FINLAND

Investigation report

C 22/1999 L

Translation of the Finnish original report

Aircraft incident during approach to Lappeenranta, Finland on 29 November 1999

OH-FAE

SAAB 340A

ISBN
ISSN

”Painaja, paikka, aika”

TABLE OF CONTENTS

ABBREVIATIONS

ADF	Automatic Direction-Finding equipment
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AOM	Aircraft Operations Manual
ATPL	Airline Transport Pilot's Licence
CAA	Civil Aviation Administration
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
FAF	Final Approach Fix
FDR	Flight Data Recorder
FL	Flight Level
ft	feet 0,3048 m
GA	Golden Air Flyg AB
GAFOR	Area Forecast
h	hour
hPa	hectopascal
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
JAR-OPS	Joint European Aviation Requirements - Operations
kt	knot(s) 1,852 km/h
LOFT	Line Oriented Flight Training
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MEL	Minimum Equipment List
METAR	Aviation routine weather report
min	minute
N/A	Not Available
NDB	Non-Directional radio Beacon
OM	Operations Manual
PAPI	Precision Approach Path Indicator
p/n	part number
QNH	Corrected mean sea level pressure
s/n	serial number
TAF	Aerodrome forecast
UTC	Co-ordinated Universal Time
VOR	VHF Omnidirectional radio Range

SYNOPSIS

On Monday 29 November 1999 at 08.04 local time (local times, UTC +2 hours, are used in this report except for weather reports) an aircraft incident occurred at Lappeenranta during final approach to runway 24, in which the aircraft OH-FAE had to make an avoiding manoeuvre to prevent collision with a chimney. The aircraft in question is a Saab 340A with 34 seats, owned by Finnair Oyj and operated by Golden Air Flyg Ab (abbreviation GA used in this report). There were three crewmembers and 23 passengers on board on flight number DC610.

The Flight Data Recorder (FDR) was removed from the aircraft in Helsinki in the afternoon of 29 November 1999. Its data was read out by Finnair Oyj and the data was available for the Accident Investigation Board, Finland on 2 December 1999. The board commenced an investigation (C 22/1999 L) on 3 December 1999. Airline pilot (ret.) Mr Lars Westermarck and student of technology Mr Manu Skyttä were appointed to investigate the incident.

The investigation was based on Finnish legislation, ICAO Annex 13 and the Council of European Union Directive 1994/56/EC.

The commander filed an air traffic incident report to the Civil Aviation Administration, Sweden on 29 November at 13.00. The air traffic controller on duty in Lappeenranta tower at the time of the incident filed the report according to Finnish aviation regulation GEN M1-4 to the Finnish Civil Aviation Administration, Flight Safety Authority on 29 November at 13.08. Accident Investigation Board, Finland was notified of the incident on 29 November at 13.12.

The commander was interviewed by the investigators on 10 December and the co-pilot on 13 December 1999.

The draft of this investigation report was sent for comments to the Finnish Flight Safety Authority and Civil Aviation Administration Finland and Sweden on 27 April 2000. The comments received have been taken into account in this final report.

The investigation was closed on 8 June 2000.

1 FACTUAL INFORMATION

1.1 History of the flight

In the evening of 28 November the crew had flown a GA scheduled flight from Helsinki to Pori, where they landed at 00.35. In the morning of 29 November at 06.08 the crew departed for Helsinki after spending the night in Pori. They had a rest period of approximately four and a half hours.

At 07.30 the crew continued from Helsinki to Lappeenranta on GA flight number DC610. According to the area forecast there was a strong south-westerly wind and moderate to severe turbulence near ground. The forecast surface wind was 220 degrees 12 – 20 knots and the wind was forecast to increase with height so that at 5000 feet the wind would be 240 degrees 40 – 70 knots. In the interviews the pilots told that the wind had been very strong and gusty all day. According to the commander there was severe turbulence below flight level 100 all the way down to the ground.

The cruising altitude for the flight to Lappeenranta was flight level 130 (FL 130), which means 13 000 feet on standard altimeter setting 1013,2 hPa. At 07.50 the crew contacted Lappeenranta air traffic control and got a clearance direct to VOR beacon Vilmas. At 07.53 the aircraft passed Vilmas and received a clearance for a VOR/DME approach to runway 24. The wind was too strong for an ILS approach to runway 06. Maximum tailwind component for the aircraft is 10 knots. The commander, who was the piloting pilot during the approach, told in the interview that after passing the VOR beacon they flew on a heading of 027 degrees for approximately one minute and entered the so called “racetrack” pattern. The autopilot was maintaining the selected heading in the HDG mode. When turning for the inbound track the commander switched the autopilot to NAV mode, in which the autopilot intercepts and follows the selected radial of the VOR beacon. When the aircraft intercepted the inbound track, radial 237 degrees, the VOR indicator was deflected to full right position for a few seconds and the autopilot began to correct the aircraft’s heading to the right. The commander immediately switched the autopilot back to HDG mode and used the HDG mode until he switched the autopilot off. The crew reported to the air traffic controller that they were 6,0 DME inbound (6,0 nautical miles from the VOR/DME beacon). The commander told in the interview that he had selected a rate of descent of 900 feet per minute.

The commander told in the interview that he saw the ground for the first time at one thousand feet. Altitudes used in this report are altitudes from the mean sea level, unless mentioned otherwise. At 860 feet the co-pilot said to the commander that they were 100 feet above the minimum. At the same moment the aircraft went back into a cloud and the commander saw a white flashing light right in front of the aircraft. He immediately switched off the autopilot and avoided the obstacle by changing the aircraft’s heading approximately ten degrees to the left according to Flight Data Recorder. Maximum bank angle was approximately 25 degrees to the left. The pitch attitude changed eight degrees nose up and the aircraft was exposed to 1,5 G’s vertical acceleration for four sec-

onds. At the lowest point the aircraft's altitude was 736 feet and during the avoiding manoeuvre the aircraft climbed to 832 feet. The chimney, which the aircraft avoided, reaches to 723 feet.

After avoiding the chimney the commander saw the approach lights of runway 24 and landed at 08.06. The landing was uneventful.

After landing, when taxiing to the apron, the commander reported by radio to the air traffic controller that he had to make an avoiding manoeuvre to prevent a collision with a chimney during approach.

1.2 Basic information

1.2.1 Aircraft information

Type:	Saab SF340A
Registration:	OH-FAE
Owner:	Finnair Oyj
Operator:	Golden Air Flyg Ab

Aircraft length:	19,73 m
Span width:	21,44 m
Wing dihedral angle:	7 degrees

The following navigational aids were available in the aircraft:

- Instrument landing system (ILS)
- VHF omnidirectional radio range receiver (VOR)
- Distance measuring equipment (DME)
- Automatic direction finder (ADF)
- Area navigation system, KNS 660 Long Range Navigation System

1.2.2 Type of operation

The flight in question was a scheduled passenger flight.

1.2.3 Persons on board

There were three crewmembers and 23 passengers on board.

1.2.4 Injuries to persons

There were no injuries to persons.

1.2.5 Damage to the aircraft

The aircraft was not damaged.

1.2.6 Other damage

There was no other damage.

1.2.7 Personnel information

Commander:

Male, age 33 years.
Airline transport pilot's licence (ATPL) and the required ratings were valid.

Flight experience	*Last 24 hours*	*Last 30 days*	*Last 90 days*	*Total experience*
All types	2 h 35 min 3 landings	87 h 45 min 135 landings	284 h 45 min 294 landings	3405 h 38 min 2718 landings
Saab 340	2 h 35 min 3 landings	87 h 45 min 135 landings	274 h 45 min 284 landings	554 h 55 min N/A

The commander got his basic flight training in Finnair Flying Club and got his private pilot's licence in 1989. In 1990 he received a night flying rating, instrument rating, commercial pilot's licence and the theoretical training required for ATPL from Helsingin Ilmailuteoria Oy. His ATPL was issued on 24 June 1998. The commander's type ratings are as follows: BE99, BE100, BE200, SHORT SC7, BE90, BE400/MU3 and SF340. BE400/MU3 and SF340 require an ATPL for acting as a commander on commercial flights. The extract from the licence register has a note "Must use corrective lenses".

The training for the type rating for Saab 340 was given by SAS Flight Academy, Sweden. His type rating was issued on 8 March 1999. Since then he has been working as a captain for Golden Air Flyg Ab (GA). Since September 1999 he has also been a line instructor for first officers.

First officer:

Male, age 45 years.
Commercial pilot's licence (CPL) and the required ratings were valid.

Flight experience	*Last 24 hours*	*Last 30 days*	*Last 90 days*	*Total experience*
All types	1 h 53 min 3 landings	41 h 33 min 62 landings	44 h 15 min 71 landings	5591 h 06 min N/A
Saab 340	1 h 53 min 3 landings	41 h 33 min 62 landings	44 h 15 min 71 landings	44 h 15 min 71 landings

The first officer got a three-year training on a course by Finnair Training Center. The course was arranged for a group chosen from Tanzania. In Finnair Training Center he received the training for CPL and instrument rating, and the theoretical training required for ATPL. His training was completed in 1981. After that he flew Twin Otter and Fokker F27 Friendship aircraft as a first officer for Air Tanzania. He had a commander's rating for the Twin Otter. In 1989-91 he flew for Air Botnia as a first officer in aircraft requiring a flight crew of two pilots. His licence was not valid 1991-96. After 1996 he flew a Twin Otter for Malmilento Oy. The first officer's type ratings are as follows: C402, C401, DHC6, F27, C404, EMB110, SA227-AT and SF340.

The training for the type rating for Saab 340 was given by Crossair, Switzerland. His type rating was issued on 13 October 1999. The type training was given for the duties of a commander, but later he flew a simulator check ride for the right seat. He completed his route training in GA on 17 November 1999. Since then he has been working as a first officer for GA.

1.2.8 Weather information on 29 November 1999

UTC times (local time –2 hours) are used for the weather information. All wind directions are magnetic except for upper wind information.

Area forecast (GAFOR) for areas 21-25 (Lappeenranta is located in area 22):

> Valid 06.00 – 12.00. The south-westerly wind is very strong especially in the afternoon. The amount of low stratus clouds decreases during the day. Surface wind 220 degrees 12 – 20 knots, maximum 36 knots. Wind at 2000 feet 230 degrees 40 – 55 knots and at 5000 feet 240 degrees 40 – 70 knots. 0°-level 3000 – 6000 feet, light local icing below FL 150, moderate to severe turbulence near surface.

TAF forecast given at 02.00 for Lappeenranta airport:

> Valid 03.00 – 12.00, wind 210 degrees 15 knots, gusts 25 knots, visibility 5000 meters, light drizzle, clouds 8/8 400 feet.

Temporarily 03.00 – 12.00, visibility over 10 kilometers, light showers of snow, clouds 5-7/8 1200 feet.

Actual weather (METAR) at Lappeenranta airport at 04.50:

Wind 210 degrees 11 knots, variable between 160 degrees and 240 degrees, visibility 4500 meters, mist, clouds 5-7/8 300 feet, temperature +6 ºC, dew point +5 ºC, QNH 1002.

Actual weather (METAR) at Lappeenranta airport at 05.50:

Wind 220 degrees 14 knots, variable between 180 degrees and 270 degrees, visibility 3000 meters, light drizzle, mist, clouds 1-3/8 200 feet and 8/8 300 feet, temperature +6 ºC, dew point +5 ºC, QNH 1002.

According to the sunrise and sunset table published by the Civil Aviation Administration, Finland in the AIP (Aeronautical Information Publication), twilight began on 29 November 1999 at 8.04 local time and the sunrise was at 9.04. Times published in the table are calculated for Kuopio airport.

1.2.9 Mass and balance

The take-off mass of the aircraft in Helsinki was 11 908 kg. Maximum take-off mass was 12 700 kg. Center of gravity was within limits. Fuel consumption en route was approximately 300 kg. Landing mass in Lappeenranta was approximately 11 600 kg. Maximum landing mass of the aircraft was 12 340 kg.

1.2.10 Aerodrome information

Coordinates of the airport reference point are 61º 02’ 45’’ N and 28º 08’ 55’’ E.

Runway 24 in Lappeenranta is 2500 meters long and 60 meters wide. Elevation of the aerodrome and of runway 24 threshold is 349 feet. The magnetic direction of runway was 239 degrees. Variation used in Lappeenranta at the time of the incident was 7 degrees east.

The row of approach lights for runway 24 is 600 meters long. The high intensity lights in the row are white and the low intensity lights are red. Runway edge lights are white high intensity lights. The PAPI (Precision Approach Path Indicator) lights indicate a approach path of 3,5 degrees. At the time of the incident, all high intensity lights and PAPI lights were set on 100% intensity and were serviceable. The runway was wet due to drizzle.

The VOR/DME beacon Vilmas is located on the extended center line of runway 24 at 2800 meters from the threshold (1,5 DME). The operation of the beacon was checked after the incident and there was no sign of malfunction.

For approach to runway 06 there are one NDB beacon and Instrument Landing System (ILS), high intensity approach and runway lights and PAPI lights indicating a approach path of three degrees available.

1.2.11 VOR/DME approach to runway 24

The inbound track for the VOR/DME approach to runway 24 is 237 degrees (radial 237 degrees). The descent starts at 2060 feet after reaching 6,0 DME. Minimum descent altitude (MDA) is 760 feet. In addition, there is an altitude restriction of 980 feet before reaching 3,1 DME. The missed approach point (MAPt) is at 2,0 DME. If 3,1 DME indication is not received then the MDA is 980 feet. See pictures 4, 5 and 6.

The inbound track and the racetrack are two degrees offset from the runway center line (239 degrees). The racetrack is offset due to the nearby restricted area (EF R 28) southeast of the aerodrome. For the same reason the racetrack speed is limited to 220 knots.

1.2.12 Obstacle affecting minima for runway 24

The obstacle in question is a chimney in the approach sector of runway 24. The obstacle is located approximately 4400 meters from the runway threshold, about 0,7 degrees left of the VOR/DME inbound track. The distance from the inbound track is approximately 90 meters. The obstacle is 723 feet above the mean sea level and 374 feet (114,0 meters) above the aerodrome.

The chimney is located approximately 160 meters right of the extended runway center line.

There are four white, high intensity flashing lights on top of the obstacle and four red low intensity lights 27 meters below the top.

According to aviation regulations (AGA M3-6, 23 January 1997) the obstacle must be marked either with high intensity obstacle lights or must be painted according to the aviation regulations' marking pattern and equipped with low intensity obstacle lights. In this case it was decided to mark the obstacle with high intensity obstacle lights.

In the instrument approach chart (IAC) used by GA the chimney is located in the approach sector at approximately 5,3 DME. The correct location of the chimney as shown on the obstacle chart published by the CAA Finland is approximately 3,9 DME. The exact coordinates for the chimney, according to a database of the CAA Finland, are 61° 03' 56,42'' N ja 28° 14' 33,5'' E. Thus in the IAC published by SAS Flight Support AB the chimney is located approximately 2600 meters (1,4 nautical miles) further away from the runway threshold than in the obstacle chart published by the CAA Finland.

1.2.13 Proximity warning systems

The aircraft is equipped with GPWS (Ground Proximity Warning System). GPWS is intended to provide warning to pilots of unintentional proximity with ground. The GPWS used has no ability to provide warning of sharply rising terrain or obstacles.

1.2.14 Flight data recorders

The aircraft was equipped with a flight data recorder (FDR, manufactured by Fairchild, p/n 17M800-261, s/n 4716). The recorder was serviceable during the flight. The FDR was removed from the aircraft on 29 November 1999 and was read out by Finnair avionics department. The FDR recorded the following parameters:

- standard pressure altitude
- radio altitude
- calibrated air speed
- magnetic heading
- engine torque
- propeller speeds (rpm)
- flap position
- angle of attack
- pitch angle
- bank angle
- autopilot on/off
- vertical acceleration
- elevator trim position
- altitude from the mean sea level
- radio transmission keying VHF1/VHF2

The FDR does not record VOR or DME indications, which would have been useful for this investigation.

The aircraft was also equipped with a continuously operating cockpit voice recorder (CVR, manufactured by Fairchild, p/n 93A100-83, s/n 55881), which records for the last 30 minutes when the aircraft electrical power is on. By pulling out the circuit breaker the recorder can be stopped to protect the recording from erasure.

The data from the CVR was not available for the investigators, because the circuit breaker had not been pulled.

1.2.15 Manuals

The company operations manuals has been divided into parts A, B, C and D. Part A contains general/basic information, requirements and operational information. Part B consists of aeroplane type operating procedures and requirements. Part C is known as the Flight Guide, and it consists of SAS route manual complemented with aerodrome

categorisation for flight crew competence qualification. Part D is the company's training manual. The manuals have been written to comply with JAR-OPS 1 requirements.

According to the pilots there are two copies of part C available for the crew in the cockpit, as well as the minimum equipment list (MEL) and tables on take-off performance for different aerodromes.

Every pilot of the company has a personal copy of operations manual parts A and B. GA updates the manuals and delivers the new pages to the pilots, who are responsible for keeping their manuals up to date.

1.2.16 Organizational and management information

The flight was operated by Golden Air Flyg Ab. GA in its present form has existed since 1993. The company has been authorised by the Civil Aviation Administration, Sweden to carry passengers, mail and cargo on non-scheduled as well as scheduled flights. GA's home base is Lidköping, Sweden. The quality manager, flight operations manager, maintenance manager, training manager and ground operations manager work in Lidköping under the Accountable Manager. The chief pilot works under the flight operations manager. Training and check captains and training first officers work under the training manager.

The authorisation to operate in Finland was given to GA on 19 April 1999 by the Finnish Civil Aviation Administration.

The commander and the co-pilot have signed an employment contract with Etelä-Pohjanmaan Lentokeskus Oy (auxiliary firm-name West Bird Aviation). Etelä-Pohjanmaan Lentokeskus Oy has been registered in 1993 and has been operating under its present name since 1996.

1.3 Tests and research

1.3.1 Reconstruction of the flight path

The data from the FDR was available for the investigators on 2 December 1999. Values of calibrated airspeed and altitude from mean sea level, recorded at one-second intervals, were used to reconstruct the flight path.

The flight path was constructed backwards from the estimated point of touchdown. The commander told in the interview that the last part of the approach had been flown according to the glide path indicated by the PAPI lights. Therefore the estimated touchdown point was 300 meters from the runway threshold. Also the air traffic controller's estimation confirms this value. The head wind was estimated to be 20 knots up to 400 feet above the aerodrome and 40 knots above 400 feet.

The ground speed was then calculated at one second intervals. On the basis of the ground speed, the distance from the touchdown point was calculated with one second time step for the last three minutes of the approach.

The calculation gave the aircraft's altitude compared to the distance from touchdown point. According to the calculation the aircraft passed the threshold at approximately 50 feet, which corresponds with the glide path indicated by the PAPI lights. In addition, the FDR data indicates the time when the crew reports to the air traffic control that they are six nautical miles from the VOR/DME beacon: "Six one zero, six miles.". This also corresponds with the calculation.

The altitude from mean sea level could be read directly from the FDR data. According to the FDR the altitude of the touchdown point from mean sea level was 352 feet. According to the obstacle chart the altitude of the touchdown zone and the aerodrome elevation are 349 feet.

1.3.2 Eyewitnesses

In the paper mill area there were several eyewitnesses who observed the incident. The investigators received statements from four eyewitnesses. Their locations are marked on the chart in picture 3. Written statements were received from two of the eyewitnesses, and the two other eyewitnesses, flight attendant and one passenger on board were interviewed by phone. A written statement was also received from a passenger who was seated on the left side of the cabin.

2 ANALYSIS

2.1 History of the flight

2.1.1 Events before the flight DC610

The previous night, 28 November the crew had flown from Helsinki to Pori, where they arrived 29 November at 00.35. Scheduled arrival time was at 00.25. A mechanic took care of the aircraft in Pori and the crew checked out at 00.40. In the morning the crew checked in for duty at 05.15. The rest period was 4 hours 35 minutes including travelling times. During the last month, according to the flight duty schedule, the commander had five scheduled flights and one unscheduled flight which included overnight stops away from the home base. The scheduled rest period for all overnight stops was less than five hours and, due to delays, the rest period was even shorter. The commander and the co-pilot told in the interviews that they had felt fit for flight duty on 29 November.

The commander told in the interview that GA had transferred commanders from Sweden and Norway to Finland due to pilot shortage. He also told that commanders regularly fly six days a week and additional shifts cannot be performed without exceeding flight time limitations. The commander and the co-pilot told in the interviews that no pressure was put on them by the company to exceed the duty time limitations. During the last 30 days the commander had flown approximately 88 hours and during the last three months approximately 285 hours. The number of flying hours is high, considering that the flights are short. The duty and flight times do not, however, exceed the limitations set by GA and the Swedish authority.

The crew flew from Pori to Helsinki, arriving at 06.45. During the flight from Pori to Helsinki the autopilot could not be used due to a yaw damper failure. The crew informed the maintenance company of the malfunction and the faulty unit was changed during the stop in Helsinki. The crew entered the malfunction in the flight log space “Incidents/Observations/Notes/Customer”, but actually it should have been entered in “Technical remarks”. The page of the flight log has been arranged so that “Technical remarks” and “Action taken” are on the same row. This makes it easier to follow the action taken due to a technical remark. It is possible that the mechanic will not notice the remark when it is entered in the wrong space of the flight log and therefore the corrective action might not be accomplished. On three of the four flight log pages (pages 871-874) that were available for the investigation, technical remarks had been entered in the wrong space.

2.1.2 Early stages of the flight

The crew received forecasts and actual weather information in Helsinki. The weather in Lappeenranta fulfilled the requirements for commencing the flight. Also the preparations for the flight from Helsinki to Lappeenranta including alternate aerodromes, fuel calculation and mass calculation were made appropriately.

The take-off and cruise of flight DC610 were uneventful. At cruising altitude FL 130 the commander again tested the yaw damper. It was functioning normally and the autopilot could be switched on. The autopilot was used until the beginning of the avoiding manoeuvre.

Very strong south-westerly wind, especially in the afternoon, and moderate to severe turbulence near surface were forecast for Lappeenranta area. The commander told in the interview that there was severe turbulence below flight level 100 all the way down to the ground. For FL 100 south-westerly to westerly winds at 50 knots were forecast.

2.1.3 The approach

The commander was the piloting pilot during the approach. In the interview he told that he had completed the approach briefing already at cruising altitude. An approach briefing includes the most important details of the approach procedure. The co-pilot told that the approach briefing had been completed just before descending to FL 70. The autopilot was used during the approach.

The commander told in the interview that the approach briefing included the approach procedure to be used, plate number and date, the procedure to be used to enter the racetrack pattern after passing the VOR/DME beacon, inbound track, Final Approach Fix (FAF), Minimum Descent Altitude (760 feet or 980 feet if DME 3,1 not received), and the missed approach procedure. Then he had gone through the speeds that were meant to be used during the approach. The commander told in the interview that he had not understood the altitude restriction at 3,1 DME as a stepdown fix, which should be passed before descending below 980 feet.

The co-pilot told in the interview that the approach briefing included the same items. He also told that he had understood the restriction mentioned by the commander as a limitation not to descend below 980 feet before reaching 3,1 DME.

According to the instrument approach chart the final approach is meant to be flown with a steady 3,5 degrees glide path. The chart used by the crew includes a table for monitoring the altitude during the final approach. The table gives correct altitudes according to the 3,5 degrees glide path at the distances of 5,0, 4,0 and 3,1 DME. The commander did not mention the table in the approach briefing. At the final approach fix (FAF) the commander selected a vertical speed of 900 feet per minute for the descent. The co-pilot's impression of the vertical speed was 500-600 feet per minute. It came out in the interview that the commander assumed that the co-pilot had followed the altitudes in the table. He told that the co-pilot had at least at 5,0 DME informed that they were following the glide path. According to the table the correct altitude at 5,0 DME is 1700 feet. The actual altitude of the aircraft was approximately 1350 feet, as recorded by the FDR. The co-pilot told in the interview that he had not followed the altitude table in the approach chart during the final approach. He said that he had been concentrating on following the "center line".

2.1.4 The final approach below 1000 feet

In the interview the commander told that he saw the ground for the first time approximately at one thousand feet. At this point they were about 0,4 nautical miles (740 meters) from the chimney. The co-pilot told in the interview that at 860 feet he called out “One hundred before minima, contact”. He did not recall when he saw the approach lights for the first time. According to GA’s Operations Manual part B, “contact” means visual contact with approach or runway lights. The commander told that he saw the aerodrome lights at that time and said to the co-pilot that he would continue to 760 feet. At the same moment the aircraft flew into the smoke coming from the chimney in the paper mill area and the commander saw a white high intensity flashing light straight ahead. He disconnected the autopilot and initiated an avoiding manoeuvre at 784 feet, as recorded by the FDR, by turning left and pulling up. The co-pilot told that according to his judgement they were clearly above the chimney when he saw the hazard lights. He estimated that they were 100 feet above the chimney. He did not remember the exact DME value at that moment, but he told that it was more than 3,1 DME. He knew that they should have been above 980 feet before reaching the distance 3,1 DME, because he had understood so from the approach briefing given by the commander.

During the avoiding manoeuvre the lowest altitude was 736 feet. While passing the chimney the aircraft was at 784 feet and the vertical distance to the chimney was 61 feet (18,6 meters). The aircraft passed the chimney approximately 50-60 meters to the left of it. According to the approach chart the minimum altitude near the chimney is 980 feet, when the minimum vertical distance between the aircraft and the chimney is 257 feet (78 meters). If the aircraft follows the 3,5 degree glide path during the final approach, the altitude will be 1300 feet at the chimney. Then the vertical distance would be approximately 580 feet (approximately 175 meters).

During the avoiding manoeuvre, the altitude increased to 832 feet. The co-pilot told that after the avoiding manoeuvre he had got the PAPI lights in sight, but he could not remember what they were indicating. In the interview the commander told that he had decided to abort the approach and pull up, but he got visual contact with the approach lights during the avoiding manoeuvre. He then maintained level flight until reaching the glide path indicated by PAPI lights. The landing was uneventful.

After landing, when the aircraft was cleared to taxi to the apron, the commander said to the air traffic controller that they had to make an avoiding manoeuvre during the approach to prevent hitting a chimney. The air traffic controller asked the commander if he was going to file a report. The commander answered that he would file one in Helsinki.

The commander told in the interview that the speed during the approach was170 knots until he switched the autopilot back to HDG mode. After that the speed was approximately 160 knots. In this aircraft the engine torque can be adjusted only manually. The commander estimated that the speed just before the chimney was approximately 140 knots. According to the data from the FDR the speed varied between 135 knots and 150 knots. The speed placard in the cockpit gives a reference speed (V_{ref}) of 115 knots for the actual landing weight with 20 degrees of flap.

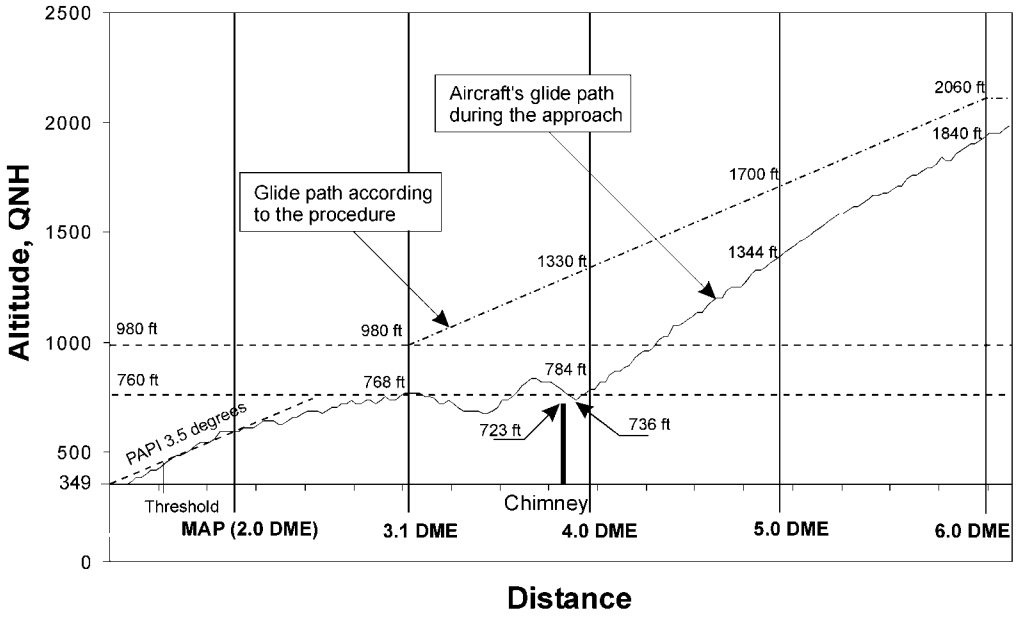
According to the pilots there was severe turbulence during the approach and the wind was strong, which disturbed the executing of the approach. According to the commander the wind correction angle was approximately 20 degrees before the chimney. He told that due to gusts the speed varied approximately 20 knots and the altitude a few hundred feet. The commander also told that he was kind of tired of the approach because of the strong and gusty wind. The co-pilot estimated that the wind was 45-50 knots during the final approach and was weakening on the way down, but it was still strong. In his opinion there was severe turbulence during the approach. On the basis of the forecast, actual weather information and statements of three persons in the cabin, the investigators estimate that the turbulence was moderate. According to the data from the FDR the wind correction angle was significantly smaller, approximately five degrees, than estimated by the commander. At the FAF, when the air traffic control gave the landing clearance, the wind information did not include any variation of direction or speed (220 degrees, 15 knots). In FDR data there was no sign of altitude variation to the extent that the commander had estimated. During the investigation statements were obtained by phone from two passengers and the flight attendant. Both passengers were experienced air travellers. The flight attendant and the passengers said that the weather was gusty, but there was no exceptionally severe turbulence.

2.1.5 Eyewitnesses

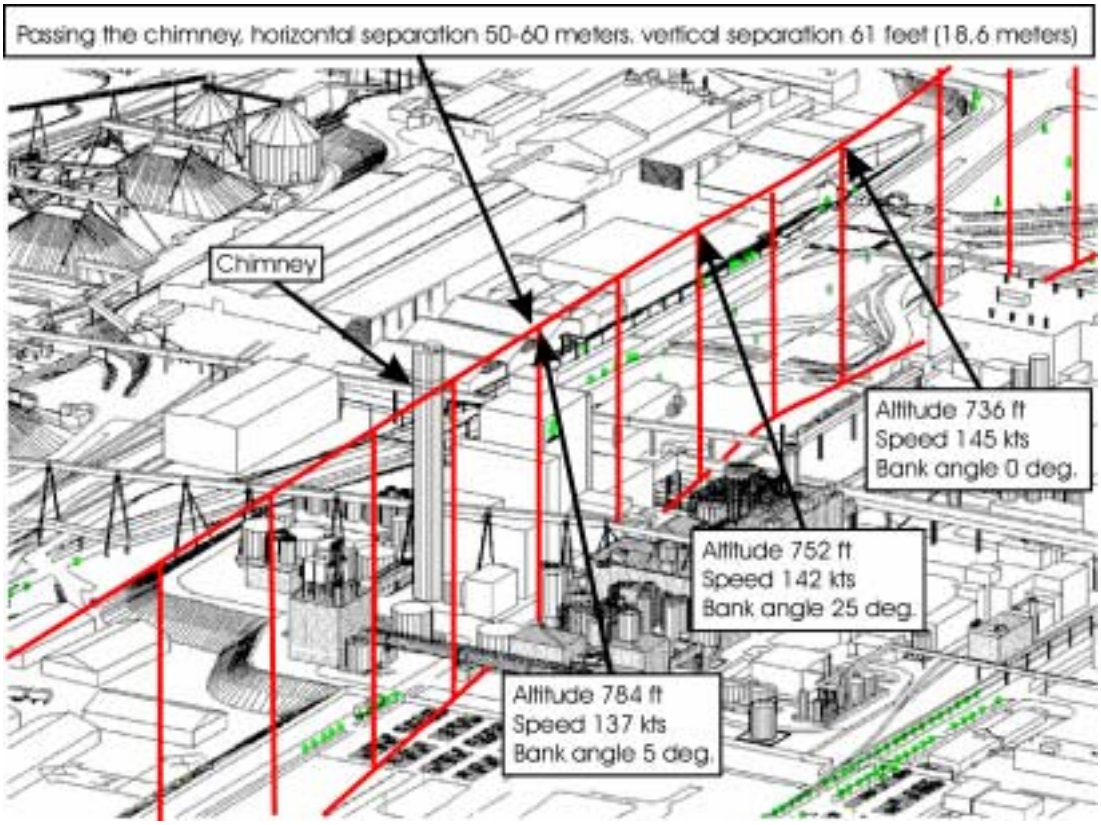
In the paper mill area there were several eyewitnesses who observed the incident. The investigators received statements from four eyewitnesses. Their locations are marked on the chart in picture 3. Written statements were received from eyewitnesses A and D, eyewitnesses B and C were interviewed by phone. A written statement was also received from a passenger who was seated on the left side of the cabin.

Eyewitness A was sitting in his car near the western gate to the Kaukas paper mill area when he observed a low flying aircraft in north-easterly direction. He stopped the car and saw an aircraft passing south of the chimney. In his opinion the aircraft was approximately 20 meters below the top of the chimney. The distance between the chimney and the eyewitness was approximately 400 meters. According to him the aircraft turned to the left to avoid collision with the chimney and the maximum bank angle was approximately 40 degrees. The aircraft levelled off and continued level flight towards the aerodrome after passing the chimney. After examining the sight angles it can be concluded that if the aircraft was flying approximately 60 meters behind the chimney, from the eyewitness' point of view it would appear to be below the top of the chimney although it actually was about 15 meters above.

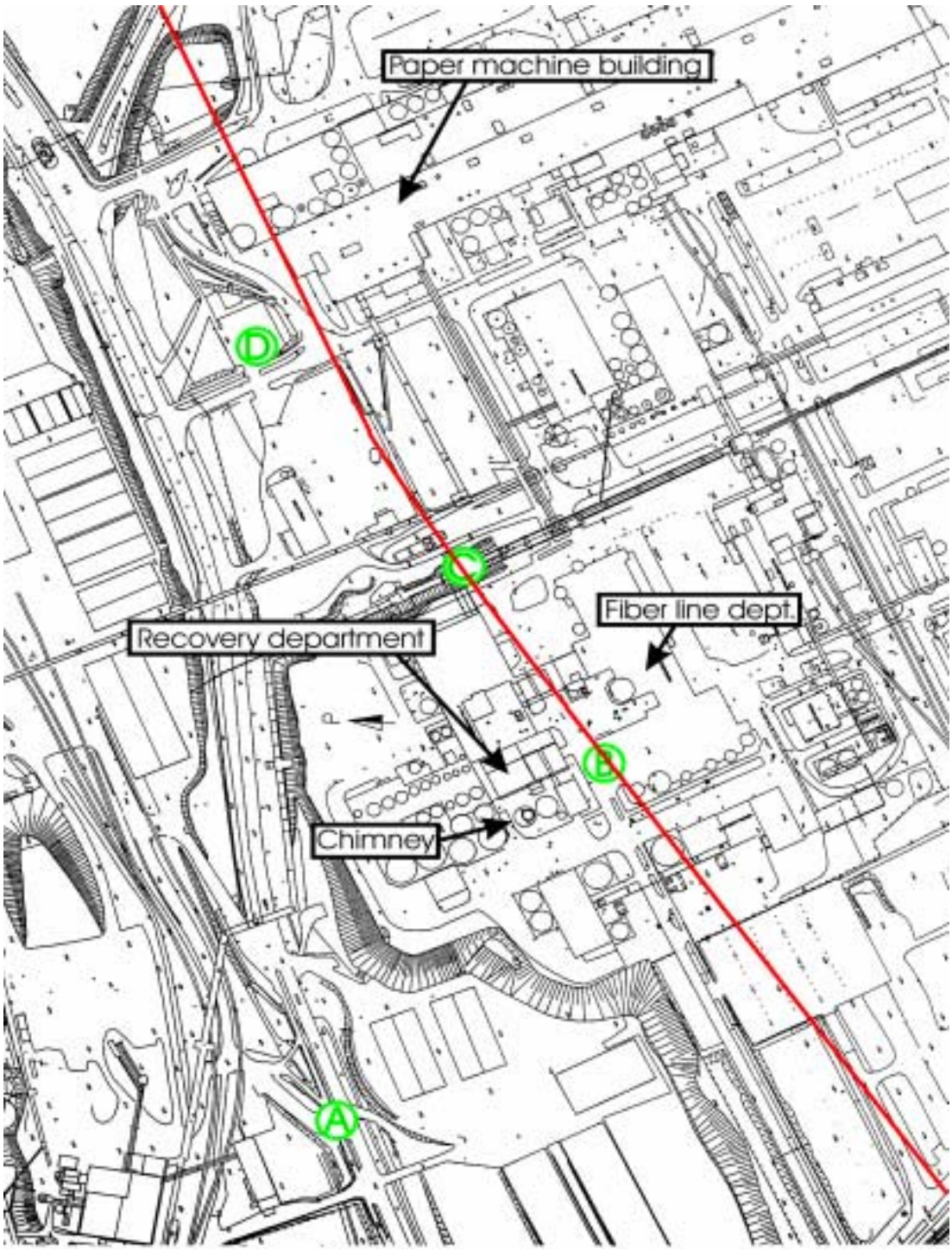
Eyewitness B was standing on the road between the recovery department and the fiber line department. The aircraft had passed straight over her at a low altitude. She saw the aircraft banked to the left and estimated that the aircraft turned approximately 30 degrees to the left. She also saw light from the cabin windows. According to this statement,



Picture 1. Altitude of the aircraft during the approach compared to the distance. The altitude information is from the FDR.



Picture 2. Picture of the flight path of the aircraft near the chimney (the aircraft is flying from right to left). The minimum altitude in the picture area is 980 feet.



Picture 3. The locations of the eyewitnesses and the flight path of the aircraft over the paper mill area.

the aircraft cannot have passed south of the eyewitness. She could not estimate the altitude of the aircraft.

Eyewitness C saw the aircraft passing over him and confirmed the estimation of eyewitnesses A, B and D about the flight path.

Eyewitness D was standing on the wood yard, north of the paper machine building. He saw the aircraft flying over the northern end of the paper machine building and making a rapid avoiding manoeuvre, turning to the left with a maximum bank angle of 30 degrees. In his opinion the aircraft passed the chimney approximately 20-30 meters below the top of the chimney. After the avoiding manoeuvre the aircraft was flying straight away from him, when the aircraft appears to descend towards the horizon. It is the opinion of the investigators that it is difficult to estimate altitude and distance from such an angle.

A passenger with aviation background was seated on the left side of the cabin and had noticed that the aircraft initiated an avoiding manoeuvre. He saw the roof of the paper machine building through the cabin window and estimated that the altitude was approximately 100 meters. This estimation corresponds with the data from the FDR.

On the basis of the statements from eyewitnesses, the commander's first observation of the flashing light and the FDR data, the investigators have created a conception of the aircraft's flight path near the chimney. This is illustrated in pictures 1, 2 and 3.

2.1.6 Analysis of the VOR/DME approach

A VOR/DME approach can be performed in two different ways. One method is the so called stepdown procedure. When this procedure is applied to the VOR/DME approach to runway 24 in Lappeenranta, the aircraft will first descend to 980 feet from 2060 feet. Then the aircraft will fly level flight until reaching the distance of 3,1 DME. After reaching 3,1 DME the aircraft will descend to 760 feet (MDA). If the required visual contact is not established, level flight will be continued to the missed approach point (MAPt = 2,0 DME). If the visual contact is still not established, a go-around will be initiated. In this procedure it is extremely important to observe the stepdown altitudes.

The other method to perform the approach is to aim for a constant angle of descent, which in this case is 3,5 degrees. This method can be used when the electronic equipment on board make it possible to monitor the distance to threshold. In the instrument approach chart used by the flight crew, the approach is shown as to be flown according to this procedure. The approach chart includes a table giving the altitudes for the constant angle of descent at different distances.

It is the opinion of the investigators that a VOR/DME approach should be flown at a constant angle of descent, which is considered to be safer. This method provides opportunity for a stabilised approach. The instrument approach charts in pictures 5 and 6 also present this type of procedure. The chart used by the pilots, as shown in picture 4, also provides good instructions for flying the approach with a constant angle of descent. In

addition, GA's Operations Manual part B instructs all approaches to be performed with the highest precision possible and using all available navigational aids.

These two VOR and VOR/DME approach procedures should be clearly separated from each other and practised in the simulator training. It should also be emphasised that the procedure described in the approach chart should be followed. It is not always possible to bring out all the specific characteristics of different approaches in simulator training. This might apply for example to the VOR/DME approach to Lappeenranta runway 24.

In the VOR/DME approach to Lappeenranta runway 24 the inbound track is two degrees offset from the runway center line. In addition, the inbound track is towards the VOR/DME beacon located on the extended center line of runway 24. The missed approach point (MAPt) is located 1136 meters from the touchdown zone (836 meters from the runway threshold), 130 meters to the right of the runway center line. At MAPt the aircraft is flying towards the VOR/DME beacon and at minimum descent altitude (MDA) the height from the runway threshold is still 411 feet (125 meters). From this point to the touchdown zone the angle of descent is approximately 6 degrees. If the DME indication is lost after reaching the final approach fix (FAF), the minimum descent altitude (MDA) is 980 feet, which can make the glide path even steeper. Any crosswind from the right contributes to the fact that the view from cockpit differs significantly from that of a normal approach aligned with the runway center line.

The investigators recommend that during the route training, or at first opportunity, the approach in question would be performed by all pilots in visual meteorological conditions with a complete approach briefing and according to the instrument approach chart.

2.2 Training of the cockpit crew

2.2.1 Commander

Before starting the type rating course for Saab 340, the commander had had a valid airline transport pilot's licence for approximately six months. The type rating course was carried out at SAS Flight Academy, Sweden. The training included a technical course, simulator training, emergency procedures training and a commander course according to the AIC B 127/1991 published by the Swedish Civil Aviation Administration. The type rating training also includes a simulator check flight and a half-an-hour training flight on Saab 340, including three landings. Before starting to work as a captain for GA he had flown line flying under supervision for 26,4 hours. When the commander received his type rating, the CRM (Crew Resource Management) training was still pending. The CRM training had not been given by the time of the interview. In the training summary of SAS Flight Academy, the self-study items concerning flight procedures and normal and expanded checklists had not been signed either.

The cockpit training is initiated by completing three sessions in a cockpit procedure trainer. The simulator training includes six sessions of four hours each, of which half the time as a piloting pilot and the other half as a monitoring pilot. According to the training syllabus the simulator training includes three VOR approaches, but the commander had

actually performed only one of those three as a VOR approach. The training syllabus does not include any VOR/DME approaches. The commander's performance on the type rating course was rated as very good. Also the simulator check flight was rated as very good. The training flight on the aircraft was flown on 24 February 1999. According to the training summary form there should be two training flights on an aircraft. CAA Finland requires 1-2 training flights on the actual aircraft for the type rating.

The route training began on 16 March 1999 and was completed on 31 March 1999. The commander started to work for GA in April 1999.

An operator's proficiency check flight was flown in a simulator on 6 August 1999, which included a manoeuvring part required by the authority and a LOFT part (Line Oriented Flight Training). LOFT is a simulator training method which gives crewmembers the opportunity to practice line operations with a full crew in a realistic environment.

The commander also acts as a line training captain for first officers in GA since September 1999.

2.2.2 Co-pilot

The co-pilot completed his type rating course for Saab 340 at Crossair, Switzerland. The technical course was completed on 22 September 1999. The simulator training for commander's duties and a simulator check flight were completed on 8 October 1999. The training flight on the aircraft was completed on 11 November 1999. The co-pilot type rating for Saab 340 was issued on 13 October 1999. He flew a simulator check flight from the right seat on 23 October 1999.

The route training of 23,1 hours was given between 3 and 17 November 1999. Since then the co-pilot has been working as a co-pilot for GA.

According to GA's training records, the co-pilot received CRM training on 26 November 1999.

2.2.3 CRM training

Crew Resource Management (CRM) means the effective utilisation of all available resources by the cockpit crew in order to achieve safe and efficient operation. CRM highlights the importance of cockpit crew co-operation. The duties of the monitoring pilot are also an important part of CRM.

According to the JAR regulations, a three days period of CRM training should be given to a pilot who is converting to another type of aircraft. The requirements for the training are given in Joint Aviation Requirements, IEM OPS 1.945(a)(9)/1.955(b)(6)/1.965(e). Providing the whole syllabus is covered, a two day course may be acceptable. According to the GA training plan, two days of CRM training should be given annually to their pilots. However, the commander's type rating was issued without the CRM training. He

had not received any CRM training in GA before the flight of 29 November 1999. The co-pilot had received CRM training on 26 November 1999.

The investigators see that GA should give CRM training to its pilots at least before the route training is initiated. The CRM issues can then be refined during the route training. In fact, the commander was acting as a line instructor for GA without having received any CRM training himself. The pilots were inexperienced in flying scheduled passenger flights and their flying experience had been accumulated in many different companies. The pilots' type rating training had also been given in training centers of different companies. Because of the pilots' different backgrounds, it is particularly important to comply with GA's own manuals and cockpit procedures in route training and normal line operations.

It is the opinion of the investigators that GA should pay more attention to the CRM training of their pilots. GA should make sure that at least the minimum requirements contained in the Joint Aviation Requirements are fulfilled.

It is the opinion of the investigators that the CAA Finland and CAA Sweden should pay more attention to the completion, content and quality of the CRM training.

2.3 Company manuals

2.3.1 Operations Manual parts A, B and D

The pilots did not have the Operations Manual (OM) parts A and B with them on the flight. The commander told in the interview that those parts were not included in the cockpit library. He told that the Swedish authority does not require the manuals to be carried on board the aircraft. He told that the pilots have many times asked for extra copies of the manuals to be available in the aircraft. In a telephone conversation, the flight operations manager of GA told to the investigator that during normal operations the manuals were not needed, because the pilots must know the manuals by heart. His explanation was that as the pilots are flying on short routes there is no possibility to use the manuals. In GA's OM part A, item 0.2.2, it is stated that: "Golden Air Flyg Ab will ensure that a copy of the manual is available for carriage in each of its commercial air transport aeroplanes". In the beginning of OM part A it is stated that the manuals comply with JAR-OPS Part 1 requirements. JAR-OPS 1.130 states: "An operator shall ensure that the current parts of the Operations Manual relevant to the duties of the crew are carried on each flight.".

In the beginning of OM part A concerning the aeroplanes used by the company, it is mentioned that Saab 340 has a maximum take-off weight of 13 155 kg. Actually the Saab 340A aircraft used by GA have a maximum take-off weight of 12 700 kg.

In OM part B there is a picture on how to perform a non-precision approach. In the picture, the Final Approach Fix (FAF) has been marked as "Outer Marker".

In item 2.2.1 of OM part D, there is a list of GA training captains. In the copies of the manual used by the investigators and the Swedish aviation authority, the names of the two captains who had given the line training to the co-pilot of the flight in question were not included in the list. In February 2000 the investigators and the Swedish authority received from GA a new revision of the page (dated 15 October 1999) where the names of the two captains had been added.

The investigators received OM parts A, B and D on 8 December 1999 from the GA Base Manager, Finland. He stated that the manuals included all amendments made so far and were up-to-date.

2.3.2 Operations Manual part C

The instrument approach chart (IAC) used by the pilots is shown in picture 4. The chart has been published by SAS Flight Support AB on 25 August 1999, and it is included in OM part C. The VOR/DME approach procedure for Lappeenranta runway 24 is presented in the IAC. For comparison, the equivalent charts published in AIP by CAA Finland (dated 10 September 1998) and Jeppesen (dated 4 September 1998) are shown in pictures 5 and 6.

In charts published by SAS Flight Support AB all symbols for obstacle lights are alike, as in ICAO Annex 4. In the equivalent chart published by Jeppesen the high intensity obstacle lights are marked with an arrow and a text “Hazard beacon”. In charts published in the AIP, Finland high and low intensity obstacle lights have different symbols.

According to ICAO Annex 4, obstacles over 1000 feet above terrain should be marked with a different kind of symbol. In the chart ILS-NDB-04 EFHK, plate 3 (the effective date is missing, checked in OM part C on 13 December 1999) published by SAS Flight Support AB, for example the mast on final runway 04, which is higher than 1000 feet, has been marked in the same way as the other obstacles, but with the text “FLG W”.

There is no equivalent text near the symbol for the chimney in Lappeenranta indicating the white flashing light. The mast situated further away on the extended center line (1040 feet above sea level) has not been marked with the text “FLG W” either, although it is also equipped with high intensity white flashing lights.

In the IAC for VOR/DME approach to runway 24 published (25 August 1999) by SAS Flight Support AB, the chimney is located 2600 meters (1,4 nautical miles) too far out from the threshold of runway 24. The investigator notified GA’s flight operations department of the incorrect location of the chimney on 3 December 1999 and advised to notify all GA pilots flying to Lappeenranta about this matter. The equivalent IAC and the obstacle chart published by CAA Finland were sent by telefax to GA on 7 December 1999. The investigators understood that the GA’s flight operation manager contacted SAS Flight Support AB immediately and informed them about the incorrect location of the chimney on the IAC. GA’s flight operation manager called the investigator on 11 January 2000 and told that SAS Flight Support AB claims that the chimney is marked on the right spot on their IAC. On 26 January 2000 the GA’s base manager, Finland told the investi-

gators that the IAC dated 25 August 1999 is still in OM part C. A new IAC was published 27 January 2000. There were no mistakes in the obstacle chart and the obstacle table published in AIP Finland.

The minimum descent altitude (MDA) 760 feet is caused by the water tower, which is located approximately 2190 meters from runway 24 threshold and 370 meters north of the extended runway center line. In the valid instrument approach charts the height of the obstacle is 510 feet from the mean sea level. In the chart published by SAS Flight Support AB (25 August 1998) the obstacle is located approximately 1300 meters north of the extended runway center line. In addition, an obstacle reaching to 576 feet is marked in the chart approximately 11 nautical miles from the runway 24 threshold. That obstacle is not marked on charts published by CAA Finland. Additionally, the boundary of the restricted area EF R 28 is marked incorrectly in the chart. The variation should be seven degrees to the east instead of eight degrees in the chart published on 25 August 1999.

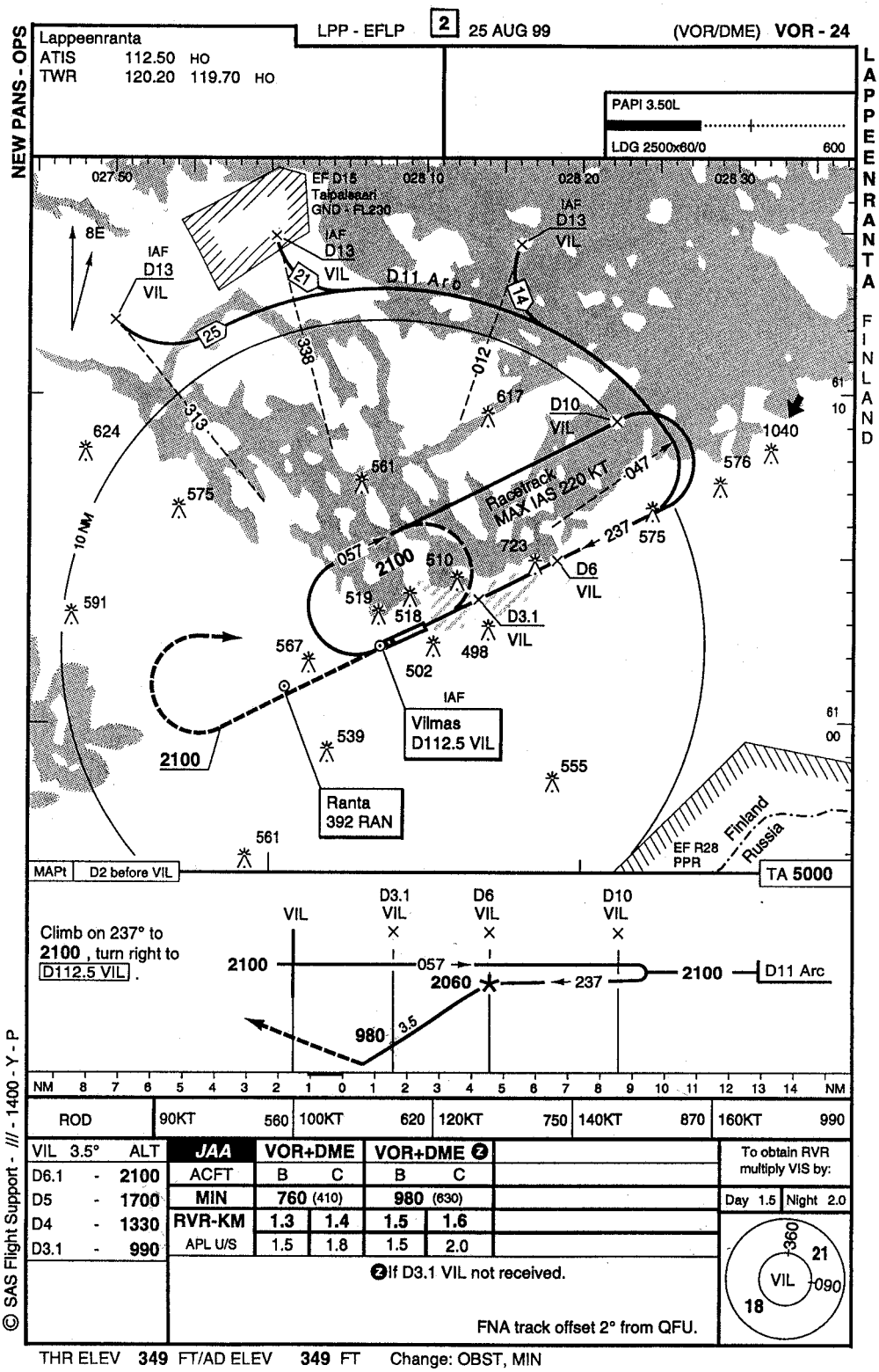
It is the opinion of the investigators that SAS Flight Support AB should react more quickly to faulty information on their charts. It is also the opinion of the investigators that SAS Flight Support AB should take into account the high intensity white flashing lights marked on instrument approach charts published in the Finnish AIP and include them on their instrument approach charts. This information is useful e.g. when pilots are performing a visual approach.

It is written in the introduction part of the manual published by SAS Flight Support AB that “SAS Flight Support AB, its agents and employees will assume no liability for any loss, injury, damage or delay, caused by errors, omissions or faulty information in Route Manuals.” According to this SAS Flight Support AB takes no liability for faulty information. Thus the responsibility is transferred to the operator who has bought the manual. The pilots must in their everyday duties be able to trust that the information in the route manual (OM C) is correct. Usually the publisher of the route manual takes responsibility for its own mistakes.

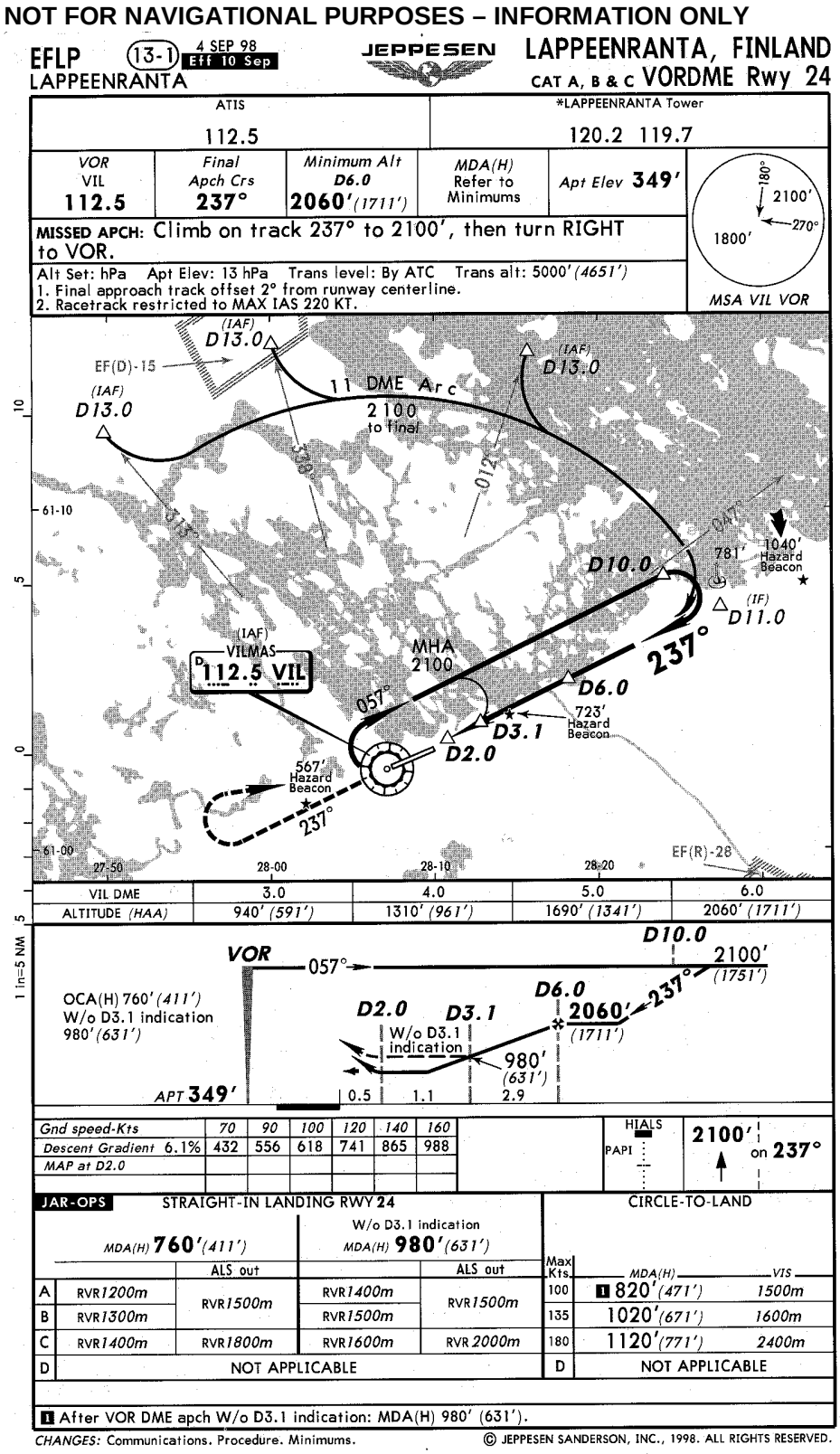
GA should ensure that their new pilots receive training on the differences between the charts used by GA and other commonly used charts like Jeppesen. In the interviews the pilots were shown the IACs in pictures 4, 5 and 6. They both considered that in the IACs published by Jeppesen and CAA Finland, the altitude restriction at 3,1 DME was marked more clearly. The investigators agree with the pilots in this matter.

2.3.3 Cockpit crew knowledge of manuals

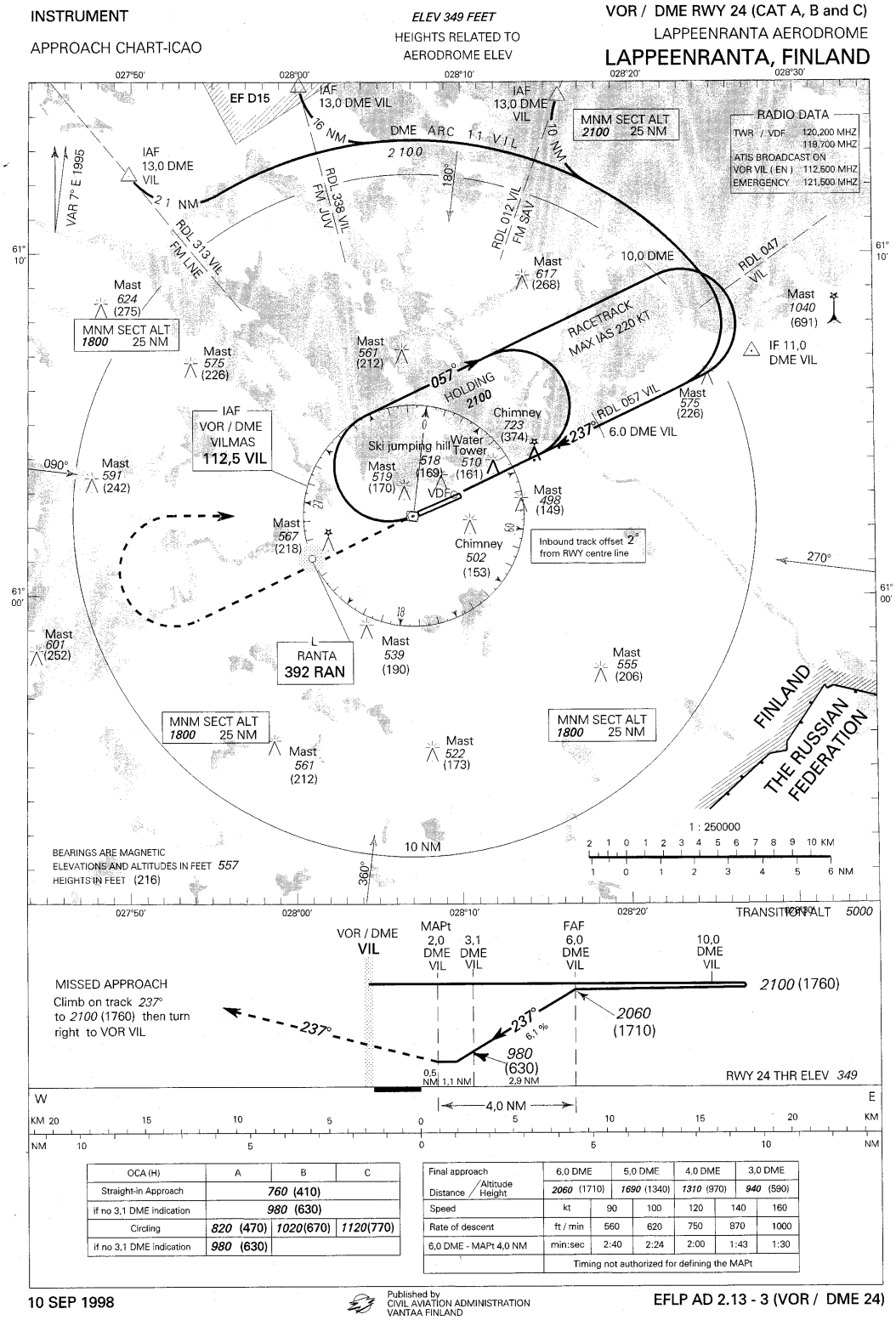
OM part B instructs the pilots to use the autopilot in all approaches except when flying a visual approach. On the basis of the interviews and conversations with the pilots, investigators got the impression that the pilot did not have an exact knowledge of the autopilot minimum altitudes in a non-precision approach. The co-pilot told in the interview that the autopilot could be used down to 500 feet AGL (Above Ground Level) in a non-precision approach. According to GA’s OM part B autopilot is allowed to be used down to 100 feet AGL during a non-precision approach.



Picture 4. Lappeenranta VOR/DME 24 instrument approach chart published by SAS Flight Support AB. Reproduced with premission of SAS.



Picture 5. Lappeenranta VOR/DME 24 instrument approach chart published by Jeppesen. Reproduced with permission of Jeppesen GmbH.



Picture 6. Lappeenranta VOR/DME 24 instrument approach chart published by CAA Finland. Reproduced with permission of CAA Finland

The aircraft operations manual (AOM, dated 20 March 1998) published by the manufacturer includes instructions for use of three different speed increments affecting the approach speed. According to the AOM the reference speed (V_{REF}) should be increased by 10 knots in icing conditions. GA's OM part B (page dated 1 July 1997) contains the same speed increment for icing conditions and the pilots were aware of that in the interviews. The same speed increment is also mentioned on the speed placard used in the cockpit.

According to the AOM there is no need for speed increments if the wind speed is less than 10 knots. If the wind is 10-20 knots, 10 knots should be added to the V_{REF}. If the wind is 20-40 knots, 15 knots should be added to the V_{REF}; and 20 knots if the wind is over 40 knots. According to GA's OM part B, half of the wind speed exceeding 10 knots and the total gust speed should be added to the V_{REF}. It came out in the interviews that the pilots did not know about all the wind increments mentioned in the manuals. During the final approach in question the wind was 15 knots. According to the manufacturer's manual the speed increment would have been 10 knots and according to GA's Operations Manual 2,5 knots. Additionally some technical malfunctions require speed increments for maintaining the controllability of the aircraft.

GA's OM part A item 11.7 (dated 28 July 1997) gives an instruction for preserving the data of the FDR and the CVR. According to the instruction the circuit breaker must be pulled in the case of an event subject to mandatory reporting:

> *"In the event of an accident or an incident subject to mandatory reporting, the recordings of the flight data recorder and the cockpit voice recorder shall be preserved for a period of 60 days. The cockpit voice recorder can be protected from erasure during flight by pulling the cockpit voice recorder circuit breaker (otherwise the records will be erased after 30 minutes). The flight data recorder will record the last 25 hours of flight, and EVENT button shall be depressed in case of abnormal events during flight."*

The circuit breaker of the CVR had not been pulled to stop the recorder, and the EVENT button of the FDR had not been depressed either. It came out in the conversation that the co-pilot did not know that the FDR had an EVENT button, which marks the time of an abnormal event when depressed.

2.4 Cockpit crew co-operation

During the approach to Lappeenranta the co-operation of the pilots and monitoring of the flight were very inadequate, because enough attention had not been paid to these issues in the training by GA.

The commander was the piloting pilot during the approach and the co-pilot was the monitoring pilot. The commander told in the interview that the approach briefing was done already at the route altitude. It came out in the interviews that the commander did not mention the two degrees offset of the inbound track from the runway center line. Neither the intention to perform the approach using a constant angle of descent nor the

altitudes in the altitude table of the IAC were not mentioned by the commander. The descent was not performed according to a constant angle of descent and altitudes in the altitude table were not observed. The co-pilot did not remind the commander that they were below the tabled altitudes on the IAC. The commander told in the interview that he had not understood the 980 feet altitude restriction. He had thought that the restriction of 980 feet is not valid if the DME indication is available. The wrong location of the chimney, which is the cause for the restriction, might have contributed to the misunderstanding. The co-pilot told in the interview that he had understood the restriction of 980 feet before reaching 3,1 DME from the approach briefing, but he did not remind the commander that they had descended below the restriction although they were further away than 3,1 DME. In the interview he told that he was concentrating on following the “center line”.

The pilots judgement was that the weather was very gusty. Due to the rough weather a precise following of the altitudes on the approach chart would have been needed by both pilots. Because the approach was flown by autopilot, both pilots would have had the possibility to monitor the approach profile more precisely. Due to the weak co-operation and monitoring the descent below the 980 feet altitude restriction was not intervened and the incident took place. During the avoiding manoeuvre the aircraft was also below the minimum descent altitude (MDA) of 760 feet before reaching the glide path indicated by the PAPI lights.

According to the investigation (NTSB report number SS-94-01: “A Review of Flightcrew-involved, Major Accidents of U.S. Air Carriers, 1978 through 1990”) done by NTSB (National Transport Safety Board) in 80 percent of the accidents included in the investigation the commander was acting as a piloting pilot and in 20 percent of the accidents the co-pilot was acting as a piloting pilot.

The co-pilot could have had a high threshold to intervene in the commander’s piloting. The co-pilots route training was completed less than two weeks before the incident. So the co-pilot was less experienced than the commander who had flown as an route instructor for the co-pilot.

2.5 Extracts from the licence register

The extracts that the investigators received from the licence register of CAA Finland were inaccurate. In the extracts there were irrelevant terms instead of the names of medical or flight examiners. Additionally the dates when the training had been completed were illogical. The commander’s training for Saab 340 type rating had been dated 31 January 1999. The simulator check flight included in the training was flown on 15 February 1999 and the training flight with Saab 340 on 23 February 1999. The co-pilot’s training for the type rating had been dated 22 September 1999, when the theoretical part of the course was completed. The simulator training was completed and the simulator check flight flown on 8 October 1999. The training flight was flown on 11 October 1999. It is the opinion of the investigators that the date on the extract should mean that the type rating training has been fully completed.

3 CONCLUSIONS

3.1 Findings

1. The cockpit crew had valid licences and they were qualified for the flight.

2. The airworthiness certificate was valid and the aircraft was airworthy.

3. The aircraft's insurance was valid.

4. The previous night the crew had flown from Helsinki to Pori, where they arrived at 00.35. In the morning the crew checked in for duty at 05.15 for a flight to Helsinki. The rest period was 4 h 35 min including travelling times. The pilots told in the interviews that they had felt fit for flight duty.

5. The crew took-off from Helsinki to Lappeenranta at 07.30. The weather in Lappeenranta fulfilled the requirements for commencing the flight. Also the preparations for the flight from Helsinki to Lappeenranta including alternate aerodrome, fuel calculation and mass calculation were made appropriately.

6. The commander told in the interview that there was severe turbulence below flight level 100 all the way down to the ground. This was also the co-pilot's estimation of the prevailing weather.

7. The commander was the piloting pilot during the approach. In the interview he told that he had completed the approach briefing according to the Operations Manual. The autopilot was used during the VOR/DME approach to Lappeenranta runway 24 until the beginning of the avoiding manoeuvre.

8. The commander told in the interview that he had not understood the altitude restriction at 3,1 DME as a stepdown fix, which should be passed before descending below 980 feet.

9. The co-pilot told in the interview that he had understood the restriction mentioned by the commander in the approach briefing as a limitation not to descend below 980 feet before reaching 3,1 DME.

10. According to the instrument approach chart the final approach is meant to be flown with a 3,5 degrees constant angle of descent. The chart used by the crew includes a table for monitoring the altitude during the final approach. The table gives correct altitudes according to the 3,5 degrees glide path at distances of 5,0, 4,0 and 3,1 DME. The commander did not mention the table in the approach briefing.

11. The approach was not flown with a constant angle of descent and during the final approach the aircraft was below the altitudes given in the table.

12. The co-pilot told in the interview that he had not followed the altitude table in the approach chart during the final approach. He said that he had been concentrating on following the “center line”.

13. The co-pilot did not remind the commander that they had descended below the restriction of 980 feet although they were further away than 3,1 DME. At 860 feet he called out “One hundred before minima, contact.”.

14. The commander told he saw the aerodrome lights at that time and said to the co-pilot that he would continue to 760 feet. They had not yet passed the chimney.

15. As the aircraft was still descending they went into the smoke coming from the chimney and the commander saw a white high intensity flashing light straight ahead. He disconnected the autopilot and initiated an avoiding manoeuvre at 784 feet as recorded by the FDR by turning left and pulling up.

16. The co-pilot told that according to his judgement they were clearly above the chimney when he saw the hazard lights.

17. During the avoiding manoeuvre the lowest altitude was 736 feet. The chimney reaches to 723 feet.

18. While passing the chimney the aircraft was at 784 feet and the vertical distance to the chimney was 61 feet (18,6 meters). The aircraft passed the chimney approximately 50-60 meters to the left of it.

19. During the avoiding manoeuvre, the altitude increased to 832 feet.

20. In the interview the commander told that he had decided to abort the approach and pull up, but he got visual contact with the approach lights during the avoiding manoeuvre. He then maintained level flight until reaching the glide path indicated by PAPI lights. The landing was uneventful.

21. The commander said to the air traffic controller that he would file an incident report in Helsinki.

22. According to the pilots there was severe turbulence during the approach and the wind was strong, which disturbed the executing of the approach. The commander told that he was kind of tired of the approach because of the strong and gusty wind.

23. On the basis of the forecast, actual weather information and statements of three persons in the cabin, the investigators estimate that the turbulence was moderate. At the final approach fix (FAF) when the air traffic controller gave the landing clearance, the wind was 220 degrees 15 knots.

24. On the basis of the statements from eyewitnesses, the commander’s first observation of the flashing light and the FDR data, the investigators have created a conception of the aircraft’s flight path near the chimney.

25. It is the opinion of the investigators that a VOR/DME approach should be flown at a constant angle of descent, which is considered to be safer. This method provides opportunity for a stabilised approach.

26. In the VOR/DME approach to Lappeenranta runway 24 the inbound track is two degrees offset from the runway center line, which makes the landing from the missed approach point (MAPt) more difficult.

27. The investigators recommend that during the route training, or at first opportunity, the approach in question would be performed by all pilots in visual meteorological conditions with a complete approach briefing and according to the instrument approach chart.

28. Before starting the type rating course for Saab 340, the commander had had a valid airline transport pilot's licence for approximately six months.

29. The CRM training that should be included in the type rating course as a part of the commander course according to the AIC B 127/1991 published by the Swedish Civil Aviation Administration was still pending after the type rating course was completed.

30. Since April 1999 the commander has been working in GA and since September 1999 he has been a line instructor for first officers.

31. By the time of the flight in question, CRM training had not been given to the commander.

32. The co-pilot's type rating for Saab 340 was issued on 13 October 1999 and since 17 November 1999 he has been working in GA. He received CRM training on 26 November 1999.

33. It is the opinion of the investigators that GA should pay more attention to the CRM training of their pilots. GA should make sure that at least the minimum requirements contained in the Joint Aviation Requirements are fulfilled.

34. It is the opinion of the investigators that the Finnish and Swedish authorities should pay more attention to the completion, content and quality of CRM training when issuing a licence or a type rating.

35. The pilots did not have the Operations Manual (OM) parts A and B with them on the flight. The commander told in the interview that those parts were not included in the cockpit library.

36. According to Operations Manual part A of GA and JAR-OPS 1.130 operator shall ensure that the current parts of the Operations Manual relevant to the duties of the crew are carried on each flight.

37. The list of GA training captains in Operations Manual part D was not up-to-date.

38. In the instrument approach chart used by GA, the chimney causing the altitude restriction of 980 feet is located 2600 meters too far out from the threshold of runway 24. It could not be seen from the chart that the chimney had a white flashing light on top of it.

39. Golden Air notified SAS Flight Support AB of the faulty location of the chimney. However, it took eight weeks until SAS Flight Support AB corrected the location.

40. In the approach chart used by GA, the water tower causing the minimum descent altitude is located approximately 900 meters too far from the extended runway center line.

41. It is the opinion of the investigators that SAS Flight Support AB should react more quickly to faulty information on their charts. The investigators also recommend that SAS Flight Support AB should consider marking the existing white flashing obstacle lights on their instrument approach charts in accordance with the Finnish AIP.

42. SAS Flight Support AB takes no liability for faulty information in their charts. Thus the responsibility is transferred to the operator who is using the charts.

43. The pilots must in their everyday duties be able to rely on that the information in the route manual is correct.

44. The pilots did not have an exact knowledge of the autopilot minimum altitudes in a non-precision approach.

45. The pilots' knowledge of approach speed increments was poor.

46. The wind increments mentioned in GA's Operations Manual part B differed from the values mentioned in the manufacturer's Aircraft Operations Manual.

47. The data from the cockpit voice recorder (CVR) was not available for the investigators, because the CVR circuit breaker was not pulled after the incident.

48. Technical remarks had been repeatedly entered in the wrong space of the flight log by GA pilots.

49. The wrong location of the chimney on the IAC might have contributed to that the commander misunderstood the altitude restriction of 980 feet.

50. Because the approach was flown by autopilot, both pilots would have had an opportunity to monitor the approach profile more precisely.

51. Due to inadequate crew co-operation and insufficient monitoring, the co-pilot did not intervene when descending below the 980 feet altitude restriction, and the incident occurred.

52. During the avoiding manoeuvre the aircraft was also below the minimum descent altitude (MDA) of 760 feet before reaching the glide path indicated by the PAPI lights.

53. The co-pilot may have had a high threshold to intervene in the commander's piloting. The co-pilots route training was completed less than two weeks before the incident, and so he was less experienced than the commander who had flown as a line training instructor for the co-pilot.

54. It is the opinion of the investigators that the extracts that the investigators received from the licence register of CAA Finland were inaccurate.

55. It is the opinion of the investigators that the date on the extract should mean that the type rating training has been fully completed.

3.2 Cause of the incident

- The pilots did not perform the approach with a 3,5 degree constant angle of descent and they descended below the altitude restriction of 980 feet before reaching 3,1 DME.

Factors contributing to the incident:

- The flight operations management of Golden Air Flyg AB had not paid enough attention to the non-precision approach training and to the importance of flying the approach according to the procedure shown on the instrument approach chart.

- The flight operations management of Golden Air Flyg AB had failed to highlight the importance of monitoring in their training.

4 RECOMMENDATIONS

1. Golden Air Flyg AB should pay more attention in its training to ensure that their pilots know and follow the procedures of the Operations Manuals. Additionally more attention should be paid to cockpit crew co-operation and CRM training. At least the requirements of the Joint European Aviation Requirements should be fulfilled.

2. Golden Air Flyg AB should pay more attention to the correctness of their Operations Manuals and make sure that the manuals are consistent with those of the aircraft manufacturer. Additionally Golden Air Flyg AB should ensure that the information in the Operations Manual C is consistent with the information published by authorities.

3. Golden Air Flyg AB should ensure that, during the line training or at first opportunity, their pilots perform non-standard approaches, such as the approach in question, in visual meteorological conditions with a complete approach briefing and according to the instrument approach chart.

4. SAS Flight Support AB should react more quickly to faulty information on their charts. The investigators also recommend that SAS Flight Support AB should consider marking the existing white flashing obstacle lights on their instrument approach charts in accordance with the Finnish AIP.

5. In the VOR/DME approach to Lappeenranta runway 24, the inbound track and the racetrack are two degrees offset from the runway center line and the racetrack speed is restricted to 220 knots to maintain a safety margin to the restricted area EF R 28. CAA Finland should investigate the possibilities to change the inbound track so that it would be on the runway center line, because the nearby restriction area affects only the track of the racetrack. This could be put into practise for example by changing the procedure to a so called “Base turn” procedure. This means for example proceeding to the VOR beacon via locator RANTA and following a defined outbound radial. After reaching a certain DME distance, right turn would be commenced to intercept the inbound track, which in this case could be the inbound radial of the runway center line.

6. CAA Finland should carry on the policy of marking obstacles with high intensity lights to increase safety, although it is not required by aviation regulations. The chimney in the approach sector to Lappeenranta is marked with white high intensity flashing lights, although it is not inevitably required by aviation regulations. In this incident the lights had a significant role in preventing an accident.

7. Finnish and Swedish authorities should pay more attention to the completion, content and quality of CRM training when issuing a licence or a type rating.

8. The Swedish authority should pay more attention to the correctness of the operators’ Operations Manuals and to ensure that the manuals are consistent with those of the aircraft manufacturers.

Helsinki 8.6.2000

Lars Westermarck

Manu Skyttä

REFERENCES

The following material is stored at the Accident Investigation Board, Finland:

1. Decision of the Accident Investigation Board No. C 22/1999 L (in Finnish)
2. Transcript of Lappeenranta tower radio communications on the frequency 120.20 MHz (partly in Finnish)
3. Incident reports (2) (commander's in English, in Finnish from ATC)
4. Interview transcripts of the commander and the co-pilot (commander in Finnish, co-pilot in English)
5. Extracts from the license register and the flight logs of the commander and the co-pilot (in Finnish)
6. Training certificates and syllabuses of the commander and the co-pilot
7. The insurance certificate and the airworthiness certificate of the aircraft
8. Flight documents
9. Documents from Lappeenranta air traffic control (in Finnish)
10. Instrument approach charts and the obstacle chart
11. Weather information
12. Statements of the eyewitnesses (in Finnish)
13. Printout from the flight data recorder
14. The aircraft's flight path calculation table (in Finnish)
15. Copies of the relevant pages from the Golden Air Flyg AB Operations Manuals and check lists
16. Copies of the relevant pages from the Saab 340 Aircraft Operations Manual