed as ILS approach[4].

1.9 Communications

Normal radio communication occurred between the aircraft and the Air Traffic Control. Communication is shown in enclosure Appendix 3.

1.10 Aerodrome information

The airport had operational status in accordance with the Swedish AIP[5], Aeronautical Information Publication. According ATIS the condition for runway 26:

- Braking action good.
- Runway damp.
- 10 % covered with ice.

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[3] ATIS = Automatic Traffic Information Service (Airport and Weather information by radio.)

[4] ILS = Instrument Landing System

[5] AIP = Aeronautical Information Publication

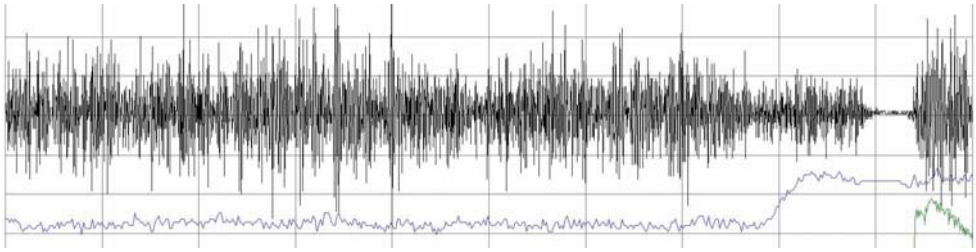
1.11 Flight recorders

1.11.1 General

The aircraft was equipped with Flight Data Recorder and Voice Recorder. After the accident this equipment was taken care of and downloaded by SAAB Aircraft in Linköping under supervision by SHK.

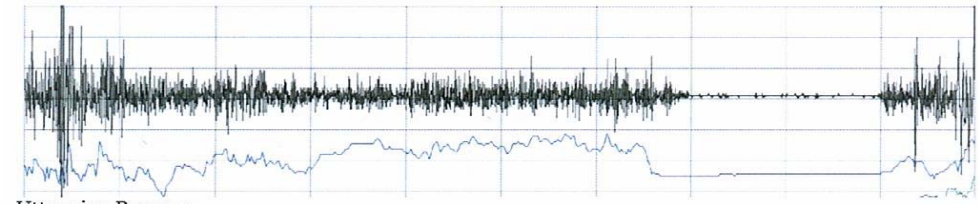
1.11.2 Flight Data Recorder (FDR)

The aircraft was equipped with Flight Data Recorder – FDR type Fairchild. 12 parameters are registered with different frequencies during the flight to Arlanda. Parameters from the actual flight as well the preceding flight are registered. The data which was found most interesting for the investigation is, besides the landing at Arlanda, the difference in vertical acceleration- g, which is recorded in connection with out taxiing at Bromma respective Plovdiv.



Taxiing out at Plovdiv

By the graphic print out it appears that as well amount and frequency on the vertical g-force are remarkably high at out taxing at Plovdiv compared to Bromma.



Taxiing out at Bromma

In this comparison Bromma is considered to be at, or shortly below, the normal level regarding smoothness according to European standard. (Definitions for this are not established, see 4.1).

The landing at Arlanda has been smooth according to FDR print outs. Remaining parameters present for the flight altogether normal data's.

1.11.3 Cockpit Voice Recorder (CVR)

The aircraft was equipped with a Cockpit Voice Recorder type Fairchild. The sound recording of interest for the investigation has been printed out and put together in Appendix 2.

1.12 Accident site and Aircraft wreckage

1.12.1 Site of occurrence

The accident occurred at Stockholm-Arlanda airport (ESSA) runway 26. Touch down took place about 500 m in on the runway. After about 1700 m the nose of the airplane touched the runway and after about further 200 m

the airplane stopped, 1-2 m left of the centerline of the runway. This was about 600 m from the end of runway 26.

1.12.2 *Aircraft wreckage*

The aircraft was documented on the runway by the airport staff and representatives from the company after agreement with SHK, before it was towed from the site. After that its nose was lifted up the nose gear was manually extend and locked. The aircraft was then towed to a hangar at the airport for further technical investigation.

1.12.3 *Damage to the aircraft*

Considerable damage occurred at the nose part of the aircraft.

- Structural damages to sheets and inside frame.
- Friction- and impact damages on the front landing gear doors.
- Damages on suspension.
- Damages on landing gear and wheel.

1.13 Medical information

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

1.14 Fire

Fire did not appear.

1.15 Survival aspects

The touch down on the runway was smooth. The vertical g- forces when the nose hit the runway were reasonably low and the persons onboard were not injured. The mechanical damages which occurred during the slid on the runway were limited and located to an area where the risk for fire from sparking was comparatively small.

The Emergency Locator Transmitter (ELT) of type Artex was not activated in the accident.

1.16 Tests and research

1.16.1 Function tests of landing gear, flaps and stabilizer trim.

The nose gear retraction mechanism has been checked and tested. At the tests it has been established that one condition for the nose gear to be fully retracted and locked, it is that the gear strut is fully extended. If this is not the case the nose wheel get stuck between landing gear doors hinge arms, and remain jammed so tight that it is not possible to extend it again with ordinary system. Landing gear function inclusive linkage to flaps and stabilizer trim worked without remarks. See 1.6.5 regarding fault indication of the stabilizer trim.

1.16.2 Technical investigation of landing gear.

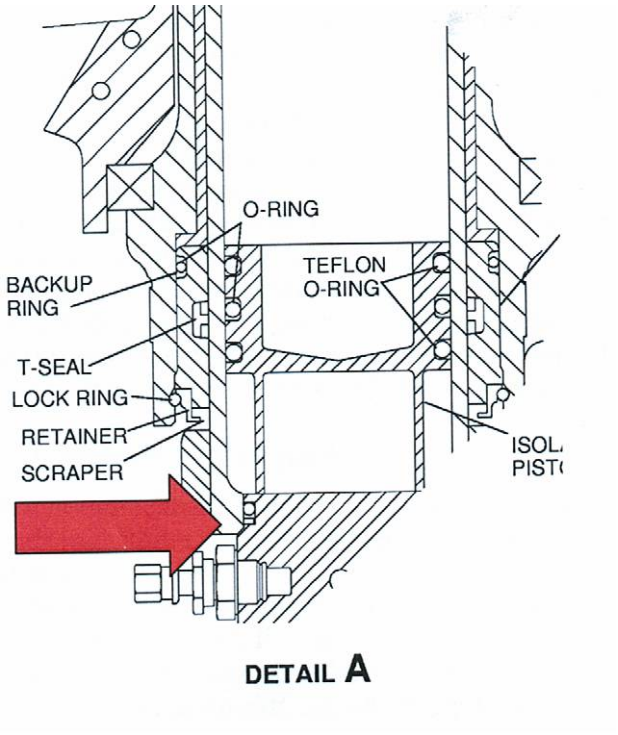
After being removed from the aircraft the nose gear was sent to Cessna Aircraft Company for investigation and tests. All tests and investigations have been supervised by NTSB (National Transportation Safety Board) in USA for the account of SHK.

The investigation has been performed according to following:

- Visual check concerning damages and visual leakage
- Leakage test during pressure at different temperatures
- Check of hydraulic oil
- Dimension check of components
- Check of o-rings

At one of the series of tests the piston part was cooled down in an environmental chamber, where the intention was to lower the temperature to -46°C. The piston was though taken out already after 15 minutes when the temperature passed -40°C. The piston was sprayed with alcohol, and submerged in an alcohol bath. No leakages could be found. At pressure test full nitrogen pressure was indicated. This testing was performed at four consecutive test series, all with the same results.

After the last test series it was decided to bring back the piston to room temperature. After heating up in 45 minutes the material had a temperature of +5°C. At the check of the nitrogen pressure it was verified that a substantial loss of pressure had occurred.



Repeated tests showed the same results. The piston was submerged in a bath of alcohol and again was cooled down to ascertain were the leakage appeared. Tests showed that the leakage mostly occurred at temperature changeovers, from warm to cold and vice versa. The leakage was located to an o-ring between the lower landing gear piston and its piston plug.

The damages could be verified to two o-rings, (part number NAS 1611-331 and NAS-1611-226). The damages were longitudinal and sharp, and were found as well on outer side as on inner side of the o-rings. The damages have probably come up through mechanical influence/wear. According to the investigation the tests indicate that one of o-rings could develop leakage, partly under time in cold environment and partly at transition from cold to warm environments.

1.17 Organizational and management information

1.17.1 The Company

The company business concept is to run taxi- and charter activity over the whole world. The company has at their disposal a mixed fleet from lighter propeller aircraft, to larger "Executive Jets" with intercontinental capacity.

The operation is run from Gothenburg-Save, respectively Stockholm/Arlanda and Bromma airports with head office in Gothenburg. The company has a stable structure, with a solid main owner as economical guarantor.

1.17.2 Operational documentation

SAS and Jeppesen route manuals constitute the base in the company's OM C[6] documentation. In addition to this there are internal rules and routines regarding operational handling flight operations.

1.17.3 Routines at flights to new destinations

The company has got an internal part of its OM C manual: Route and Aerodrome instructions and information. In this manual there are among others

[6] OM C = Operations Manual – Airport & Navigation part

categorization of different airports with consideration to equipment and environment.

The airports are divided in three different categories, A,B and C where one simplified can say that all instrumental airports with runways of normal length without high surrounding terrain, always are categorized as the "simple" category A. For first time flights to category A airports, there are no additional requirements other than the standard planning. Plovdiv was categorized as an A airport.

In addition to the system with categorization, the company was using an internal data base, where information and operational tips could be found as information to crew. There was no information regarding Plovdiv in the data base, as no operations had been carried out to that airport.

1.17.4 Emergency checklist–nose yaw

The emergency checklist that the pilots were using at their attempt to emergency extend the landing gear, is the recommended procedures by the manufacturer and is included in Abnormal Checklist.

The Commander stated that he did not consider it relevant to perform the forth point of the checklist, Rudder-YAW AIRPLANE. The reason was that he regarded that this measure only should be performed if the gear was extended or partly extended, in order to achieve final locking. Alternatively you should also perform this nose yaw if the spare bottle with pressurized air was discharged. In the existing situation the Commander did not consider this point on the checklist to have any influence to the situation.

1.18 Additional information

1.18.1 General conditions for operators of taxi flights

This day's operation would be considered as a rather normal day for the pilots in a taxi flight company. The task this day was to make it possible for a customer to have a business appointment in a small city in Bulgaria, and yet be able to be back in Sweden the same evening. Missions like these forms the core in the company business strategy, with flights to odd destinations and often with short notice.

To form an opinion of what different conditions that exist, it may be mentioned that planning of operations as here described often are performed according to prescribed routines in other parts of the aviation business. If a major carrier shall start operations to an operatively new destination, it is normal that a delegation is send from the company to investigate all applicable conditions at the destination. This also includes status and condition of the runways.

A smaller air taxi company has seldom time, personnel or economical resources to handle flights to new destinations in a similar way. The consequence is that they have to relay on the documentation which is obtainable about the planned flight. In this actual case, the crew had access to information in SAS and Jeppsen Route Manuals.

The documentation stated that the runway at Plovdiv had got a hard surface, consisting of either asphalt or concrete. The hard surface on the runway of Plovdiv consists of concrete. This type of runway construction is very common in Russia/CIS[7] and former eastern countries. Constructions of these concrete runways are done with prefabricated sections which are assembled on-site, which can give rise as well as slants and uneven joints of varying width and depth. With the passage of time and sometimes due to

[7] CIS = Commonwealth of Independent States

lack of maintenance, the concrete runways gradually become very uneven and wavy.

The crew had no information about the runway condition when they planned and performed the flight to Plovdiv. Information about the runway surface coating consisting of concrete, was only to be found in The Bulgarian AIP, which was not available to the crew in the regular flight planning-stage.

1.18.2 Measures taken

After the accident the manufacturer has issued a supplement in the checklist for PFC (Pre Flight Check), with the following recommendations to the operators.

- If the visual part on the landing gear piston is less than two inches (51 mm) a technical check of the landing gear is recommended.
- If the piston “hits the bottom” during taxiing a technical check is recommended.
- If the landing gear does not indicate locked after extension, its recommended to let it stay in its position and not to try to make it lock by maneuvering the landing gear lever up and down repeatedly.

1.18.3 Service Bulletin SB560XL-32-26

The aircraft manufacturer published the 22nd November 2005 SB560XL-32-26 in which prescribes obligatory maintenance checks and modification of the nose gear retraction mechanism in order to minimize the risk for malfunction.

1.18.4 Documentation

The navigation documentation which was used by the operators for planning and the aids for navigation are named RM (Route Manual). In this all data can be found regarding airways, approach procedures, and airport data. Basic information to the manuals is collected from respective country’s AIP, where all relevant information is stored.

The international regulation which rules the international air traffic is found in the annex to the convention regarding international civil aviation, the so-called Chicago convention. These rules are among other things the basics for the information which are published in AIP. The regulations for airports are in annex 14.

2 ANALYSIS

2.1 The accident

When the aircraft made the emergency landing at Arlanda airport, the malfunction was known by as well the crew as by the concerned instances on the ground. The accident could therefore be categorized as certainly serious, but on the whole a controlled incident, where the consequences restricted to material damages to the airplane.

The flight to Stockholm was performed with a damaged airplane, which was flown with operational limits due to the failure. After the attempt to extend the nose gear, the approach at Stockholm was performed with an

aircraft without functioning nose landing gear. When the crew reported the aircraft conditions, the ATC was alerted, and activated the rescue team.

In spite of relatively low ceiling, the weather conditions were good, with only light winds almost in the direction of the runway. Braking action was good on runway 26, with patches of ice.

Last part of the approach was done with almost stable sink rate according to FDR print outs. The touch down was smooth, and the pilot kept the nose of the aircraft up as long as it was aero dynamically possible. The nose touched the runway rather soft, and the damages which came up have more or less been caused by friction against the runway surface.

The rescue vehicles were at the site immediately when the aircraft had stopped, and the evacuation could be executed without any further incidents. The co-operation of the crew seems to have been working satisfying during all phases of the flight.

SHK has observed that the emergency checklist, which should be used at situations like this, not entirely has been followed by the crew. The forth point which include “nose yaw” of the airplane, was not carried out after decision by the commander. The reason to this was that he judged that this maneuver should not influence the situation. It is not unlikely that this maneuver could have influenced the situation.

It is SHK: s opinion that very strong reasons should be present for excluding points in the procedures. In this case there were no such reasons, why the act of the commander should motivate the company to go through training and policy regarding checklists and procedures.

2.2 Malfunction of the nose gear

The construction of the retracting mechanism of the nose wheel gear implies that the nose gear must be fully extended to be able to “fit in” the concerned compartment in the nose part of the airplane. This implies that the pressure in the gas cylinder of the gear is high enough to counteract the dynamic pressure from ram air that tries to compress the gear during the retractions movement.

After the accident it was stated that the cylinder was more or less without pressure and that retraction of the gear was done when it wasn’t fully extended. The result was that the nose gear got stuck between the landing gear door hinges, and jammed the nose gear so tight that it neither could be released with the airplane’s ordinary system or emergency extension system.

The aircraft manufacturer has after the accident taken several actions, including modification of the nose gear retraction mechanism, which will reduce the risk of malfunction as described above. SHK concludes therefore no reason to give any recommendation in this respect.

2.3 Primary technical malfunction

At the technical investigation it was found that two of the o-rings in the lower part of the shock strut was defect. One of these, the lower, provides the seal between the lower part of the strut (the gas filled unit) and the cylinder plug (see 1.16.2).Therefore everything points to the fact that the stated pressure loss in the nose gear was caused by a gas leak at this o-ring.

Exactly when the leakage occurred can not be determined. As the leakage during the testing, in connection with major temperature changes, from colder to warmer, this leak may already have occurred before take off at Plovdiv.

Against this stands the fact that the pilots did not observe any abnormalities in the landing gear in connection with the pre-flight check, and also

that they experienced the normal “bowing” of the aircraft when power was increased at take off.

Therefore it is likely that most part of the pressure loss occurred during acceleration on the uneven runway during take off. The area with the cylinder plug containing the actual o-ring, and where the nose wheel fork was attached, was particularly exposed.

2.4 Classification of Take Off and Landing Runways

The regulations concerning classification of runways are to be found in Annex 14 to the Chicago convention. Chapter 3 consists of take off and landing runway conditions, requirements and criterions regarding the quality. This chapter contains however no recommendations regarding unevenness.

These are to be found in sub appendix of the annex, points 5.1 and 5.3. The texture lacks though descriptions and/or recommendations giving regarding different conditions a runway of concrete will bring about.

In the manuals that Luftfartsstyrelsen (Civil Aviations Authorities) has approved as aids for planning and navigation, there is no distinction made between runways of asphalt and concrete respectively. SHK´s opinion is that this information could be significant for certain operators in connection with the planning of flight, and regarding choice of aircraft type.

3 CONCLUSIONS

3.1 Findings

a) The crew members were qualified to perform the flight.
b) The aircraft had a valid Certificate of Airworthiness.
c) The crew had no information about the condition of the runway in LBPB.
d) The nose gear nitrogen cylinder could under certain conditions leak.
e) Two of the o-rings in the nitrogen cylinder were defective.
f) At one of the defective o-rings was detected a leakage.
g) The nose gear piston had not sprung out to necessary length.
h) The nose wheel got jammed in a partly retracted position, with an emergency landing as a consequence.

3.2 Causes

The accident was probably caused of aircraft operation on a very uneven runway which caused damages to the nose gear. The damages resulted in a jammed nose gear in a partly retracted position with an emergency landing as a consequence. Contributing has been an unfortunate construction of the nose gear retraction mechanism on the aircraft type.

4 RECOMMENDATIONS

The Swedish Civil Aviation Administration is recommended:

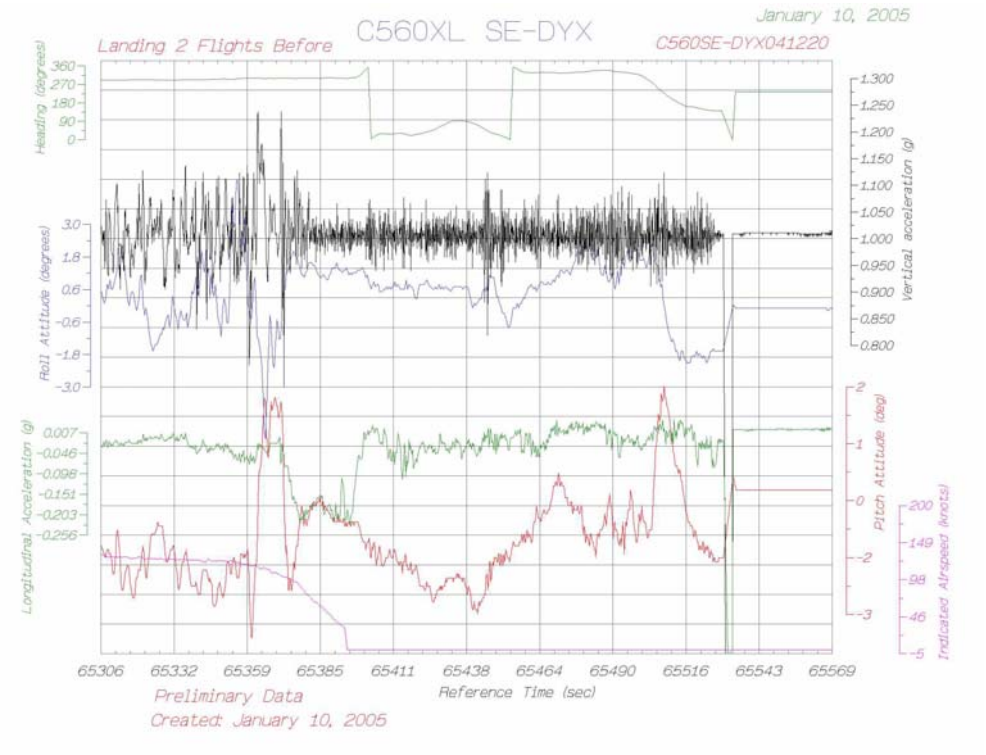
- In collaboration with the international civil aviation authorities, to encourage the creation of a suitable classification which will be introduced considering quality and condition concerning surface and unevenness on runways *(RL 2006:14e R1)*.

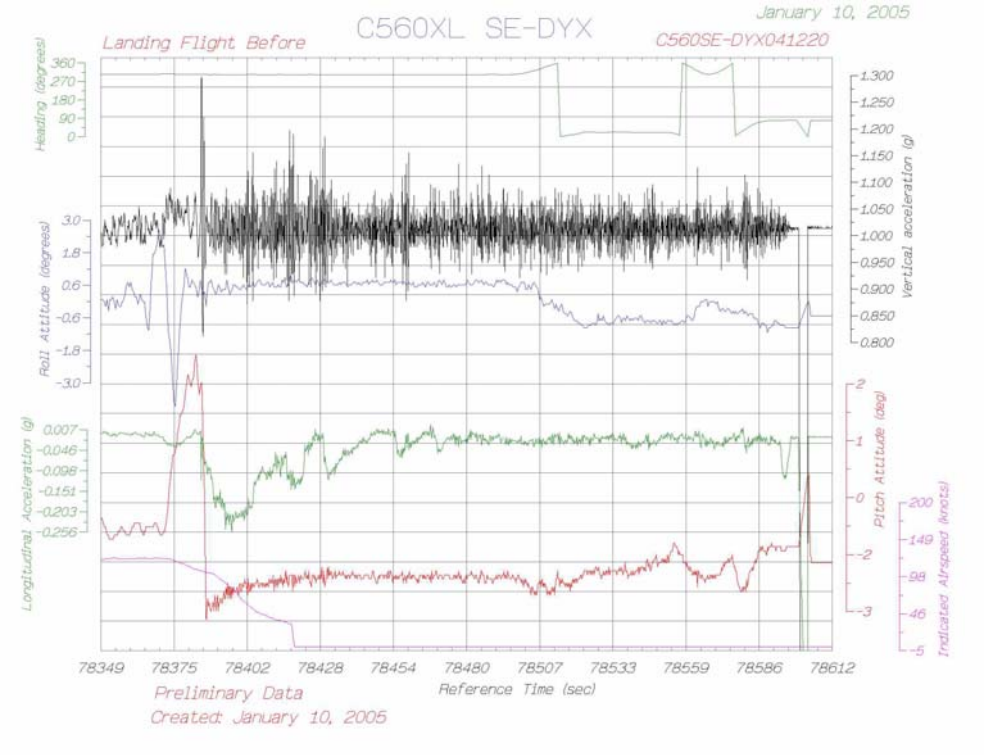
- Work for that information about the real surface is introduced as a standard on landing charts in Route Manuals *(RL 2006:14e R2)*.

- Investigate whether there is a need for special regulations concerning low fly-by passes and if such a need is identified, to issue such regulations. (RL 2006:14e R3).
  (Compare with the SHK document in item A-41/06 in Appendix 3 of this report.)

Appendix 1

FDR Print Out.





Appendix 2

SE-DYX Radio traffic and internal communication

Summary

Print-out has only been done of information which is of interest of the course of event.

Headlines

Time: Time for the message. The time reference has been set to zero at the beginning of the recording.

From: Origin to the message
FC - Captain at track nr 2 (left side)
FP - Co-pilot at track nr 1 (right pilot)
WARZ - - Warszawa control
Malmö - Malmö control
STO - Stockholm control
APP - Arlanda approach
ARR - Arlanda arrival
TWR - Arlanda tower
ATIS - Automatic terminal information service (Arlanda)

Not: Annotations
- Interphone.

Information: The message printed out in plain language.
?? means that it has not been possible to interpret the information.
(Parenthesis is used to indicate that the interpretation is uncertain).
[Angle brackets are used to indicate comments].

Time	*From*	**Not**	**Information**
00:00:00	FC	#	It's not often that we have such a fuel on 500.
	FP	#	Well, no.
	FC	#	It's better than bravo on 410.
	FP	#	Yes.
00:00:09	FP	#	Would you like hearing a thought?
	FC	#	Yes.
	FP	#	Let me say clearly here now before you.... say anything.
	FC	#	Yes.
	FP	#	If we in this situation, not right now, but closer to Sweden, if so to speak, should extend the gear on altitude, blow it and get three green, shouldn't that also mean that we get rid of hydraulic press, but that we simply, if it is so that it goes in up- or in down-lock, that we get so much pressure so that we get rid off the stab miss compare.
	FC	#	That we could get yes. But.... we haven't got so much use of that because there are so much more drag with those gears than we have with that speed there.
00:00:49	FP	#	Yes, no but therefore I thought when we about are coming up over the Highland of Småland just when we start to descend. Do you understand the thought?
	FC	#	Ehh… I don't really understand the point of that…. Do you mean we have got more time of thinking?
	FP	#	Yes.
	FC	#	Yes... I can't see any big advantage of that... because... it is first a damn noise for the passengers at the back too.
	FP	#	Yes, of course that is secondary right now, but I understand your thinking.
	FC	#	If we can keep them comfortable as long as possible it's good I think.
	FP	#	But do you understand the way of thinking?

	FC	#	Yes, off course that if we get three green ... but I don't think we will get that you see.
	FP	#	When we are blowing?
	FC	#	Yes. No, when we extend we will not get it anyhow.
	FP	#	That we have tested once, we didn't get it, though.
	FC	#	I don't think we will get it either. I don't think we will get rid of the gree... red light.
	FP	#	In which situation do you talk about now? After we have been blowing or only when we have extended?
	FC	#	No, I don't think we will get three green lights there, at the landing.
	FP	#	After we have been blowing?
	FC	#	Yes. Because the switch is damaged... it's very powerful hydraulic, thus, but if it takes so much so we will not get it out, I think that switch is damaged. But I believe anyhow that the gear is out, I believe so. And it performs so that it demands oil the whole time now, right, so that it isn't able, damned it, to pull.
	FP	#	No.
	FC	#	I think we will land with a serviceable aircraft, but however we will not have green lights.
	FP	#	No. And then we will remain on the runway.
00:03:01	FP	#	Then I'm with you.
	FC	#	For that switch, it will be the same even if we have air or oil right….and if it doesn't extend on oil, because there is a hell of overcapacity on the hydraulic.
	FP	#	Yes that I have understood.
	FC	#	Its 22, closer to 22 gallons per minute right, in flow on that one.
	FP	#	Then it is good speed.
	FC	#	Yes. And 3000 psi thus, so that... it only works in 100 psi to begin with when you close it, or 1000 psi is it, right… 1000... Is it 1000 or 3000, 1000 psi it is..
	FP	#	Isn't it 1500 when you….
	FC	#	Yes, it is possible that I think bravo a bit because that's the aircraft I have been working mostly with. If it is 1000 or 1500 it's a hell of a pressure anyway. So, it will slam out so it just....
	FP	#	Bang about it.
	FC	#	It's different when you run it in the hangar with that small hydraulic power unit we had before, there was no power on that one, was it, so it performed too slowly. But if you have a real hydraulic unit which give as much as the one on the aircraft here, then it is unbelievable, right.
00:04:10	FP	#	That's right. Steve had told that… he didn't have the whole picture, but he said that there were better capacity at Bromma than what we have at Arlanda.
	FC	#	What did you say, better?
	FP	#	We have better capacity to take care of the aircraft at Bromma than what we have at Arlanda. He has informed Christer if we have flaps, so we have that, we don't know if we have brake steering, we don't know anything … that's why we want such a long runway as possible.
	FC	#	Yes, and so they have better rescue too, it's the rescue I'm looking for.
00:04:55	FC	#	I may not use any reverse if we will not get all gear out, because then maybe we will get a lot of shit in the engine… pull up asphalt and things and so we will get into the engine.
	FP	#	Yes, you mean if it collapses?
	FC	#	If it collapses, yes.
	FP	#	Yes then we will brake anyhow.
	FC	#	Yes.
	FP	#	Is there any reinforcement under there, or?
	FC	#	No, not that can stand these. It's only sheet that gives in, thus
	FP	#	Yes, in it's self it is rather much before....
	FC	#	We don't need to raise our feet then.
	FC	#	But the gear is placed under here you know, in this box, thus, it's not fare away you know.
	FP	#	We can't creep down and fix a little, it's only (40) degrees :-)
00:06:20	FP	#	Now we are leaving Poland.
	FC	#	Gdansk.
00:07:45	FC	#	…look, we have a little higher landing speed, or a little higher weight. Yes, we have put on a hell of a lot, it is probably cool(OK)

00:09:11	FP	#	What are we doing with the hydraulic pump then, do they send it to overhaul, or?
	FC	#	No, one doesn't do that.
	FP	#	It has performed well, but on the other hand so, yes...
	FC	#	It usually runs so little that…
	FC	#	If I had flown Citation 7 e.g. so maybe I shouldn't have done like this when you have hydraulic?? And things....
	FP	#	No, that can't be a big shot.
	FC	#	No then I hadn't dared to do that, then I had, thus...
	FP	#	…. proceeded to Sofia.
	FC	#	Yes, precisely.
	FP	#	Because it won't take many minutes to go there.
	FC	#	No.
00:11:11	WARZ		SE-DYX Warszawa contact Malmö radar 128,05.
	FP		128,05 SYX, good night.
	FP	#	Shall we inform him about the diversion?
	FC	#	No, you, wait a minute, why shall he Malmö, he will of course direct… we can wait a little while (bit).
	FP		Malmö good evening, SE-DYX flightlevel 410 inbound Penor.
	Malmö		Good evening SE-DYX Malmö radar contact.
00:12:25	FP	#	Runway 26 we assumed then. Yes Trosa 3 Tango. Yes, if they ask something we say that we have technical reasons, and then we won't say anything more. If they ask something more then we say that we are working on (dealing with) it.
	FC	#	Yees.
	FP	#	But I ask for diversion here then.
	FC	#	Yes, we like to divert. Nothing more.
	FP	#	No.
00:12:53	FP		Malmö from SE-DYX we have a request, diversion from Bromma to Arlanda.
	Malmö		SE-DEX, YX confirm … arrival at Arlanda instead.
	FP		Yes confirm we are going to Arlanda instead of Bromma and I am reading you 2, you are kind of weak.
	Malmö		Understand, you request Arlanda call you back.
	Malmö		SYX fly direct Trosa.
	FP		Direct Trosa, YX.
00:14:26	Malmö		SE-DYX you are recleared Arlanda instead of Bromma.
	FP		Thank you so much, YX.
00:16:23	FC	#	Now the flaps are up, you.
	FP	#	Yes it is damn it, you. He has worked up some pressure now then.
00:18:09	FP	#	Yes, then it might has been laying and worked itself up accordingly. Got a bit of…. pressure.
	FC	#	Yes the accumulator is alright anyhow.
00:27:04	FP	#	[after phone call with "Christer"] He, Roger will try to get himself out there. He said, that when we have extended the gear, afterwards, and blown and everything, if it is so that we got three green, it might work even if we only got two green I don't know, retard the throttle fully and see if we get a warning when we have the flaps up, and then we will have this warning, you know, on the gear. If the gear is not down….
	FC	#	Isn't that on the same switch then?
	FP	#	No, that's that I don't, Christer said this.
	FC	#	Oej. It's possible that it is click click click, you know there are three things there, you know.
	FP	#	But you only get what he has told here. So, extend and blow and everything, and oh retard the throttle, see if we get a warning.
	FC	#	Yes, extend first.
	FP	#	Yes, extend first.
	FC	#	Yes.
	FP	#	And then we can turn the rotary-switch he said, check if, it was apparently some malfunction you and he had talked about on the ground that it didn't indicate anything or what in hell it was, he said that if you run the landing gear test. What was it you had talked about there?
	FC	#	No I don't know what it was, I don't remember. No.

	FP	#	And then whatever you do just when you have landed don't switch off the engines. That was his advice.
	FC	#	We must think that engine, if that engine starts.
	FP	#	Yes, as long as you have got them then we will have pressure don't we, he meant.
00:28:39	FP	#	So he said it, that if it is so that if you feel like and if you get time you are welcome to call me when you have blown the gear. I said I will do that if I just get time.
	FC	#	I don't think we shall do that.
	FP	#	I think we are busy then right.
	FP	#	I take an ATIS, is that alright? Do you take the radio?
	FC	#	Yes.
	ATIS		Arlanda arrival ATIS Alfa time 1850 ILS approach runway 26 braking action good time 1500 contamination damp and ice 1 mm 10 % transition level 55 braking action taxiways medium to good braking action apron poor departure runway 19 right metreport wind 210 degrees 6 knots visibility 6 km mist clouds broken 600 feet broken 1300 feet temperature 3 dew point 2 QNH 1007 hP tempo visibility 4000 meters broken 400 feet Arlanda arrival ATIS Alfa.
00:30:09	FC	#	Reduce the speed slightly.
	Malmö		SYX when ready descend FL290.
	FC		When ready descend FL 290, SYX.
	FC	#	Reduce more. Reduce more throttles.
	FC	#	290.
	FP	#	290, okey.
	FP	#	Set. Vertical speed.
	FC	#	Reduce 10% more. It went over 340 here you know, or 630, 640.
	FC	#	Now we will descend with one thousand sink rate instead.
00:30:58	FC	#	You set idle there yes.
	FP	#	Yes, 70.
	FC	#	You set idle.
	FP	#	Yes, now it is all the way back.
	FP	#	Runway 26 and the weather are not too bad. That means that it is fully o.k. to land but….yes… 210 degrees 6 knots 6 km, broken at 600 broken at 1300, 3 degrees 1007. And tempo it can be 4000 meters and broken at 400.
	FC	#	I set up some aids here then.
	FP	#	Yes thanks.
00:32:33	FC	#	Good we started the descending in time yes, because that the speed… we have zero there right.
	FP	#	Yes.
	FP	#	Arlanda DME locked. 10.1 at ESA that is the ILS on 26, 339 is the marker, the approach starts at two and five, glide path at 7, check marker at 1420, minima is 460 feet, 340 on the radar.
	FC	#	Yes, 340 on the radar.
	FP	#	High minimums there. Set, right side. If going around, turn right heading 300 as soon as possible.
	FC	#	Yes it is also there right, distance…
	FP	#	Yes 3,5 Arlanda. If going around turn and climb to 1500.
	FC	#	And course 300, you said.
	FP	#	Course 300. And this arrival you can probably set up, runway 26, was it called Trosa 3T, do you want that one?
	FC	#	Yes.
00:35:57	FP	#	Right, here you get the descend checklist, then.
	Malmö		SE-DYX contact Stockholm 133,45.
	FP		133, 45 YX Bye-bye.
00:36:16	FP	#	Thank you. 200 knots there. It was also. Wasn't it also, right.
	FC	#	Yes that's right. Yes it is also but it is the mach meter now right?
	FP	#	No it is knots now. Max 200 or the other one.
	FC	#	Good. Just going to look not at the knob right now. Shall we just check if it was the trim how it works? It feels a bit hard, we slow down more, a little, back 5% more.
	FP	#	Yes, it's idle there so...
	FC	#	Yes good, if we keep that instead, I throttled up you know. A hell of luck we started in time thus.
	FP	#	Windshield is on. Anti ice, let's see if we need it later or.

	FC	#	Yes we switch it on now.
	FP	#	Yes, we switch it on at once, pressurization 200 feet, correct.
	FP	#	Crew briefing.
	FC	#	Yes, ILS to26.
	FP	#	Yes, FMS avionic and flight instruments, all set. Landing speed set. Go around N1, it was 3 degrees, 86,0
	FC	#	86,0.
	FP	#	Yes, and cross feed, that's O.K. And APU, shall I contact Stockholm? What was it called, it is Juliet, no it is Alfa was it called.
	FP		Good evening Stockholm, SE-DYX we are descending flight level 290 inbound Trosa with Alfa.
	STO		SE-DYX Stockholm radar contact follow Trosa 3T runway 26 Arlanda.
	FP		Trosa 3T for 26 at Arlanda YX.
	STO		SYX descend FL190.
	FP		Descending level 190 YX.
	FC	#	190 set.
	FP	#	Checked.
00:38:22	FC	#	I think it should be stated that you had to start with an early descend on hydraulic pressure failure and miss compare there. It is not so good to take out speed brakes when you can't get them in afterwards either.
	STO		SYX continue direct TEBBY you will have vectors 26.
	FP		Direct TEBBY for vectors 26, YX.
	FC	#	28.
	FP	#	Yes, no I have no list you know.
	FC	#	What list are you thinking of?
	FP	#	Yes blow gear and …
	FC	#	No but I can fetch it, anyhow I shall check that the cabin is quite well.
	FP	#	O.K.
	FC	#	Then you have control of the speed? (That it doesn't set…)
	FP	#	?? 28 also.
00:43:18	STO		SYX descend to FL110.
	FP		Descending level 110, YX.
00:43:45	FP	#	They received it well?
	FC	#	Yes yes, I said exactly as it was, that I will extend the gear early, and if it doesn't work I will blow. If we get no indication then I will declare emergency and so you might see blue cars as flashes after landing but I will inform further on the radio I said.
	FP	#	Yes. We are cleared down to110. 1007 I set on the stand by.
	FC	#	1007 yes.
00:45:02	FC	#	It was hell of luck that we …
	FP	#	… started in time. Yes we are descending on idle the whole time here now. Shall we (switch) on the Pax Safety so that they won't stand up, shall we?
	FC		No, no one will do that now. (One has moved aft also).
00:45:46	FC	#	Now he starts to trim backwards again, how nice.
00:45:52	FC	#	Now this isn't ....because also when it was up around 200 exactly then it was heavy to hold.
	FP	#	That was exactly what the autopilot could stand.
	FC	#	But it's good you get a warning there.
00:46:44	FP	#	Yes, you have to say when you want to extend so I start to read the list then. Christer told us, in it self, to that one we shall not, we shall pull it, I did know that you did know so therefore I did not talk anything more about…..
	FC	#	No, good you didn't nag about it because I thought that if the gear falls down then I think it was boring and start push it in again then.
	FP	#	That he had even got from (Wichita) then.
	FC	#	Yes I understand that. But I thought upon that there are two things which control the devil then the hydraulic will work anyhow.
	FP	#	Now the speed is coming back anyway.
	FC	#	Yes I saw that. Now it's well trimmed there, now we will throttle up a little more so we won't misbehave here.
00:48:13	FC	#	If you set (that on) pass safety on then everything will light up. Then we will not?? As we need either, but perhaps that will do it now anyway.

	FP	#	You will not make fuss with a fly by over the tower or something like it?
	FC	#	No, no. It's impossible to see anything now anyhow. On daytime you know.
00:49:54	FC	#	Tell Arlanda that we are keeping speed down due to that we got a hydraulically, hydraulic failure, because just now we don't need any priority. We are going to fly below 200 knots.
	STO		SE-DYX contact Stockholm 126,65.
	FP		126,65, YX, good evening.
	FC	#	Now we are on approach also. You can take a new ATIS before you talk to them.
	ATIS		Arlanda arrival ATIS Bravo time 1920 ILS approach runway 26 braking action good time 1500 contamination damp and ice 1 mm 10% Transition Level 55 braking action taxiways medium to good braking action apron poor departure runway 19 right metreport wind 230 degrees 6 knots visibility 6 km mist clouds broken 600 feet broken 1300 feet temperature 3 dewpoint 2 QNH 1007 HP tempo visibility 4000 meters broken 400 feet.
	FP		Stockholm good evening, SE-DYX descending 110 inbound Tebby we have Bravo.
	APP		Good evening SE-DYX radar contact, descend to FL70.
	FP		Descending level 70 YX.
	FP		And Arlanda from YX.
	APP		Go ahead.
	FP		For your information we are keeping the speed down we have hydraulic problem but it's not affecting us at this time but we need to keep speed below 200.
	APP		O.K. Roger.
	FP	#	Yes, then he got to know what he needed I think.
	FC	#	Exactly.
00:52:51	FC	#	I take vertical speed so we get down a bit there so we can have a little, sneak, put myself a bit higher because I have a chance to that now. Taking vertical speed there instead. Pulling off a little bit there so it will increase to 15–1700 something, what.
	FP	#	Yes.
	FP	#	When we finally get the gear down later then it won't be any problem to keep the speed.
	FC	#	But it is better to conflict 70 there and perhaps we should have 4000 there, it is so I mean, right.
	FC	#	Plaits for any other runway you have not to far away, right? If it should be needed.
	FP	#	No it is right there beside. Then they may vector us around.
	FC	#	Yes, vectors we can do. But I mostly thought of setting an ILS- frequency.
	FP	#	Yes, then I turn it in (set it up). Yes you mean now that if we say that we have an emergency and he asks if we can go to19 left or something like that?
	FC	#	Yes.
00:54:18	FC	#	Which one is it for take off?
	FP	#	19 right.
	FC	#	19 right, then we shall have19 left in that case.
	FP	#	Yes. Shall we go for this, so we will know?
	FP	#	Then I say this: landing gear will not extend checklist, abnormal procedure.
	APP		SYX what speed will you be able to keep on final?
	FP		Normal speed 180 190 YX.
	APP		O.K., thank you.
	FP	#	Landing gear handle, check down. [mechanical sound] Yes. Gear control, circuit breaker left hand panel , check in.
	FC	#	Gear control, is in.
	FP	#	Yes. Auxiliary gear control, pull T-handle and rotate to lock.
	FC	#	Yes, but first I will take down this a bit and see what this can do before we lock it, right. That we agreed about didn't we?
	FP	#	Yes
	FC	#	And we have speed for flaps.
	FP	#	Of course.
	FC	#	But that's not enough, or?
	FP	#	7.
	FC	#	7 is enough.
	FP	#	7 is enough. Are you going to land with 7, yes that you will do, yes. Or are you going to land with 15.
	FC	#	I am allowed to land with no flaps also so that….

	FP	#	No but what did you think to do. That is approach??. Auxiliary gear control, pull T-handle.
	FC	#	Wait a minute.
00:56:41	FC	#	Both.
	APP		SYX descend to altitude 5000 feet QNH 1007.
	FP		5000 feet on 1007 YX.
	FC	#	1007.
	FP	#	Yes. And through 8000.
x	FC	#	Yes. There. And so we do like that, so we get a little de-icing so we don't blow something else. And then we will, one more time, agree?
	FP	#	Yes, do you want that?
	FC	#	Yes.
	FP	#	Then (stabmiscompare) is out.
	FC	#	Yes you thought of that one down there yes.
00:57:23	FP	#	Yes.
00:57:36	FP	#	No.
	FC	#	Nehepp.
	FP	#	Pull and turn.
	FC	#	So now I have done them. (yawed) aircraft, lets skip it.
	FP	#	Yes. Auxilary gear control, pull knob to blow down. …Yes not much happened. Yes gear indicates.
	FC	#	Gear indicated lights.
	FP	#	Checked three greens. Thousand to go.
00:58:20	APP		SYX maintain your present heading you have around 35 miles to fly.
	FP		YX, heading.
	FP	#	Do you get blue dot? Are we on heading?
	FC	#	Yes, I can't get it out??
	FP	#	Auxiliary gear control reset knob and t-handle. Then we can't do much more.
	FC	#	No.
	FC	#	I can't get it in.
	FP	#	No, then I'll inform the ATC .Check speed.
00:59:11	FP	#	You are with me on a mayday?
	FC	#	Yes, we need priority, not priority landing, but
	FP	#	No an ordinary mayday, right?
	FC	#	Yes. Declare an emergency.
00:59:27	FP		And Stockholm from SE-DYX we are declaring an emergency, mayday, mayday, mayday. We are unable to establish gear down and lock so we need equipment standing by.
	APP		SYX roger and still your present heading for runway, would you like 01 left instead that would give you 6 knots tailwind?
	FC		Negative.
	FP		Negative on the tailwind we are uncertain about the flaps too, so we need as much headwind as possible.
	APP		YX roger would you like to make a fly-by to just establish that the gear is down?
	FP		No, negative on that we will perform everything I don't think you can see anything it's an indicator.
	APP		O.K.
	FP		Thank you anyway.
01:00:16	FC	#	Oh yes. I am flying. Tell the passengers that we still haven't got the light, lack the nose gear…yes I thought you could take that instead, so I will fly.
	FP	#	All right, but I haven't got that possibility here.
	FC	#	Oh yes, cabin, same panel.
	FP	#	Well there yes.
	FP	#	[Communication over PA to the passenger] This is from the cockpit. We are unable to establish gear down locked so we need to perform an emergency landing. We report on Arlanda and they have equipment standing by just in case you see blue flashing lights. We will be down in about 5, 10 minutes.
	APP		YX persons on board.
	FC		We are six persons onboard totally and we have 1200 tons of fuel.
	APP		Thank you.
01:01:24	FP		And that's nose gear unlocked light.
	APP		YX Roger to that.

	APP		YX you will have 25 to 30 miles from present runway 26 as number 1 shortly.
	FP		YX Roger.
	APP		And YX at pilots discretion cleared 2500 feet.
	FP		2500 pilots discretion, YX.
	FC	#	2500.
	FP	#	Yes.
	FC	#	So that was that. Do we set the ILS, inboard course…
	FP	#	Is... 253.
	FC	#	253.
	FP	#	Shall (we) do the normal approach, altimeters 5000 1007, reckon lights are on, passengers, they are briefed and seated, lights are on, (lavdoor) is open, and annunciator panel is ”as is”, and flaps 7. Yes gear is down??
	APP		SYX contact Stockholm arrival 120,5.
	FP		120,5 YX, Bye.
01:02:57	FC	#	We start decend.
	FP		And Stockholm, good evening, SE-DYX we are descending altitude 2500 feet on 1007.
	ARR		SE-DYX radar contact.
	ARR		YX do you prefer standard procedure vectoring 10 miles final or a shorter final?
	FC	#	Yes that’s OK 10 miles.
	FP		10 miles is fine with us, YX. And you are informed about the condition?
	ARR		Yes I am informed.
01:03:47	FP	#	Are we fastened? Are you fastened?
	FC	#	Yes. For once we also take the one which is below..
	FP	#	We have no books or any shit here which can fly around and hit oneself in the head.
	ARR		SYX turn right by 5 degrees for a better intercept.
	FP		Right by 5, YX.
	FP	#	Do you want speed brakes after we have landed?
	FC	#	Yes.
	FP	#	We test.
	FC	#	Yes. I will also land with full flaps...Thousand checked.
	FC	#	What did he say? [on the radio regarding an another aircraft]
	FP	#	125,12
	FC	#	25,12?
	FP	#	Thought he said that. Yes that is true, Tower . 125,12.
	FC	#	Isn’t it 118,5?
	FP	#	No that is on the other runways then. 01/19 it is on that.
	FC	#	O.K. ... Yes let us hope so.
	FP	#	It will turn out all right.
01:05:47	FC	#	I can’t understand why the devil will not go further out.
	FP	#	Check speed there.
	FC	#	Yes.
	FP	#	Now you have 130 in approach.
	FC	#	Yes.
	ARR		SYX report your speed.
	FP		Speed 150 YX.
	ARR		SYX turn left heading 290 cleared approach runway 26.
	FP		Left 290 and cleared approach 26 YX.
01:06:52	FC	#	We haven’t got cleared for approach, right?
	FP	#	Yes, cleared approach 26.
	FP	#	Then the other will take runway 19 then.
	FC	#	Who is it that is flying ... is he on final??
	FP	#	Yes, he does, it was one who just came through??. Yes, we have not tree green but we have antiskid on, landing lights those we can switch on when we can see the runway, or we will become blind. Pressurization has dropped, ignition is on, we fly with anti-ice too
	FC	#	Anti-ice is on yes.
	FP	#	Flaps is 7, sync is off, speed brakes is in and threshold.
	FC	#	Then we are established.
	FP		And YX is established.
	ARR		SYX contact tower on 125,12.

	FP		125,12, YX bye.
01:08:14	FC	#	Switching off the anti-collision for a while?
	FP	#	Yes.
	FP		And Arlanda good evening, SE-DYX fully established ILS 26.
	TWR		SYX good evening 220 degrees 5 knots continue approach you are shortly number 1.
	FP		YX continue.
01:09:06	FP	#	Outer marker checked. 1430.
	FP	#	Thousand to go.
	TWR		SYX runway 26, cleared to land.
	FP		Cleared to land 26, YX.
	FC	#	Then set flaps in between.
01:09:32	FP	#	Flaps in between.
01:09:34		#	[Continuing pip-sound starts. Continues till 01:11:09]
01:09:35	FP	#	Yes, then they are not locked properly.
01:09:49	FP	#	Can you silence that one in a way? It can not be done, right?
	FC	#	I thought you could do that. Gear horn…
	FC	#	So, now we will land anyhow.
01:10:02	FP	#	You see the runway, anyway?
	FC	#	Yes.
01:10:05	FC	#	Flaps full.
	FC	#	This is going to blew... this will probably shake up a little then.
	FP	#	That's what you think?
	FC	#	Yes.
01:10:21	FP	#	There you have approach speed.
	FC	#	Yes checked.
01:10:30		#	[Signal sound from Middle Marker]
01:10:32	FP	#	Full flaps. Two green clear to land.
01:10:34		#	[Auto call "Too low, gear" repeated 9 times to 01:10:50]
01:10:42	FC	#	We don't need so?? speed either, what?
	FP	#	No.
01:10:52	FP	#	And all lights are on.
	FC	#	Just switch all on.
	FP	#	I have switched them on.
01:11:00	FP	#	Five feet.
01:11:07	FP	#	Speedbrakes?
	FC	#	No.
01:11:09		#	[Pip sound cease and a second later a light bump is heard]
	FC	#	Noo.
01:11:18	FC	#	No.
	FP	#	No.
01:11:19		#	[A sharp scratch sound. Continues to 01:11:38, i.e. 18 seconds]
01:11:21	FP	#	Speedbrakes, out.
01:11:24	TWR		Yankee X-ray does it feel well?
01:11:34	FP	#	It didn't go well. But it turned out well for us.
01:11:38	FP	#	So, now we evacuate.
	FC	#	Remember the door now.
01.11:41	TWR		Yankee X-ray Arlanda.
	FC		Yankee X-ray
01.11:44	TWR		Is everything alright, you may gladly remain there because we are landing on another runway here so that the runway may be blocked for a while.
01:11:52	FC		It didn't turn out well.
01:11:56	TWR		What has happened then?
01:11:58	FC		We have collapsed the nose gear.
01:12:00	TWR		O.K.
01:12:00			[Sound from a turbine which is winding down]
01:12:18			[Sound another turbine which is winding down]
01:12:25	TWR		YX do you want contact with the rescue team, and talk with them because they are right up around you?
01:12:31	FC		Yes I must, I will leave here shortly, we are evacuating.
01:13:16		#	[Click-sound and so the interphone recording becomes silent].
01:13:22	FC	#	Ignition. [Heard on Area Mike channel].

01:13:24		#	[several click-sound].
01.13:28	FC	#	?? everybody evacuated yet ?
01:13.42	FC	#	Does everyone feel well?
01:14:19	FC	#	No (injured), all feel well. We need a bus; you can take those passengers down?? Connecting flights?? Gothenburg. [Is faintly heard in the back ground on Area Mike channel]
01:15:10	FC	#	?? one more experience

Statens haverikommission
Swedish Accident Investigation Board

Appendix 3

2006-04-05

A-41/06
Dossier 3.1

The Swedish Civil Aviation Authority
SE-601 73 NORRKÖPING, Sweden

Low fly by passes in association with technical problems

The Swedish Accident Investigation Board (Statens Haverikommission – SHK) has noted in a number of investigations that are in progress where low fly-bys have been performed or been considered during various operational and weather conditions, following suspected landing gear malfunctions.

The applicable incidents are:

- L-50/04, Cessna Citation in December 2004 at Arlanda airport. Nosewheel collapse on landing on runway 26. Air traffic control asked if the aircraft commander wanted to perform a low fly-by. The aircraft commander declined due to the prevailing weather conditions.
- L-33/05, PA 31 in September 2005 at Umeå airport. Nosewheel collapse on landing on runway 32. A low fly-by was performed at a very low height above the runway.
- L-05/06, Avro RJ 85 in March 2006 at Landvetter airport. Nosewheel collapse on landing on runway 03. Low fly-by at low height in darkness.
- L-06/06, PA 31 in March 2006 at Umeå airport. Emergency landing on the airport after belly landing on snow parallel to the runway. Repeated fly-bys at low height.

The low fly-bys had the intention of trying to obtain visual confirmation of a suspected aircraft malfunction, usually concerning some part of the landing gear. Manoeuvres of this kind, as far as SHK knows, have become some sort of general practice where problems are experienced with the landing gear before landing.

SHK understands the need felt by an aircraft commander to obtain confirmation of faults and malfunctions in the case of aircraft types where the position of the landing gear cannot be seen from the cockpit. In many cases the landing gear may be assumed to be locked down even though the cockpit indications show this is not the case. However, no information to confirm whether the landing gear is locked down or not, can be obtained in this way. Nevertheless, there is a possibility of, for example, identifying a failure on one side, so that a judgement can be made concerning which is the most likely direction of a possible devation from the runway.

SHK considers that a serious problem is raised by the fact that these low passes are performed in uncontrolled ways without restrictions. Such low passes are naturally carried out at low speed in landing configuration, i.e. with landing gear and flaps extended. It should also be borne in mind that these low passes take place with an aircraft that is to some extent defective, by a crew at increased stress level preceding an expected emergency landing.

In one of the cases, that on 10 March at Landvetter, this manoeuvre was performed with a four-engined jet aircraft at approximately 300 feet in darkness along the area between the runway and the control tower. The aircraft was in commercial transport service with paying passengers on board. The level of risk associated with such a manoeuvre is naturally hard to assess, but seen from a broader flight safety perspective the subsequent emergency landing could be said to be less of a risk.

The investigations into the above-mentioned incidents are not yet complete. However, SHK wishes to draw the attention of the Swedish Civil Aviation Authority to this matter so that possible rules for low fly-bys can be considered and – if such rules are drawn up – issued without delay.

Stockholm as dated above

Göran Rosvall
Chairperson
The Swedish Accident Investigation Board