Statens haverikommission
Swedish Accident Investigation Board

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Aeroplane incident to OE-GVA on approach to Stockholm/Bromma airport in Stockholm County, Sweden on the 26th of November 2008

Case L-28/08

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Statens haverikommission (SHK) Swedish Accident Investigation Board

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Statens haverikommission
Swedish Accident Investigation Board

2010-11-05 L-28/08

Swedish Transport Agency/
Aviation Department

601 73 NORRKÖPING

Report RL 2010: 14e

The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an aeroplane incident that occurred on 26th of November 2008 involving an aeroplane with registration OE-GVA.

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.

Göran Rosvall Roland Karlsson

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Aeroplane; registration and model	OE-GVA, Learjet LR40 XR
Class/Airworthiness	Normal, Valid Airworthiness Review Certificate (ARC[1])
Owner/Operator	Credit Suisse, P.O. Box 1, CH-8070 Zurich, Switzerland/ Vista Jet Salzburg, Austria
Time of occurrence	26 November 2008, 13:30 hours, in daylight Note: All times are given in Swedish standard time (UTC + 1 hr)
Place	Nacka, in Stockholm , about 59 17 10N; 18 11 45E; about 200 m above sea level
Type of flight	Non scheduled flight
Weather	According to METAR[2] Bromma: Wind 260/06 knots, visibility 10 km, BKN[3] 700 feet, BKN 1000 feet temp./dewpoint 1/1 °C, QNH[4] 996 hPa
Persons on board:	2
crew members	2
passengers	0
Injuries to persons	None
Damage to aeroplane	No damage
Other damage	None
Commander/Instructor/Pilot in command:	
Age, license	47 years, ATPL-(A)
Total flying time	4912 h, of which 372 h on the type
Flying hours previous 90 days	120:41 h, all on type
Number of landings previous 90 days	76, all on type type
Co-pilot	
Age, license	27 years, CPL-(A)
Total flying time	629 h, of which 107 h on the type
Flying hours previous 90 days	78:09 h, all on type
Number of landings previous 90 days	53, all on type

The Swedish Accident Investigation Board (SHK) was notified on 15 January 2008 that an aircraft with registration OE-GVA had an incident on 26 November 2008 at 12:30 hrs at Nacka, Stockholm County.

The incident has been investigated by SHK represented by Göran Rosvall Chairperson, and Roland Karlsson, Chief investigator flight operations.

The investigation was followed by Britt-Marie Kärlin until September 9 2009, and thereafter by Billy Nilsson, Swedish Transport Agency Aviation Depart-

[1] ARC – Airworthiness Review Certificate
[2] METAR – METeorological Aerodrome Report – meteorological half-hourly observation on an airport
[3] BKN – broken cloud layer
[4] QNH – air pressure reduced to sea level

ment. The Board was assisted by Günther Raicher, Air Accident Investigation Branch, Austria, as accredited representative.

Summary

The aircraft was under radar vectoring to runway 30 at Stockholm Bromma airport, when it deviated from the cleared altitude and descended below the minimum obstacle clearance altitude. The air traffic control warned the pilots and called for a turn away from the obstacle. The aircraft was thereafter radar vectored for a new approach and landed without further incident at Stockholm Bromma airport.

There were no injuries to persons or property.

The incident was caused by inappropriate prioritisation and allocation of the pilot´s workload.

Recommendations

None.

1. FACTUAL INFORMATION

1.1 History of the flight

The flight was a non-scheduled flight without passengers, i.e. positioning flight, from Paris/Le Bourget to Stockholm/Bromma airport.

The aeroplane was on radar vectoring for an ILS-approach to runway 30 at Stockholm/Bromma airport when it departed from the assigned heading and cleared altitude and started to descend towards two radio/TV-broadcasting antennas located in the vicinity of the approach track. The aeroplane did not react when the pilot commanded a turn towards the airport on the autopilot, but continued straight ahead. When this was revealed by the pilots, the autopilot was disconnected and the turn was initiated manually. During the turn, the aeroplane unintentionally started to descend.

The deviation was observed by the air traffic control, ATC,[5] and the aeroplane was instructed to turn and climb to avoid collision with the antennas and the ground. After a go-around and a climb, and another radar vectoring the aeroplane landed routinely at Stockholm/Bromma airport. An occurrence report was filed by the air traffic control. The Commander reported to the operator of an aborted approach.

The radio/TV-broadcasting antennas, Fig. 1, are located in Nacka at position 59 17 46N, 18 10 34.9E. The height of the antennas are about 1 171 feet (about 357 m) above sea level and the lowest altitude of the aeroplane was about 650 feet (about 200 m). The minimum horizontal distance to the antennas was about 1.4 km.

Fig. 1. Radio/TV-broadcasting antennas in Nacka.

[5] ATC – Air Traffic Control

1.2 Injuries to persons

	Crew	*Passengers*	*Total in the aeroplane*	*Others*
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	–	–	–	–
None	2	–	–	2
Total	2	–	–	2

1.3 Damage to the aeroplane

No damage.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 Commander

The commander was 47 years old at the time and had a valid ATPL-(A).

Flying hours				
latest	*24 hours*	*7 days*	*90 days*	*Total*
All types	*2:30*	*8:36*	*120:41*	*4912*
This type	*2:30*	*8:36*	*120:41*	*372*

Number of landings this type previous 90 days: 76.
Flight training and Skill Test on type was concluded in July 2005.
The latest Operator´s Proficiency Check[6] (OPC), on Learjet 45, was performed on August 8 2008, and the Proficiency Check[7] (PC) was valid through May 2009.

1.5.2 Co-pilot

The co-pilot was 27 years old at the time and had a valid CPL-(A).

,				
latest	*24 hours*	*7 days*	*90 days*	*Total*
All types	*2:30*	*10:50*	*78:09*	*629*
This type	*2:30*	*10:50*	*78:09*	*107*

Number of landings this type previous 90 days: 53.
Flight training and Proficiency Check (PC) on type was concluded on August 4, 2008.

1.5.3 Cabin crew

None, not required.

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[6] Operator´s Proficiency Check – required proficiency check by the operator every six months

[7] Proficiency Check – Required proficiency check by the aviation authority every twelve months. Skill Test is considered equivalent to PC

1.5.4 The crew members´ duty schedule

Both pilots had been on duty 5 h and 50 min before the incident and was preceded by a rest period of 12 h and 48 min. Both the duty time and rest period were within the prescribed limits.

1.6 Aircraft information

1.6.1 Airworthiness and maintenance

Aeroplane	
TC-holder	Bombardier Aerospace
Model	Learjet LR 40 XR
Serial number	45-2079
Year of manufacture	2007
Gross mass	9 299 kg
Total flying time	947:56 timmar
Number of cycles	745

The aeroplane had a valid ARC, and the aeroplane had no remaining technical complaints relevant for the incident.

Learjet LR40 XR, Fig. 2, is a high-technology airplane with the latest standard of instrument and navigation equipment installed. SHK therefore finds it relevant to elaborate, in Section 1.16.5, on some important systems and instruments that the pilots use in flight. The purpose is to highlight the large amount of information and multiple systems that the pilots have to manage, particularly during approach for landing.

Fig. 2. Learjet LR40XR, OE-GVA. J. Wornham©, with permission.

1.7 Meteorological information

According to METAR Bromma:

Wind 260/06 knots, visibility 10 km, BKN 700 feet, BKN 1000 feet temp./dew point 1/1 °C, QNH 996 hPa.

Daylight prevailed during the incident.

1.8 Aids to navigation

1.8.1 Ground based systems for self-navigation

Runway 30 at Stockholm/Bromma has a precision-approach landing system, ILS[8], located at the airport, and a non-directional radio beacon, NDB,[9] with identification code OU, located at about 6.7 km from the runway threshold. At about 14.3 km from the runway there is another NDB with identification code NAK. It is located about 2 km to the northeast of the approach track and in the vicinity of the radio/TV-broadcasting antennas in Nacka.

Before entering Stockholm TMA[10] the air traffic is normally cleared by the ATC via a standard arrival route, STAR[11], to the runway in use at Stockholm/Bromma. STARs for self-navigation to runway 30 are published in the LFV IAIP[12], Fig. 3. Approach procedures are also published in the LFV IAIP, both for ILS and NDB approaches, Fig. 4.

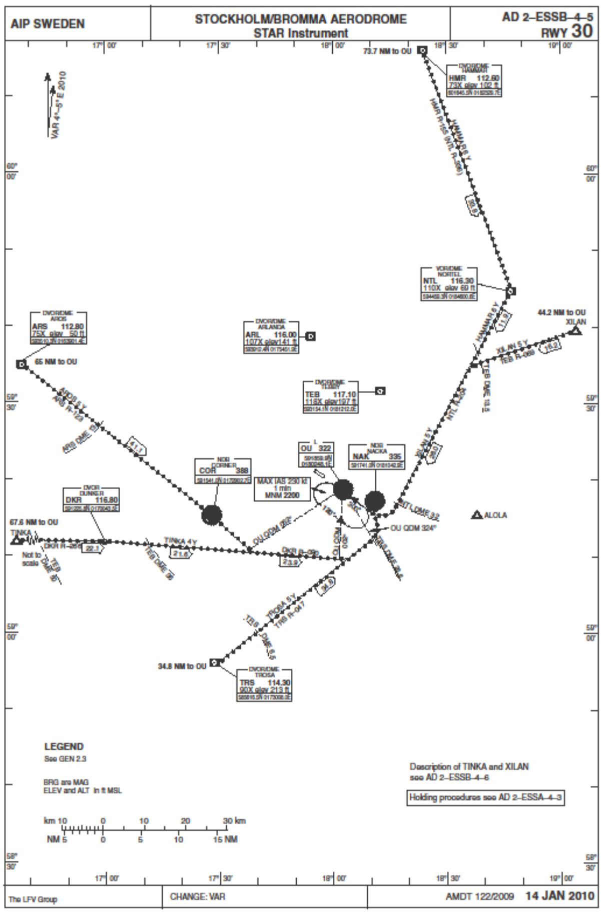

Fig. 3. Standard Arrival Routes to runway 30 at Stockholm/Bromma airport. LFV IAIP.

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8 ILS – Instrument Landing System – precision approach landing system with lateral and vertical guidande

9 NDB – Non-Directional beacon – Radio beacon for non-precision approach with lateral guidance

10 TMA – Terminal Area – controlled airspace for departure and approach to one or more airports

11 STAR – Standard Terminal Arrival Route – standardised flight track issued by LFV

12 LFV IAIP – Integrated Aeronautical Information Publication – flight information publication issued by the LFV

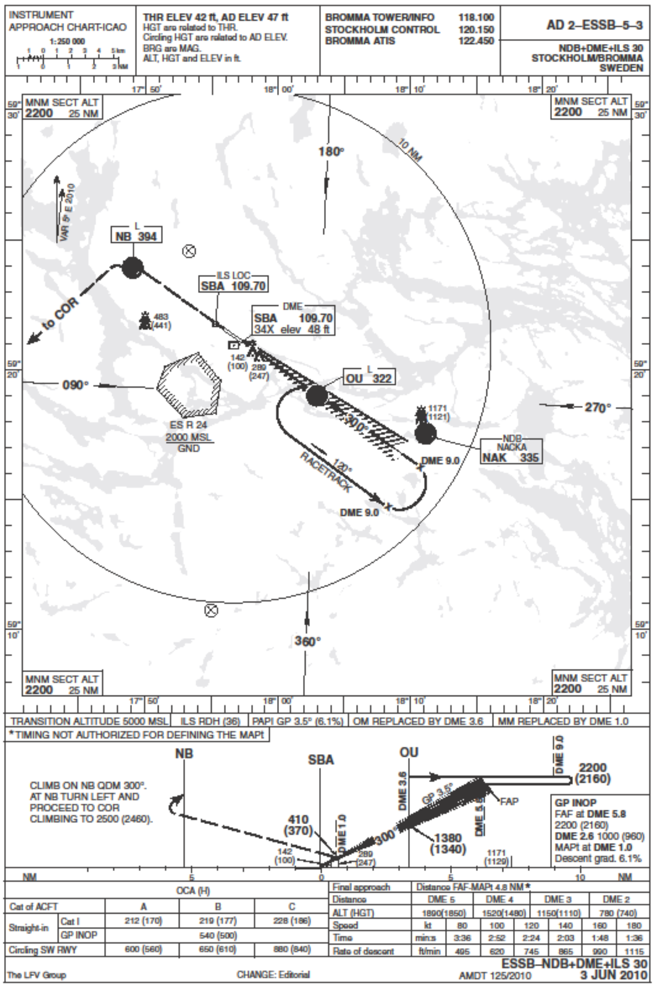

Fig. 4. Approach chart to runway 30 at Stockholm/Bromma airport. LFV IAIP.

1.8.2 Radar vectoring for approach

The TMA is monitored by radar in ATC. Within the TMA, radar vectoring of air traffic is used for separation, shortening of flight or to facilitate an approach procedure. It is common practice that aircraft are cleared by self-navigation via a STAR and later is radar vectored on tracks that deviate from the STAR. In such cases the ATC vectors aircraft to a position and on a convenient heading for the final approach. During radar vectoring the responsibility for separation to the terrain rests with both the Commander and ATC.

1.8.3 Automatic approach

The current most common commercial airplane types are able to automatically intercept the approach procedure from a position close to the approach track, and thereafter perform an automatic ILS-approach to the decision altitude.

The majority of commercial aircraft are also equipped with a Flight Management System, FMS[13]. With the help of FMS, the flight can in advance be programmed to follow a STAR and ultimately an ILS-approach. By linking together the FMS and the autopilot, the aircraft can automatically fly both the STAR and the final approach. The role of the pilots is then mainly to supervise the

[13] FMS – Flight Management System – computerized system that manages the flight according to flight plan and pilot´s input

flight, and when necessary take over the control by manually operating the autopilot or to maneuver the aircraft by the control columns.

1.9 Communications

The radio communications between the ATC and the aeroplane was recorded and safeguarded.

1.10 Aerodrome information

The airport was an instrument aerodrome with runway reference code 2C, according to the LFV AIP-Sverige/Sweden.

1.11 Flight and voice recorders

Flight and voice recorders were installed in the aeroplane, but were not safeguarded, since the incident was known to SHK six weeks after the incident.

1.12 Location of the incident

1.12.1 Location of the incident

About 1.4 km south-southeast of the radio/TV-broadcasting antennas in Nacka, about 200 m above the mean sea level.

1.12.2 Aircraft wreckage

Not applicable.

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

There was no fire.

1.15 Survival aspects

Not applicable.

1.16 Tests and research

1.16.1 Interviews of the pilots

The flight was initially cleared to Stockholm/Bromma via the STAR Trosa 5Y. The co-pilot was Pilot Flying, PF[14], while the Commander was Pilot Non-Flying, PNF[15], and performed the other flight operational tasks like radio communication and checklist reading. According to the pilots, it was common practice with the operator to let the co-pilots act as PF, on empty flights while the Commanders were acting PF on flights carrying passengers. The intention was that the Commanders during empty flights would pay particular attention to communicate experiences and provide some instructions to the normally less experienced co-pilots.

The flight was radar vectored at the incident; the co-pilot was PF and was operating the aeroplane on autopilot according to instructions from the ATC about heading, altitude and speed. The minutes preceding the incident there was one instruction about heading change and four instructions to reduce the speed. When the new heading, left 330 degrees, was confirmed, the PF selected the new heading on the autopilot panel. The flight was at the same time cleared for ILS-approach, and the APPR[16]-mode was selected on the autopilot panel. The aeroplane was apparently not commencing the turn to the new heading, but continued straight ahead. The pilots were at this moment also busy with check-list reading and other preparations for the imminent landing.

When the pilots realised that they were going through the approach track, the PNF disconnected the autopilot and made a steep left turn to join the inbound track. This action was aimed at helping the PF to quickly point the aeroplane into the approach direction. The PNFs take-over of the controls was not made by the use of standard phraseology. During the left turn towards the approach track, the aeroplane started an unintentional descent. There was no formally correct transfer of controls back to the PF.

The ATC gave warnings and instructions to immediately turn to a heading of 270 degrees and commence a climb, which were confirmed by the pilots.

Somewhat later the GPWS[17]-warning was triggered and the PNF regained the control of the aeroplane by the phrase ”I have it”, and commenced a go-around[18] and a left turn. The PNF claims that he had visual contact with the ground at this moment, but not with the runway, and that he was aware of obstacles in the area, i.e. the radio/TV-broadcasting antennas. After climbing to 2 500 feet, the ATC issued new headings and the approach to runway 30 på Stockholm/Bromma was carried out with no further deviations.

According to the Commander the minimum altitude of the aeroplane was about 1 700 feet at the incident.

1.16.2 Recorded information from the ATC radar

The progress of the flight, heading, altitude, speed, time and the transponder code were routinely recorded at the ATC.

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[14] PF – pilot at the controls

[15] PNF – assisting pilot

[16] APPR – selectable approach mode of the autopilot for automatic ILS-approach

[17] GPWS – Ground Proximity Warning System – automatic terrain warning collision system with voice- and light warnings

[18] Go-around – aborted approach

In Fig. 5, a screen-dump is shown, i.e. a snap-shot from the ATC radar. The image shows the position of the aeroplane in relation to the nearest of the two radio/TV-broadcasting antennas, when the lowest altitude of the aeroplane was recorded.

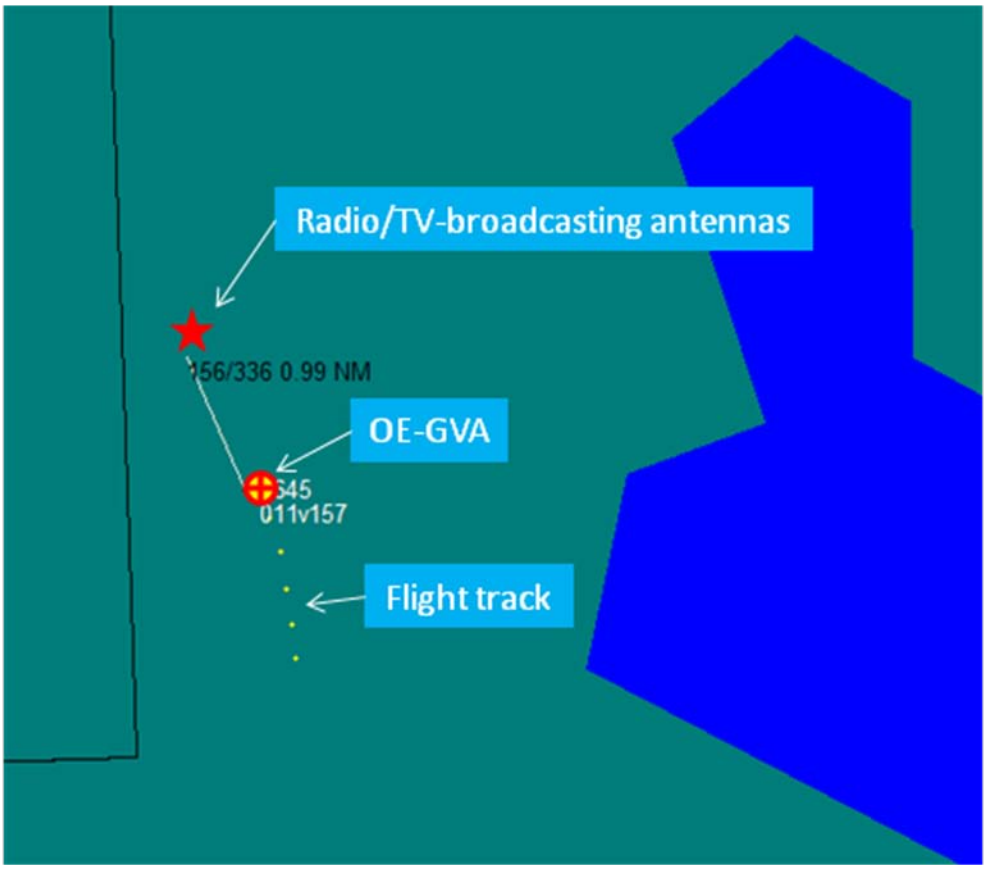

Fig. 5. Zoomed radar image showing the position of the aeroplane at the lowest recorded altitude.

The numbers in Fig. 5: 156/336 0.99 NM, represent: bearing in degrees to and from the antennas, and the distance to the aeroplane in Nautical Miles – 0.99, this corresponds to about 1.83 km.

The white numbers in Fig. 4 mean: 0645 = the transponder code[19], 011 = the altitude over mean sea level of the aeroplane in feet at standard ambient air pressure, v = the altitude is increasing, and 157 is the ground speed of the aeroplane in knots.

The altitude of the aeroplane is 1 100 feet, according to Fig.4. At the incident the air pressure was 996 hPa, i.e. 17 hPa lower than the standard air pressure of 1013.2 hPa, STD[20]. 1 hPa corresponds to an altitude difference of about 30 feet. The current pressure corresponds to an altitude difference of about 510 feet (17 * 30 = 510 feet), i.e. about 155 m. Since the reference pressure surface in this case is below the surface of current QNH, the altitude of the aeroplane was 1 100 – 510 = 590 feet, corresponding to about 180 m above the ground.

Fig. 6, shows the position of the aeroplane at the minimum recorded distance to the radio/TV broadcasting antennas.

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[19] Transponder code – aircraft identification code

[20] STD – Standard setting of altimeter. Indicates altitude as if the air pressure was 1 013,2 hPa

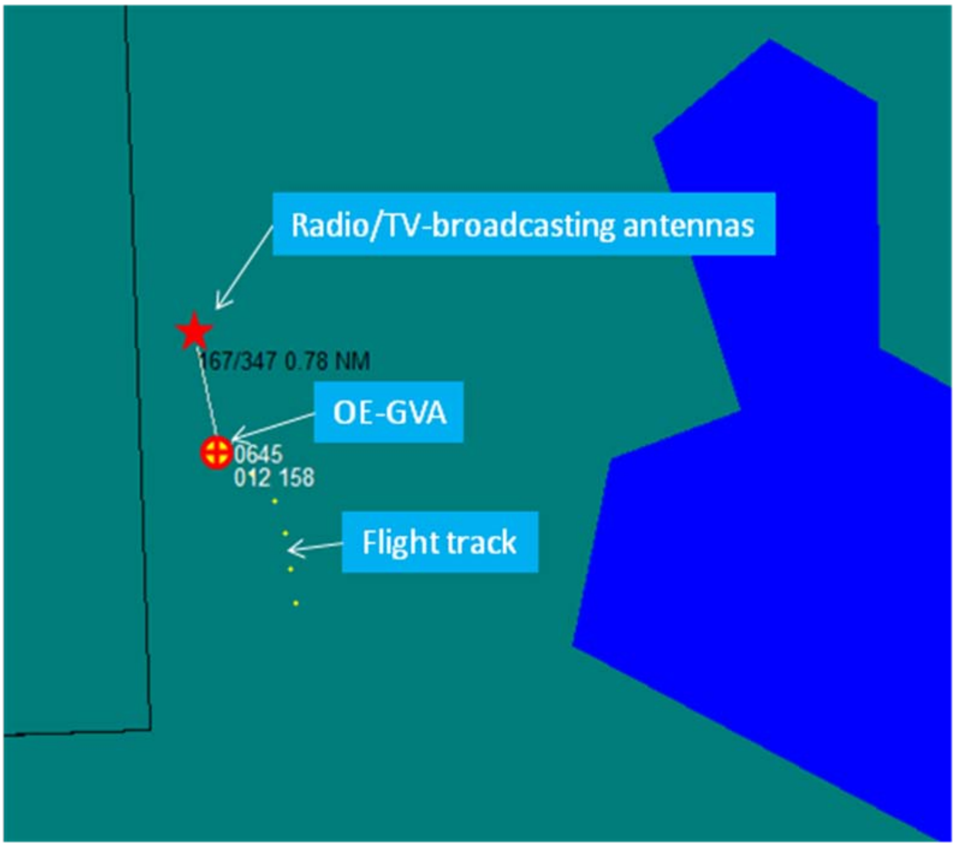

Fig. 6. Zoomed radar image showing the position of the aeroplane at the minimum recorded distance to the radio/TV broadcasting antennas.

1.16.3 Recorded radar information from the Swedish Armed Forces

The sequence of the flight was also recorded and safe-guarded routinely by the Military Services, MUST[21], Fig. 7. In Fig. 7, the position of the aeroplane, its height above the mean sea level at STD pressure, and the minimum recorded distance of the two radio/TV-broadcasting antennas were superposed. According to this radar recording, the minimum recorded altitude of the aeroplane was 330 m STD, corresponding to about 175 m as corrected to QNH (330 – 155 = 175). In Fig. 7 some relevant radio communication between the aeroplane and the ATC was also superposed.

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[21] MUST - Militära Underrättelse- och Säkerhetstjänsten – military intelligence and security services

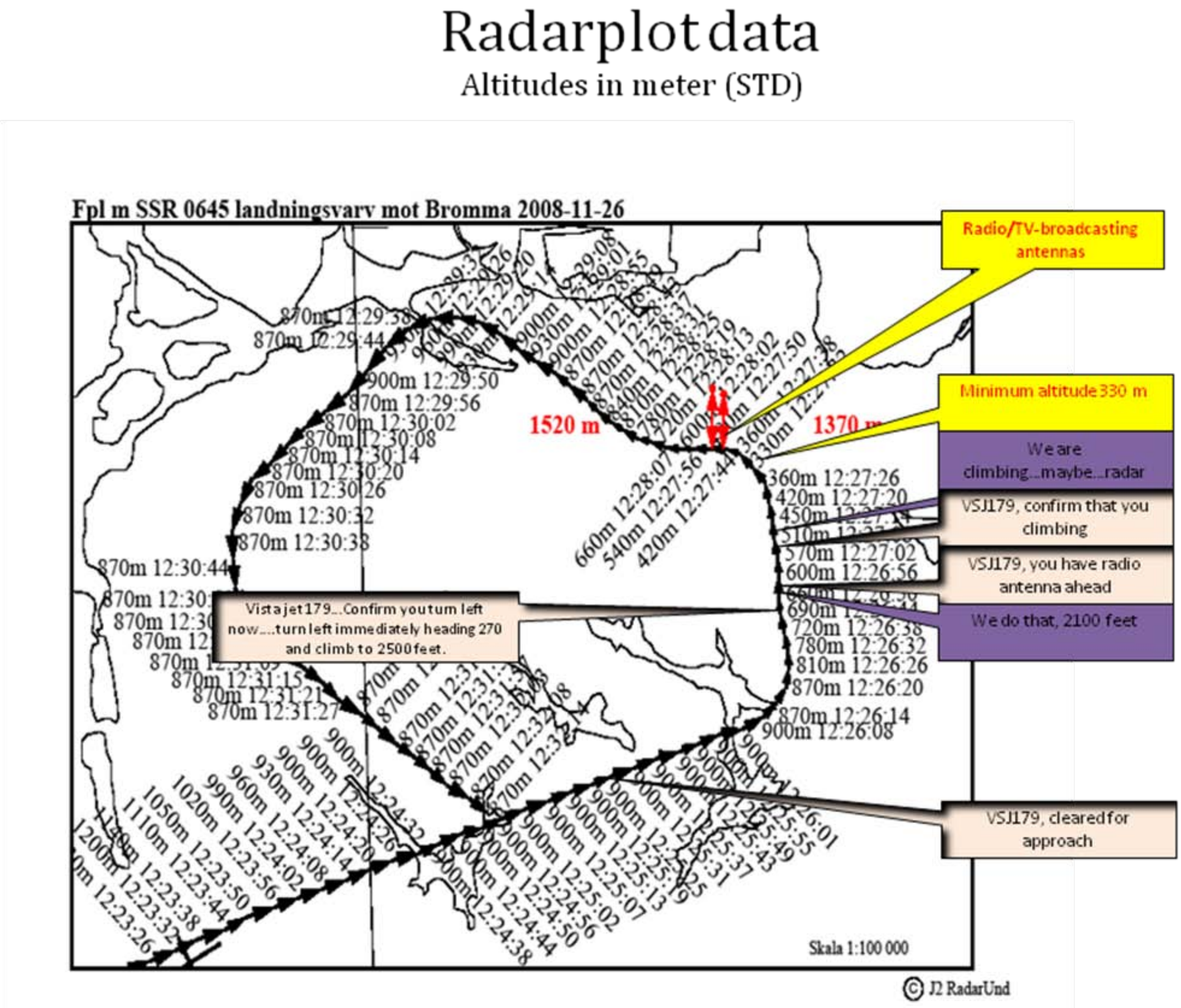

Fig. 7. The MUST-radar recorded altitude of the aeroplane at different times during the incident, with the radio communication between ATC and the aeroplane superposed. The ATC-transmissions are shown within shaded frames.

Fig. 7 shows that the aeroplane was maintaining the cleared altitude (900 m STD – 2 500 feet QNH) until the left turn was initiated at about 12:26:08 hrs. The aeroplane turned to a northerly heading and continued to descend on this heading during about 80 seconds. During this time the aeroplane was instructed to turn left to 270 degrees and climb to 2 500 feet (QNH), and confirm that the climb was initiated.

1.16.4 The altitude profile of the flight and the radio communication with ATC

The altitude of the aeroplane was plotted against time during the incident, and is shown in Fig. 8 and Fig. 9. Relevant parts of the radio communication between the aeroplane and the ATC are also shown in the figures.

The altitudes in parenthesis in Fig. 8 indicate the altitude over the sea of the aeroplane corrected for actual air pressure. The numbers 1 – 4 indicate the radio communication between the aeroplane and the ATC.

Fig. 9 shows the same time sequence with the altitudes in feet on an altimeter adjusted to STD air pressure.

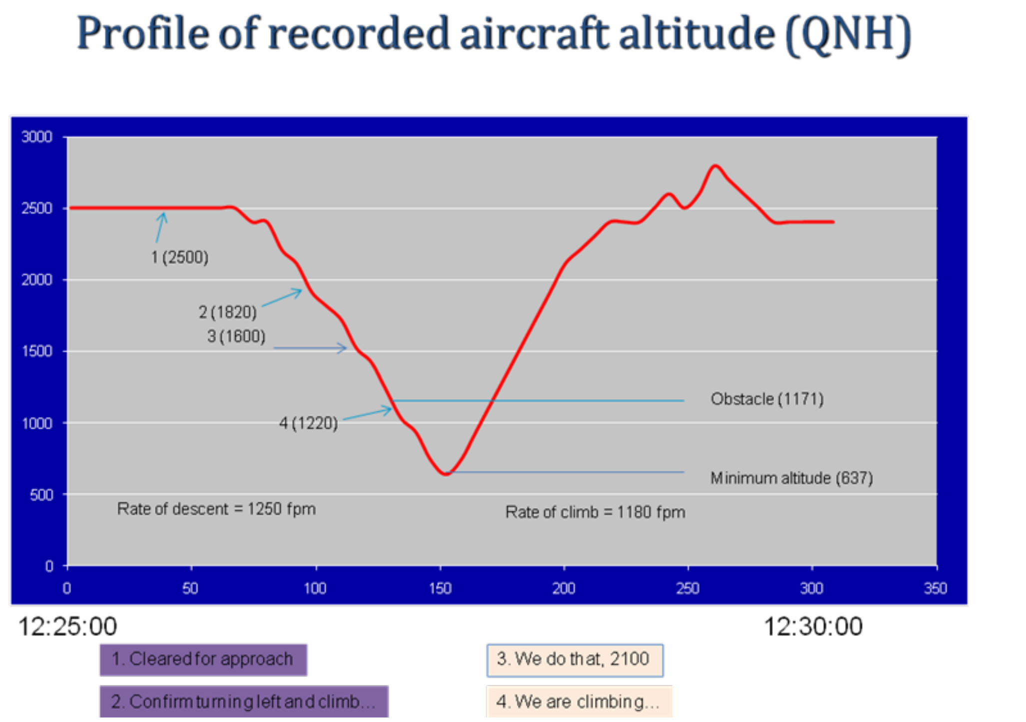

Fig. 8. Diagram of the aeroplane´s altitude in feet QNH, with some of the radio communications, numbers 1 - 4. The time sequence is shown on the horizontal axis.

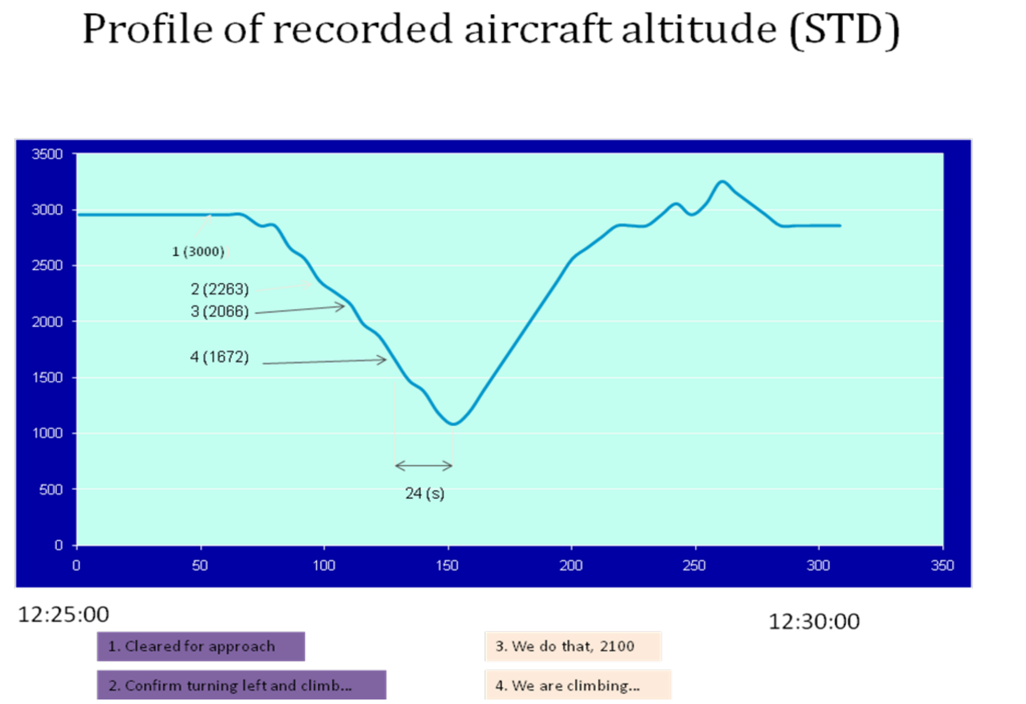

Fig. 9. Diagram showing the aeroplane´s altitude in feet STD, with some of the radio communications, numbers 1 -4.

1.16.5 Electronic instruments on the aeroplane

The aeroplane was equipped with electronic flight instruments, EFIS[22], and an integrated system, EICAS[23], for monitoring of engine operation and warning of failures in essential aeroplane systems. EICAS replaces the traditional electromechanical engine instruments. The instrument panel is however equipped with three electromechanical instruments, indicating speed, altitude and aeroplane attitude, for use in an emergency if the electronic systems become unserviceable.

The aeroplane was equipped with two FMSs. The FMS are operated by two identical keyboards with integrated displays, Fig. 10, which are placed on the pedestal between the pilots, Fig. 12.

The FMS input data come from an, ADC[24], which processes data from the pitot tube[25], the static ports[26] of the aeroplane, the navigation data base and pilot inputs. The aeroplane has two independent ADCs, but only one at a time can be active.

Fig. 10. FMS pilot interface.

Navigation system

The aeroplane was equipped with system for ILS and NDB approaches, DME[27], GPS[28]-based precision navigation system according to required standard for flight in controlled airspace.

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[22] EFIS – Electronic Flight Instrument System – electronic flight instruments with screen display

[23] EICAS – Engine Indicating and Crew Alerting System – electronic system for monitoring and warning of engines and other aircraft systems with screen display

[24] ADC– Air Data Computer – electronic computer for processing of data from basic air probes

[25] Pitot tube – dynamic pressure measuring device connected to instrument for speed indication

[26] Static port– sensor for measuring of the static air pressure outside of the aircraft

[27] DME–Distance Measuring Equipment – electronic system for measuring distances to a DME beacon

[28] GPS – Global Positioning System – worldwide satellite-based navigation system

The aeroplane can be flown both automatically on autopilot and manually by the control columns from both pilot positions. The autopilot can be operated in several modes selected by the pilots, and by inputs from the FMS.

The aeroplane was also equipped with a Flight Guidance System with a Flight Director, FD. This system enables the pilots to manually fly the aeroplane with high precision by following command symbols in the flight instruments. The Flight Director System indicates the correct position of the aeroplane attitude for e.g. keeping altitude, turning or to perform an ILS-approach.

The FMS incorporates a keyboard, a LCD[29], navigation computer and a 12-channel GPS-sensor. The pilots program the FMS according to the desired route and for positioning the aeroplane for the final approach by ground based navigation systems. Programming of the FMS can be made both on the ground and when airborne. The navigation computer holds a database with preprogrammed airways, STARs and SIDs, instrument approaches and holding patterns. Flight routes, waypoints and altitude limits may also be inserted by the pilots. The data base is updated on a 28 day cycle according to an internationally agreed system. Two databases are stored in the FMS, but only one can be active at each time. The data update is made prior to the effective date, and the pilots must check the validity of the active database prior to flight. Updating of the data is performed by technical staff by inserting a 3.5” floppy disk[30].

The FMS is also capable to calculate some trend information, like arrival times at fix points and point for an optimum descent profile. Usually the FMS is re-programmed several times during a flight, as a result of changing conditions along the route. For example, when the route is changed, altitude and speed changes, change of runway or destination or other changes that may occur during the flight.

Instrument panels

There are two large EFIS-colour screens on the instrument panel at each pilot position, the PFD[31] and the MFD[32], Fig. 11, and two smaller EICAS-screens in the mid part of the panel, Fig. 12. The PFD displays information about aeroplane attitude, heading, altitude, speed and vertical speed. Furthermore, navigational information, altimeter reference pressure, activated modes of autopilot and FMS, warnings and instructions of the automatic collision avoidance system, TCAS[33]. The aeroplane was also equipped with GPWS, a system that basically warns the pilots if the aeroplane approaches the ground without being configured for landing. The warnings are displayed in the PFD together with a voice warning.

---

[29] LCD – Liquid Crystal Display – data screen with liquid crystal technique

[30] Floppy disk – magnetic data storage medium

[31] PFD – Primary Flight Display – primary flight instrument with integrated flight information

[32] MFD – Multi-Function Display - information display that can be configured in numerous ways

[33] TCAS – Traffic Collision Avoidance System – airborne automatic collision avoidance system

Fig. 11. The PFD is displayed to the left and the MFD to the right.

The MFD normally displays navigational and heading information and, when necessary, a weather radar image. The MFD can also be configured to display a large number of selected aeroplane and engine parameters. The information on the PFD and MFD can be interchanged in case of a screen failure, and also be transferred to one of the screens at the other pilot position.

Fig. 12. The pilot positions in Learjet 40XR. The numbers indicate: 1 – PFD, 2 – MFD, 3 – EICAS, 4 – FMS, 5 – FD, 6 – autopilot, 7 – electromechanical emergency instruments.

EICAS-screens on the centre panel

The two EICAS-screens, Fig. 12, monitor the engine, electric, hydraulic and pressure cabin systems and replace the conventional electromechanical instruments. Some essential aeroplane systems can also be shown schematically on the EICAS-screens. Warnings of malfunctioning systems can also be shown in prioritized order. The EICAS information can be transferred to the MFD.

Autopilot system

The aeroplane is equipped with a three-axis autopilot, which is operated by a panel on the glare-shield, Fig. 12. The autopilot is basically used for keeping heading and altitude, and for automatic tracking of ILS-localizer and glide path. The autopilot system also incorporates an auto-throttle system, which enables the aeroplane to keep a speed selected by the pilots or by information from the FMS. The auto-throttle is operated by a turning a knob on the autopilot panel.

The autopilot system can also be set to capture a pre-selected altitude. When the aeroplane approaches a pre-selected altitude, the autopilot system enters a flare-mode and the vertical speed is gradually decreased until the selected altitude is reached. Should the aeroplane deviate more than 300 feet from a captured altitude a light and a warning sound is triggered.

The autopilot system also includes a basic mode, which keeps the aeroplane´s wings levelled and present attitude. The heading selector is deactivated in basic mode. The autopilot system may change from a higher mode into basic mode in certain cases of manipulation of aeroplane systems, e.g. if the aeroplane barrel-trim is activated by the switches on the pilot´s steering wheel. In basic mode the aeroplane would not react on a turn of the heading selector on the autopilot panel, and the aeroplane continues straight ahead with same attitude. There are also other possible pilot actions that would force the autopilot into basic mode, e.g. repeated selection of APPR-mode.

Training of pilots on Learjet 40

The manufacturers Recommended Operating Procedures and Techniques[34] for Learjet 40/45, indicates that new pilots are given basic training in the use of Universal Navigation Systems, UNS[35], during the simulator course. A new pilot is trained to initiate the FMS, program a flight plan in the FMS, link a SID or STAR, etc, which is considered more than adequate for a new pilot whose primary goal is to get familiar with the airplane. Training of the more advanced functions of the FMS is recommended to be practiced in visual meteorological conditions.

It is common practice that exchange of knowledge and operational experiences between pilots are accomplished during flight. In fact, it is the obligation of every Commander to share advice to co-pilots about flight operational matters that not are included in the requirements of the skill test.

According to VistaJet, the practice is to share the flights equally between the Commander and co-pilot. However, it is subject to the Commander´s decision depending on the flight characteristics.

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[34] Recommended Operating Procedures and Techniques – issued by the manufacturer

[35] UNS – conventional navigation systems : ILS, NDB, DME

1.17 Organisational and management information

VistaJet is a privately owned flight operator that started business in 2004, and is based in Switzerland. The company features offices in Salzburg, Dubai, Kuala Lumpur and Farnborough.

At the time of the incident VistaJet operated about twenty business jet airplane and was offering world-wide flights. Six different airplane types were represented in the company, all of which were manufactured in recent years by Bombardier Aerospace in the USA.

The flight operational management was located in Salzburg, Austria, while the pilots were based in different flight bases. Some of the pilots were qualified to operate more than one aeroplane type.

1.17.1 Measures taken by the operator after the incident

The incident was reported internally by the Commander as a go-around after a failed approach.

The pilots were interviewed by the Flight Operation Manager after the incident, and were reminded to carefully observe cleared altitudes, especially when flying close to terrain. Routines for disconnecting of autopilot and transfer of controls were also reviewed.

A couple of months after the incident the Flight Safety Officer made an inquiry of the investigation. The report recommended changes in the SOP[36] regarding transfer of control, and a review of the internal reporting system.

VistaJet has added a remark in the SOPs regarding the transfer of control, and also the internal reporting system has been revised as a result of the internal investigation.

1.18 Additional information

1.18.1 Issues of equal opportunity between men and women

Not applicable.

1.18.2 Environmental issues.

Not applicable.

[36] SOP – Standard Operating Procedures issued by the operator

2. ANALYSIS

2.1 General

The course of the flight was mainly revealed by the recorded radar information and radio communication between the aeroplane and ATC.

The events on board the aeroplane and the crew actions during the flight were however not possible to fully establish, since the pilots' recollection of the incident was somewhat diffuse.

SHK therefore presents a possible scenario based on the pilots' interview, the recorded information from ATC, interviews with pilots rated on the type, and general experience from operation of complex instrument and navigation systems.

2.2 The flight

2.2.1 The heading deviation

The airplane was on radar vectoring to a position for commencing the ILS-approach to runway 30 at Stockholm/Bromma. Before, and during the first part of the incident the co-pilot was PF on autopilot. When the airplane was instructed to turn left to a heading of 330 degrees, there was no response as the new heading was selected on the autopilot panel, but the airplane continued straight ahead. The recorded radar information reveals that the airplane commenced a left turn about half a minute later and was at the same time leaving the altitude.

According to the statements of the pilots, the Commander took controls, disconnected the autopilot and performed the left turn manually, when the airplane went through the extended centerline. The turn was however not completed, but was interrupted at a northerly heading, when the controls were handed back to the co-pilot. In this phase the airplane started to descend. Neither the take-over nor the return of the controls was made by the use of standardized phraseology. This probably made the co-pilot hesitant about who was PF.

The reason why the airplane did not turn when the new heading was selected, was probably that the autopilot unintentionally was in basic mode, i.e. the airplane remained at altitude and heading, proceeding straight ahead at 2 500 feet QNH, until the autopilot was disconnected.

The pilots were probably surprised by the fact that the airplane not did turn when the new heading was selected, and started to look for reasons.

2.2.2 The altitude deviation from 2 500 feet QNH to 1 220 feet QNH

When the airplane left the cleared altitude during the approach, the ATC instructed the airplane to turn left and climb to the cleared altitude.

The pilot that communicated with the ATC reported at this moment incorrect altitude to the ATC, "We do that, 2 100". This indicates that the pilot read 2 100 feet on one of the altimeters. The true altitude was at this time about 1 600 feet QNH, according to the radar information corrected to current air pressure.

The Commander stated when interviewed, and in his report, that the airplane unintentionally left the cleared altitude and descended to about 1 700 feet before the go-around was initiated. The true altitude was then about 1 220 feet QNH.

SHK notes that the altitude reported by the pilot was about 500 feet higher in both cases, than the corrected altitude as recorded by the radar stations. The altitude difference between standard setting of the altimeters and adjustment to current air pressure was also about 500 feet. Consequently, SHK finds it probable that the pilot that reported the 2 100 feet, was reading from an altimeter that was set to standard air pressure. The Commander's impression that the minimum altitude was about 1 700 feet (when true altitude was about 1 220 feet) when he reported "We are climbing", supports this hypothesis.

Prior to the incident the airplane was however flying on autopilot at the cleared altitude, 2 500 feet QNH (900 m STD), which indicates that the autopilot´s reference altimeter was set to the correct QNH.

2.2.3 The altitude deviation from 1 220 feet QNH to 650 feet QNH

After the Commander at 1 220 feet reported "We are climbing", the airplane continued to descend for another 24 seconds, see Fig. 8, to the lowest recorded altitude of about 650 feet. SHK could not find any obvious reason to this. However, there was probably a very high level of stress amongst the pilots at this point of the flight. The ATC had repeatedly instructed the pilot to turn and warned about obstacles in the direction of the flight, while the pilots probably still were busy with finding the reason to the failed turn. In this phase the GPWS-warning was also triggered. This warning is a loud voice and light signal that continues until the airplane is heading away from the obstacle and climbing. The pilot´s stress level was probably further increased by the warning and ultimately triggered the Commander to regain the controls, turn and climb away from the obstacle.

2.2.4 The training of pilots

The equipment standard on the Learjet LR 40 XR is very high and the pilot environment is complex, as described in Section 1.16.5. The initial training of the pilots is however focused on the use of the basic functions. To fully understand and use the capacities of the autopilot and FMS and all the available options, a great basic knowledge of electronic flight instruments and extensive real world training are needed.

The manufacturers recommended training procedures for new pilots indicate that the objective of the basic training is to be familiar with the airplane. For training of the more advanced features it is referred to real world flying. Pilots that have received basic training on the airplane confirm this picture, namely that the training of the use of FMS was brief. This is however not restricted to this airplane type, but is a known phenomenon for other airplanes with advanced electronic systems.

It is a consequence of increased system complexity in modern airplane types that pilots spend more time "head down" in the cock-pit while programming the FMS and autopilot, and for exchange of operational experience. When disturbances or problems to manage the automatic systems arise, the troubleshooting may lead to a reduced awareness of the basic flight parameters. The moment where the pilots revert to the conventional navigational systems and manual flight may therefore be postponed to a more critical phase of flight.

This incident shows that there is probably room for improvement in both the operator´s and manufacturers´ training programs for understanding and management of the autopilot and the FMS.

At least one of the altimeters was probably set to STD, and not to QNH. This may have contributed to that the risk of collision with the antennas and with the ground was underestimated by the crew, and the go-around was made at a late stage.

The investigation also points to the necessity of using the standard phraseology when changing controls of the airplane.

3. CONCLUSIONS

3.1 Findings

a) The flight crew was qualified to perform the flight.
b) The aeroplane had a valid ARC.
c) The operator had a valid AOC.
d) The ATC warned about the risk for collision with obstacles.
e) The lowest altitude of the aeroplane was about 180 m over the ground.
f) At least one of the altimeters was set to STD air pressure.

3.2 Causes

The incident was caused by inappropriate prioritisation and allocation of the pilot´s workload.

4. RECOMMENDATIONS

None.