Investigation report

C1/2007L

Serious incident at Seinäjoki Airport on 1 January 2007

Translation of the Finnish original report

Registration: OH-ATB

Aircraft type and model: ATR 42–500

According to Annex 13 to the Convention on International Civil Aviation, paragraph 3.1, the purpose of aircraft accident and incident investigation is the prevention of accidents. It is not the purpose of aircraft accident investigation or the investigation report to apportion blame or to assign responsibility. This basic rule is also contained in the Investigation of Accidents Act, 3 May 1985 (373/85) and European Union Directive 94/56/EC. Use of the report for reasons other than improvement of safety should be avoided.

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SUMMARY

An incident occurred in Seinäjoki aerodrome airspace on 1 January 2007 from 17:50-18:30 local time. The incident involved a Finncomm Airlines ATR-42 airliner, call sign WBA205S. The aircraft made several unsuccessful instrument approach attempts to Seinäjoki. Onboard warning systems generated several warnings during approaches. In the end, the aircraft was flown to Vaasa, the alternate aerodrome. Accident Investigation Board Finland (AIB) appointed an investigation commission for this incident. Investigator Jouko Koskimies was named Investigator-in-Charge with Air Accident Investigator Hannu Melaranta and MSc Markku Roschier as members of the commission. Dr. Päivikki Eskelinen-Rönkä was invited to the commission as an expert in speech and audio analysis.

The aircraft departed Helsinki at 17:15 and flew to Seinäjoki at FL 200. The first officer was the Pilot Flying. Meteorological conditions at Seinäjoki were: cloud base varying between 500 and 1500 ft; light snow; surface wind 120 degrees 10-12 KT, gusting to 18 KT; wind at 3000 ft 160 degrees 30 KT.

At 17:48 the aircraft passed Seinäjoki outer marker (PSJ) for runway 32 and initiated an NDB approach via locator O for runway 14. On the final approach the aircraft descended too low, resulting in an EGPWS warning. The first officer flew a missed approach profile towards PSJ. Again, the aircraft descended too low during the approach and they received another EGPWS warning. After the second missed approach procedure, during the turn to the final approach course, their airspeed decreased, the autopilot disengaged and the stick pusher activated. The flight crew assumed an electrical malfunction and climbed to 7000 ft to work out the cause of malfunction. When no such malfunction was detected, they returned to the outer marker and began to descend in the racetrack pattern. For the third time, the aircraft went too low, resulting in yet another EGPWS warning. The first officer then flew a missed approach procedure. Soon after this the flight crew noticed that the first officer's altimeter was incorrectly set to 1013.2 hPa. The captain's altimeter was set to Seinäjoki QNH 978 hPa. After that they did an ILS approach to runway 32 and a circling manoeuvre to runway 14. While in the circling manoeuvre, they received yet another warning of an erroneous flight configuration. During the turn to the final approach course the aircraft banked approximately 50 degrees resulting in a bank angle warning. During the missed approach procedure the turn continued and finally they flew at a heading of 050 degrees instead of heading 130 degrees towards PSJ. At 18:29 the captain requested and received a clearance to Vaasa, where they landed at 18:50.

Investigation revealed a mistake concerning the selection of the flight crew for this flight. The captain had only logged some 50 hours on the ATR and the first officer had approximately 80 hours on the aircraft. Irrespective of the captain's 3500 total flying hours, the crew was inexperienced according to company's policy with this aircraft type. The approach preparations to Seinäjoki proceeded too slowly causing the crew to rush. The approach checklist was inadequately completed and they forgot to change the altimeter settings from standard air pressure 1013.2 hPa to Seinäjoki QNH 978 hPa. The result was that they flew the entire time 950 feet too low. Therefore, during the NDB approach to runway 14 the aircraft descended to 345 ft (105 m) above Ground Level (AGL), which activated the unsafe terrain clearance warning. The same factors generated

the second warning. This time they descended to 425 ft (130 m) AGL. As they continued with the approach, they lost so much airspeed and the angle of attack increased so much that the stall warning activated, the autopilot disengaged and the stick pusher activated. The anti-icing system was on; therefore, the stall warning and the stick pusher activation threshold took place at a higher airspeed and lower angle of attack compared to normal. This time they descended to 1250 ft (385 m) at minimum.

Unsafe terrain clearances generated the EGPWS warnings. Too low airspeed and the rapidly increased angle of attack activated the stall warning and the stick pusher. The first officer's fatigue and loss of concentration caused the excessive bank angle during the circling approach. The captain should have taken over at this stage. The Cockpit Voice Recorder (CVR) data analysis revealed poor Crew Resource Management (CRM), several missing checks, inadequate system knowledge and incomplete following through of approach procedures.

In order to establish the underlying factors of the occurrence, the investigation looked into the airline's quality system, training system, organization and management as well as their security culture. Shortcomings were discovered in all of the above. The company had not sufficiently prepared for the challenges of the then ongoing business expansion. Nevertheless, the airline took corrective action during the time of the investigation. The commission issued three recommendations.

The incorrect altimeter setting, the flight crew's limited experience on the aircraft type and insufficient situational awareness were considered the causal factors for the chain of events which triggered the incident. Shortcomings in the airline's training system, organization, quality system and security culture were regarded as contributing factors.

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ABBREVIATIONS

AAS	Anti-icing system
AFIS	Aerodrome Flight Information Service
AIP	Aeronautical Information Publication
AGL	Above Ground Level
AP	Autopilot
ATPL	Airline Transport Pilot Licence
ATS	Air Traffic Service
BEA	Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile
COM2	Cockpit radio number 2
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DGR	Dangerous Goods Transport
DFDR	Digital Flight Data Recorder
EFES	Area Control Centre, South Finland
EFSI	Seinäjoki Airport
EFVA	Vaasa Airport
EGAR	Electronic Gross Weight Analyzer
EGPWS	Enhanced Ground Proximity Warning System
EFIS	Electronic Flight Instrument
FDR	Flight Data Recorder
FIZ	Flight Information Zone
FMS	Flight Management System
GEN	General
GPS	Global Positioning System
hPa	Hectopascal
IAL	Instrument Approach and Landing
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
JAR	Joint Aviation Requirement
MC	Master Caution
MCT	Maximum continuous (thrust)
MHz	Megahertz
MSSR	Monopulse Secondary Surveillance Radar
N/A	Not available
NDB	Non-directional radio beacon
NM	Nautical Mile
OM	Operations Manual
OPS control	Operations Control
PF	Pilot flying

PHI	Occurrence reporting form (ATS)
PNF	Pilot Not Flying
QNH	Altimeter setting
RAPS	Recovery Analysis and Presentation System
TRE	Type Rating Examiner
TRTO	Type Rating Training Organisation
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio range

SYNOPSIS

An incident occurred in Seinäjoki aerodrome airspace on 1 January 2007. The incident involved a Finncomm Airlines ATR-42 airliner, call sign WBA205S, on a scheduled flight from Helsinki to Kokkola via Seinäjoki. The aircraft made unsuccessful instrument approach attempts at Seinäjoki. Onboard warning systems generated several warnings during approaches. In the end, the aircraft was flown to Vaasa, the alternate aerodrome. The aircraft was not damaged, nor were there any injuries to persons.

All times in the report are Finnish time. The incident took place from 17:48 to 18:30. The aircraft landed in Vaasa at 18:50. Approximately one hour later the captain informed the Chief Air Accident Investigator of Accident Investigation Board Finland (AIB) of the incident. He, in turn, ordered that the flight recorders be removed. They were delivered to AIB the following day.

Accident Investigation Board Finland (AIB) appointed an investigation commission, C1/2007L, for this incident. Investigator Jouko Koskimies was named Investigator-in-Charge with Air Accident Investigator Hannu Melaranta and MSc Markku Roschier as members of the commission. Dr. Päivikki Eskelinen-Rönkä was later invited to the commission as an audio analysis expert.

The history of the flight was established from flight crew reports, Cockpit Voice Recorder (CVR) and Digital Flight Data Recorder (DFDR) data, Seinäjoki and Vaasa aerodrome Air Traffic Recorder data as well as from radar tracks recorded by ACC South Finland and the Finnish Air Force. The condition of the aerodrome, aids to navigation and the aircraft as well as the proficiency and training of the flight crew were ascertained through document investigation. In addition, the activities of the operator and the organization as well as an overview of the management and training systems were also established.

On 15 January 2007 the investigation commission sent the French (aircraft country of origin) accident investigation authority *BEA* a Notification of a Serious Incident. On 18 January 2007 BEA designated Mr. Emmanuel Delbarre as their accredited representative.

On 16 January 2007 the commission sent a written notice to the Civil Aviation Authority regarding the shortcomings observed on the Seinäjoki aerodrome recorder (radiotelephony and telephone communications).

The draft final report was dispatched to the Finnish Civil Aviation Authority, Finavia, Seinäjoki aerodrome, the French accident investigation authority (BEA), Finncomm Airlines Oy, concerned parties and other informed sources for statement or possible comment, as provided by law. AIB received domestic statements and comments by 14 February 2008. No statements were received from abroad. The comments and statements have been incorporated into the report. Hence, they are not included as appendices.

The investigation was completed on 8 April 2008. The investigation commission issued three recommendations. The investigation report was translated into English.

The material used in the investigation is stored at the Accident Investigation Board Finland..

1 FACTUAL INFORMATION

1.1 History of the flight

On 1 January 2007 a Finncomm Airlines ATR-42 airliner, registration OH-ATB and call sign WBA205S, was approaching Seinäjoki aerodrome at FL 200 (6100 m) on the scheduled Helsinki-Seinäjoki-Kokkola route.

The aircraft departed Helsinki at 17:15. The route and the sequence of events are described in detail in appendices 3 and 4. The data in appendix 4 illustrates events and procedures; the information does not always represent maximum recorded values.

The co-pilot was the Pilot Flying (PF) and the captain the Pilot Not Flying (PNF). Already before takeoff the co-pilot had control over the autopilot and Flight Director. This being the case, aircraft systems utilized and recorded altitude information from the co-pilot's altimeter.

During the pre-flight briefing the crew discussed the sufficiency of their type experience. The co-pilot said that he believed he already had the required 100 hours on the ATR. However, they did not verify this. The captain regarded the co-pilot's estimate trustworthy and deemed that they would no longer be an "inexperienced crew", as per company regulation.

At approximately 17:30, abeam Tampere, the captain called Seinäjoki Aerodrome Flight Information Service (AFIS) on COM2 for weather and runway conditions. The AFIS officer reported that the runway was being cleared and proceeded to read the following meteorological information:

> *"Visibility four kilometres, scattered cloud at 500 feet, partly cloudy at 700 feet and overcast at 1100 feet. Temperature zero, dew point zero, QNH 978. And as soon as I get…I'll tell you about the runway…in a few minutes. - - - Oh, the maximum winds: 18 knots for the past ten minutes".*

Upon receiving this information the crew noted that limitations permitted a downwind approach and landing on runway 32. However, the captain considered it safer to use runway 14 because of the prevailing meteorological and runway conditions.

The crew continued to compute landing values on the portable flight planning system computer. As they entered the data they used 978 hPa as QNH. Seinäjoki AFIS reported 14 mm wet snow on the runway and good braking action. Measured friction was 39/40/40.

At roughly 17:39 Tampere ACC cleared the aircraft to leave FL 200 and notified the crew that QNH was 978 and the transition level was 60. The captain read back the clearance. The crew continued to calculate the landing values on their flight operations software. At 17:43 the captain reported to the ACC that he was leaving FL 200. Based on CVR data, no call-out "transition, QNH 978" was made.

The co-pilot selected runway 14 and locator O (Oscar) on the FMS to facilitate the NDB approach. At approximately 17:45 Tampere ACC instructed the aircraft to contact Seinäjoki AFIS. At the same time, the captain was talking to the airline's Seinäjoki office on the other radio. He informed the flight operations officer of their estimated time of arrival and made some other arrangements as well. At 17:46 the captain contacted Seinäjoki AFIS and received the following information:

> *"Okay 205S, no reported traffic. Wind right now is 120 degrees 13 knots, variable between 110 and 150, maximum 17. Visibility 3.5 kilometres, light snow, scattered cloud at 600, broken at 800 and overcast at 1400 feet. Temperature and dew point just below 0.5 degrees on the plus side, pressure 978, transition 60. As far as the runway is concerned, there's more accumulation, the friction that I read to you a moment ago referred to a layer of slush less than one millimetre. Now there's already two-three millimetres on the ground. We were just wondering whether we should clear the centre of the runway again. Why don't you hold for a moment while we do it. The previous friction information is no longer valid."*

The captain responded that they would take their time anyway because they intended to fly an NDB approach to runway 14. The AFIS officer requested the aircraft to report outer marker PSJ inbound and said that they were still clearing the runway. Following this, the flight crew proceeded to go through the approach check.

Judging by CVR data, the crew were beginning to run out of time. They had started the first item on the approach briefing, the approach check, by going through the IAL chart and the NDB approach to runway 14 (appendix 1). The NDB approach to runway 14 at Seinäjoki is not included in the onboard FMS database. As they proceeded with the briefing the co-pilot told the captain that he had never flown an NDB approach to runway 14 at Seinäjoki. He said that the procedure had been explained in the classroom approximately a year earlier, but that he no longer knew how it went. The approach check was thus interrupted and, subsequently, they did not check their altimeter settings. Therefore, 1013.2 hPa remained as the setting on the co-pilot's altimeter. When asked, the captain did not recall whether he had routinely set the QNH on his altimeter and on the auxiliary altimeter.

At 17:48 the captain reported outer marker PSJ outbound towards locator O, which they passed at 17:49:30. Even though the co-pilot's altimeter indicated 2500 ft, their actual altitude, according to DFDR data, was 1200 ft. This is based on radio altimeter data.

The ACC's Monopulse Secondary Surveillance Radar (MSSR) data (appendix 3) shows that they drifted slightly north of course during their turn to intercept the final approach bearing. Thereafter, a corrective manoeuvre took them clearly south of course. Even though the captain shortened the outbound leg, the strong tailwind also extended their approach pattern. However, they did remain within the holding area and obstacle clearance boundaries.

CVR recordings show that the captain instructed the co-pilot several times during the approach. According to the information on his altimeter, the co-pilot left 2500 ft ca. 30

seconds prior to commencing the base turn. They reached the initial approach altitude, 1700 ft, approximately 15 seconds before they turned into the approach bearing. However, their actual altitude at the time, according to DFDR, was 550 ft. As per their account, they maintained ground visibility but horizontal visibility was reduced by snow. They intercepted the final approach course at approximately 17:53. The co-pilot was unsure whether they could start the descent at that time. At the behest of the captain, he commenced a 500 ft/min descent. The final check was not completed. At 17:54 when the aircraft was approximately seven kilometres from locator O, the onboard EGPWS system sounded “FIVE HUNDRED”, followed by the warning “TOO LOW, TERRAIN”. According to DFDR radio altimeter data (appendix 4.1, section 1) their minimum height was 342 ft (105 m). The co-pilot immediately aborted the descent, climbed 300 ft and maintained this altitude. They tried to make visual contact with the runway, to no avail. As a result, the captain ordered a missed approach to PSJ at 1700 ft. They started the climb ca. 30 seconds after they had received the EGPWS warning.

The AFIS officer was able to track the aircraft on his radar monitor for almost the entire time. The monitor displays the ACC surveillance radar picture. The AFIS officer asked whether the aircraft had already passed locator O inbound. The captain replied affirmatively and added that they had to perform a missed approach because a snow flurry prevented them from making visual contact with the runway. Then the AFIS officer asked what they intended to do next, whereupon the captain said that they intended to fly to PSJ, followed by an ILS approach for a circling approach to runway 14. It was not until 17:55, after the captain’s radio communication, when the aircraft actually passed locator O from the north.

The manually flown go-around ended when they were abeam locator O, at which time the co-pilot had reached 3000 ft and steered towards the outer marker PSJ. They continued climbing to 3500 ft. According to DFDR data (appendix 4.1) the climb was unsteady during the missed approach and their airspeed, heading and power settings varied. The co-pilot later said that he found it difficult to fly the missed approach. After having completed the go-around they engaged the autopilot and consulted the runway 32 IAL chart (appendix 2) for procedure-specific headings and altitudes. The captain told the co-pilot to descend back to 1700 ft towards PSJ, which the co-pilot did. The FMS indicated that the wind at this altitude was 160 deg and 30 kt. They crossed over PSJ at 17:58, which the captain reported to the AFIS officer, who then requested them to report PSJ inbound. The co-pilot descended until his altimeter read 1700 ft, maintaining the heading 100 deg. Then, at 17:59:30, the EGPWS sounded “FIVE HUNDRED”, followed by “TERRAIN AHEAD, PULL UP”. The autopilot also disengaged (appendix 4.1, section 4). The co-pilot commenced a go-around and told the captain that he would climb to 2500 ft. Simultaneously, the captain noticed that his lower attitude and heading reference display had gone blank. The co-pilot’s instrument displays, however, were nominal.

The captain engaged the autopilot and selected maximum continuous thrust (MCT). According to the co-pilot’s altimeter, the aircraft was at 2800 ft, outbound from the outer marker. When they reached the prescribed outbound time, the co-pilot commenced a procedure turn and the descent to 1700 ft by reducing power. Airspeed also decreased. Then, at 18:01, the Master Caution (MC) went off, a stall warning sounded and the autopilot disengaged. The co-pilot changed over to manual control. DFDR recordings show that two fairly large tailplane deflections caused the angle of attack to increase by 10 degrees within less than 10 seconds (appendix 4.2, section 5). The MC sounded again, the stick pusher activated twice within 5 seconds and the aircraft began to lose altitude. According to the DFDR, airspeed was 130 kt and altitude 1500 ft AGL. The aircraft lost approximately 250 ft during this occurrence. The DFDR indicated no icing. The co-pilot selected full power and started a climb, maintaining 180 kt. Maximum power was momentarily exceeded during the climb.

The captain informed the AFIS officer that they had electrical problems and that they were passing 4000 ft in a climb. The AFIS officer enquired about the severity of the situation and asked whether it constituted an emergency. The captain replied that they did not require any assistance. Then he briefly described what had happened and said that they would continue to climb to 7000 ft to the heading of 220 degrees and try to figure out the cause of the anomalies. The AFIS officer said that he would report this to the ACC, whereafter he continued to monitor the aircraft on his radar display.

The aircraft reached FL 70 at 18:03. The flight crew discussed the electrical fault and the possibility of flying directly to Vaasa. The conversation was interrupted when they tried to engage the autopilot. The co-pilot noticed that their lateral trimming was incorrect. Once they retrimmed the rudder, the autopilot engaged. They decided to return to the racetrack pattern at PSJ and reported this to the AFIS officer. At this time they were approximately 20 km south-southwest of Seinäjoki. They turned back towards PSJ at 18:05. On the way the MC went off again and the captain noted that this was caused by icing. According to the DFDR, the AAS system indicated icing. The crew wondered about the stick pusher activation because, in their opinion, they had not received a stall warning and their airspeed had been sufficient.

They planned to reduce altitude in the racetrack pattern, whereafter they would fly an ILS approach to runway 32, culminating in a circle-to-land approach to runway 14. The aircraft passed PSJ at 18:09 and the captain reported this and their joining the racetrack pattern and the start of the descent to the AFIS officer. The AFIS officer asked about the situation onboard and whether they intended to land. The captain replied affirmatively and went on to discuss the runway conditions and friction measurements. The AFIS officer still wanted to double-check that the electrical malfunctions were over and that no help was required. The captain confirmed this and also added that his instruments had momentarily gone blank but that the situation was now back to normal. The crew did not perform an approach check when they started the descent. The co-pilot's altimeter was still set to standard pressure. The captain does not recall whether he set his altimeter to QNH.

They completed two full racetrack patterns while reducing altitude. The crew discussed the approach and decided to fly a circling approach to runway 14. During the last time around the MC went off yet another time and the co-pilot noticed that the system warned of "degraded performance". The co-pilot thought that this was due to insufficient airspeed. When they reached 1700 ft (as per the co-pilot's altimeter) at 18:04, the autopilot seemed to maintain that altitude. However, at the same time, the MC sounded a warning and the EGPWS called “FIVE HUNDRED, TOO LOW, GEAR”. According to the DFDR, their altitude was 460 ft (appendix 4.2, section 8). The captain ordered a go-around and the autopilot disengaged. The co-pilot commenced the go-around and climbed to 2500 ft. They were still flying in the racetrack pattern.

At approximately 18:16, as they were about to intercept the ILS localizer, the captain checked that his altimeter setting was 978 hPa, at which time the co-pilot noticed that his altimeter setting was 1013.2 hPa. He corrected the setting and wanted to double-check whether they had completed the checklists. The captain was of the opinion that they had done it. However, the discussion was interrupted when the AFIS officer provided updated meteorological and runway information and said that a friction measurement was in progress. Snow had turned into rain and the AAS system reported no icing. Visibility was 6 km and cloud base 1500 ft, permitting a circling approach to runway 14.

The captain informed the AFIS officer that they would fly one more pattern in racetrack, whereafter they would fly an ILS approach to runway 32, followed by a right turn to a circling approach to runway 14. The co-pilot requested that they redo the approach check. However, the captain thought that they had already completed it. The co-pilot replied by noting that, in spite of the check, he still had had the erroneous altimeter setting 1013 hPa. The captain then quickly completed the checklist. Immediately after this the AFIS officer reported that the new friction measurements for runway 14 were 42/43/43/. The co-pilot turned into the racetrack pattern one more time and flew to the heading of 110 degrees.

The cabin attendant contacted the flight crew and asked whether it would at all be possible to inform the passengers, as some of them were very uneasy by now. A moment later the captain complied.

While in the holding pattern they received a “Cruise speed low” warning. The co-pilot interpreted this as having resulted from the system not taking into account that they were in an approach for a landing.

The approach was uneventful and the autopilot locked onto the ILS localizer. The Master Caution sounded again, but the warning ended when they selected 15 deg flaps. At 18:22 the captain reported PSJ inbound, whereafter the following radio communication ensued:

AFIS officer:	*205S, wind 130 degrees 10 knots, maximum 12, 100 per cent lights and runway 32 is clear, you will circle to one four, won’t you?*
Captain:	*Yep, we’ll circle, 205S*
AFIS officer:	*Report on final one four*
Captain:	*Will do, 205S.*

The crew established 800 ft as their circle-to-land minimum. At 18:23 the MC warned “TOO LOW, GEAR” (appendix 4.3. section 10). They lowered the landing gear, whereby the warning ended. The co-pilot told the captain that he would hand-fly the circling approach. They did not brief the circling approach. Even though the captain had previously informed the AFIS officer that they would make a right turn circling approach, the co-pilot started a left turn approach. The captain reported this to the AFIS officer who, in turn, acknowledged. The captain completed a partial final check. At the same time he noticed that he had lost visual contact with the runway. The AFIS officer said that he had clearly seen the aircraft on the downwind leg, but not after that.

At 18:24, when the co-pilot manually flew the aircraft and turned onto final, the aircraft banked almost 50 degrees, resulting in the warning "BANK ANGLE, BANK ANGLE" and the nose of the aircraft dropping (appendix 4.4, section 11). The captain cautioned the co-pilot about the bank angle and of the nose dropping so the co-pilot reduced the bank angle. The aircraft continued going to the heading 210 degrees for a moment, followed by banking approximately 50 degrees yet again (appendix 4.4, section 12). The captain ordered a missed approach. They lost sight of the aerodrome and the co-pilot reported that he was heading towards PSJ to 1700 ft. However, during the missed approach they continued to turn, ending up in the heading of 030 degrees. The warning system cautioned of excessive airspeed until the landing gear was retracted. The flaps were still fully extended. The co-pilot noted that, as per OM-B, they were in icing conditions and requested that flaps be retracted to 15 degrees. A moment later the warning system sounded another excessive airspeed warning until they had fully retracted the flaps. . The co-pilot continued to fly the aircraft manually. They turned again, ending up going into the heading of 050 degrees.

From his radar display the AFIS officer saw that the aircraft was heading northeast and, therefore, inquired about their situation. The captain said that their electrical malfunctions persisted and requested a clearance to Vaasa. At 18:29 the AFIS officer relayed the ACC clearance to Vaasa on FL 60. By this time they had flown all the way to Nurmo, approximately 20 km northeast of Seinäjoki aerodrome, whereas they should have followed the missed approach procedure and homed to the outer marker PSJ. The co-pilot initiated a turn towards PSJ and, having heard the ATC clearance, continued a right turn towards Vaasa and climbed to FL 60. The AFIS officer reported the events to the aerodrome manager as well as to the managing director of Finncomm Airlines. He again asked the aircraft whether they had decided to fly to Vaasa because of electrical malfunctions or due to runway conditions. The captain replied that the electrical malfunctions were the cause. The captain announced to the passengers that they were flying to Vaasa, saying that the aircraft's electrical faults were the reason for doing so.

The rest of the flight and approach to Vaasa were uneventful. All procedures and checks were completed as per the manual. The air traffic controller at Vaasa asked why the aircraft was flying to Vaasa. The captain told him that they were having electrical malfunctions. This prompted the ATC controller to deduce that the situation constituted the danger of a potential accident. He ordered the aerodrome rescue personnel to man their vehicles. They remained, however, inside the rescue station. At 18:50 the aircraft landed uneventfully and smoothly. Nevertheless, the flight crew were on their guard and prepared to initiate a missed approach in fear of receiving further cautions. After they parked the aircraft, the captain turned the CVR off.

Within about an hour of landing, the captain telephoned the person on call at the Accident Investigation Board Finland who, in turn, reported the incident to the Chief Air Accident Investigator. He then called the captain who recounted the incident in more detail. In accordance with Aviation Regulation GEN M1-4, the captain reported the occurrence on the airline's own Occurrence Report form. This report arrived at the AIB on 4 January 2007. The AFIS officer in Seinäjoki and the ATC controller in Vaasa reported the occurrence on ATS Occurrence Reporting forms (PHI) iaw Aviation Regulation GEN M1-4. These reports arrived at the AIB on 2 January 2007.

1.2 Injuries to persons

There were no injuries to persons.

1.3 Damage to aircraft

There was no damage to the aircraft.

1.4 Other damage

There was no other damage.

1.5 Personnel information

OH-ATB pilot-in-command	Age 36
Licences:	Air Transport Pilot's Licence, valid until 3.3.2010
Medical certificate:	JAR class 1, valid until 27.8.2007
Ratings:	All required ratings were valid

Flying experience	Last 24 hours	Last 30 days	Last 90 days	Total hours
All types	4 h	18 h	51 h	3513 h
Type in question	4 h	18 h	51h	51 h

OH-ATB co-pilot	Age 28
Licences:	JAR Air Transport Pilot's Licence, valid until 10.4.2011
Medical certificate:	JAR class 1, valid until 6.9.2007
Ratings:	All required ratings were valid.

Flying experience	Last 24 hours	Last 30 days	Last 90 days	Total hours
All types	2.2 h	44 h	82 h	365 h
Type in question	2.2 h	44 h	82 h	82 h

Seinäjoki AFIS officer:	Age 53
Licences:	AFIS officer, valid until 18.10.2007
Medical certificate:	JAR class 2, valid until 24.8.2007
Ratings:	All required ratings were valid.

1.6 Aircraft information

Type	ATR 42–500
Registration	OH-ATB
Owner	EPL Aircraft Lease Two Oy
Operator	Finnish Commuter Airlines Oy
Manufacturer	Avions de Transport Régional (ATR), France
Serial number	643
Certificate of registration	No. 1942
Certificate of airworthiness	Valid until 28.2.2007

The ATR 42-500 is a 48-seat turboprop airliner intended for short-haul feeder traffic. It can also operate from small aerodromes. Length 22.6 m, wingspan 24.6 m, maximum takeoff weight 18 300 kg.

This is the latest version of the type, equipped with modern and versatile navigation and electronics gear.

1.7 Meteorological information

On 1 January 2007 a rain front passed over Finland from the southwest to the northeast. The front generated snow flurries and rain showers in the region of Southern Bothnia. At the time of the incident surface winds were east-southeasterly at 8-12 kt. The cloud base varied between 300-1500 ft and the upper wind at 5000 ft was 160 deg 30 kt.

METARs at Seinäjoki aerodrome (EFSI) and Vaasa aerodrome (EFVA) (Finnish time):

16:50
EFSI: Wind 110 deg 11 kt, visibility 2400 m, light rain, cloud 1–2/8 400 ft, 5–7/8 600 ft, 8/8 2800 ft, temperature and dew point +0° C, QNH 979 hPa

EFVA: Wind 100 deg 9 kt, visibility over 10 km, rain and snow, cloud 3–5/8 400 ft, 5–7/8 800 ft, 8/8 2300 ft, temperature and dew point +1° C, QNH 978 hPa

17:20
EFSI: Wind 120 deg 12 kt, visibility 2500 m, light snow, cloud 1–2/8 500 ft, 5–7/8 700 ft, 8/8 1500 ft, temperature and dew point + 0° C, QNH 978 hPa

EFVA: Wind 100 deg 9 kt, visibility over 10 km, light snow, cloud 3–5/8 400 ft, 5–7/8 800 ft, 8/8 2600 ft, temperature +1° C, dew point +0° C, QNH 978 hPa

17:50
EFSI: Wind 120 deg 11 kt, visibility 2500 m, light snow, cloud 1–2/8 500 ft, 5–7/8 700 ft, 8/8 1500 ft, temperature and dew point +1° C, QNH 978 hPa

EFVA: Wind 100 deg 8 kt, variable between 070–150 deg, visibility 8 km, rain and snow, cloud 3–5/8 400 ft, 5–7/8 900 ft, 8/8 2500 ft, temperature +1° C, dew point +0° C, QNH 978 hPa

18:20
EFSI: N/A

EFVA: Wind 110 deg 8 kt, visibility 8 km, rain and snow, cloud 3–5/8 400 ft, 5–7/8 900 ft, 8/8 1500 ft, temperature +1° C, dew point +0° C, QNH 977 hPa.

OH-ATB flew in Seinäjoki airspace from 17:50–18:30.

18:50
EFSI: Wind 130 deg 11 kt, visibility over 10 km, light drizzle, cloud 5–7/8 700 ft, 8/8 1100 ft, temperature and dew point +1° C, QNH 977 hPa

EFVA: Wind 110 deg 8 kt, visibility 8 km, rain and snow, cloud 3–5/8 400 ft, 5–7/8 800 ft, 8/8 1200 ft, temperature and dew point +1° C, QNH 977 hPa.

OH-ATB landed in Vaasa at 18:50.

TAFs on 1 January 2007:

EFSI from 17–19: Wind 110 deg 12 kt, visibility 5000 m, light snow, cloud 8/8 500 ft; temporarily from 17–19 visibility 2000 m, rain and snow, cloud 8/8 300 ft.

EFVA from 17–02: Wind 100 deg 9 kt, visibility 9 km, light snow, cloud 5–7/8 600 ft; temporarily from 17–02 visibility 2000 m, rain and snow, cloud 5–7/8 400 ft.

Runway conditions

Seinäjoki SNOWTAM at 17:30**:** Runway 14: wet snow 1mm deep, measured friction 39/40/40 (Skiddometer), deposit over total length of the runway, estimated friction medium to poor (2) on taxiways and apron.

From 17:45-18:20 the AFIS officer provided updated information according to which there was a 20 m wide cleared runway area with 2–3 mm slush. Outside the cleared area the slush was 6–7 mm deep. Gradually the snow turned into sleet and finally it changed into rain. Measured friction for runway 14 at 18:15 was 42/43/43, i.e. good.

1.8 Aids to navigation and radars

No defects were detected in the onboard navigation equipment before or after the flight.

All equipment at Seinäjoki and Vaasa aerodromes operated normally. Finavia had flight calibrated the aerodrome's navigation equipment on 21 August 2006. No irregularities were detected and all equipment was in proper working order.

Apart from the very lowest altitudes along the route, the MSSR radar network of ACC South Finland (EFES) tracked the aircraft. Radar track recordings were made available to the investigation commission. The same applied to the Finnish Air Force's surveillance radar data.

There is a *RATE* radar display in the workspace of the Seinäjoki AFIS officer. The display gets its radar picture from the EFES MSSR radar network. The AFIS officer monitored the aircraft on his display and, apart from the lowest altitudes, he was aware of the aircraft's position. As per current regulations, the AFIS officer can only use the monitor as a source of information.

1.9 Communications

Seinäjoki aerodrome radiotelephony communications (VHF 123.600 MHz) as well as Vaasa aerodrome VHF frequency 119.300 MHz operated loud and clear, as did both aerodromes' landline telephone connections.

Although the aerodrome recorder recorded all radio traffic, it did not record the direct EFSI–EFKA and EFSI–EFES telephone conversations or the timestamp. Hence, the investigation commission sent a written notice to the Civil Aviation Authority (CAA), which, in turn, notified the finding to Seinäjoki aerodrome. The shortcomings were corrected.

1.10 Aerodrome information

Seinäjoki airport is an aerodrome operated by the *Rengonharju* foundation. The foundation was established in 1977 by the municipalities of Ilmajoki, Jalasjärvi, Nurmo and Peräseinäjoki, the city of Seinäjoki, the Southern Bothnia Flying Club, the Association of Enterprises in Seinäjoki, Ilmajoki and Seinäjoki Savings Banks as well as the Association of Private Entrepreneurs in Ilmajoki. The present members of the foundation are the municipalities of Ilmajoki, Jalasjärvi, Nurmo and Ylistaro as well as the cities of Kurikka, Lapua and Seinäjoki. Lapua joined the foundation on 1 September 2006.

The foundation was registered on 31 March 1978. According to the charter, the purpose of the foundation was to establish aerodrome services for the Seinäjoki economic region. The foundation's supreme decision-making organs are the Administrative Council and Board of Directors. The president of the foundation operates as the manager of the airport.

There is one asphalt-paved runway: 32/14, 1543 m long and 30 m wide. The size of the grass covered runway strip is 1663 x 150 metres. The elevation is ca. 90 m (300 ft). The bearing of runway 32 is 316° (310 degrees magnetic) and the bearing of runway 14 is 136° (130 degrees magnetic).

An ILS instrument approach procedure, a two-beacon NDB approach procedure, high intensity approach path indicators and high intensity approach and runway lights exist for runway 32. A single beacon NDB approach procedure, low intensity approach lights and a high intensity approach path and runway lights exist for runway 14. The airport outsources navigation equipment maintenance from Finavia.

Seinäjoki is an Aerodrome Flight Information Service (AFIS) airport. An AFIS officer provides this service. The airport area and equipment have been inspected, the most recent audit having taken place on 7–8 December 2000. The airport does not have a document of certification from the aviation authorities. Instead, on 4 January 2006 they were granted an extension until 31 December 2010 to host a certification audit. On 25 October 2006, CAA Finland issued a construction permit to the Rengonharju foundation to widen the runway from 30 m to 45 m as well as to extend it from 1540 m to 2000 m. The work is in progress.

The CAA Air Navigation Services unit audited Seinäjoki airport on 1 October 2002, 18 May 2005 and 14 December 2006. Staff qualifications have been checked iaw ESARR 1 (Eurocontrol Safety Regulatory Requirements).

Seinäjoki is listed as a class A aerodrome in Finncomm's Operations Manual (OM-A). The aerodrome has a certified instrument approach procedure, the runway has no take-off or landing limitations, the published circling approach minimum is below 1000 ft and the navigation equipment facilitates night operations. No additional or special training is required of flight crews for Seinäjoki.

1.11 Flight recorders

OH-ATB was equipped with flight recorders, manufactured by L3-Communications (USA). The recorders were the following types:

- Digital Flight Data Recorder (DFDR), part no. 2100-4043-00, serial no. 00041 5968
- Cockpit Voice Recorder (CVR), part no. 2100-1020-02, serial no. 00042 1629

The captain turned the CVR off after the aircraft landed in Vaasa. Both flight recorders were removed from the aircraft and delivered to Helsinki-Vantaa, from where they were picked up by AIB Finland.

The CVR was working properly and the quality of the recording was good. The investigation commission's expert analysed the recording.

The aircraft was also equipped with a Multi Purpose Computer. The airline sent its maintenance memory data to the manufacturer of ATR for analysis.

The DFDR was working properly and it was downloaded at the Finnish Air Force Flight Test Centre. The data was used to create a computer animation of the flight.

1.12 Wreckage and impact information

It was not necessary to conduct an on-site inspection.

No faults or malfunctions had been observed in the aircraft prior to the flight in question. Approximately two months later intermittent defects were detected in the Navigation Processing Unit GPS card. The company had sent the device to the manufacturer for repairs.

1.13 Medical and toxicological information

No medical and toxicological tests were performed.

1.14 Fire

There was no fire.

1.15 Rescue operations and survival aspects

No rescue activities were required, nor were rescue units alerted. The AFIS officer at Seinäjoki was prepared to alert the rescue units because of the possibility of an accident. However, the captain reported that no help was required.

Due to the possibility of an accident, the air traffic controller at Vaasa placed the airport rescue units on standby. Nevertheless, their deployment was not required.

1.16 Test and research

The ATR's manufacturer analysed the maintenance memory (Quick Access Recorder, QAR) of the Multi Purpose Computer. The results were made available to the investigation commission.

The CVR was downloaded on 8 January 2007, supervised by the commission. The aircraft type's system warnings were displayed and recorded at the ATR simulator on 23 January 2007. The commission's audio expert analysed the data in order to establish the chronological sequence of events and warnings.

The DFDR was downloaded at Helsinki-Vantaa on 19 January 2007 with Finncomm's own equipment. A member of the investigation commission witnessed the procedure. The data was analysed at the Finnish Air Force Flight Test Centre in May of 2007and used to create a ground track of the aircraft's route superimposed on a map as well as a computer animation, synchronized with CVR data.

1.17 Organizations and management

The airline's organization and activities are depicted as they were during the time of the occurrence.

1.17.1 The organization and operation of the company

Finncomm Airlines Oy is a charter airline, established in 1993 in Seinäjoki. Local business leaders considered it important to establish an airline for the Seinäjoki business region. In 2003 the company began to fly feeder traffic between Helsinki and other parts of the country. Due to this, aircraft and crews often stay overnight at places other than Helsinki. Route schedules were tailored for feeder traffic and so flights were concentrated at certain times of the day. Feeder traffic is challenging from the perspective of on-time performance and crew resources. Hangars have been built for the airline at the most important airports. These help prevent schedule delays caused, among other things, by cold weather conditions and facilitate pre-flight checks.

The company uses Helsinki-Vantaa airport as its designated home base. In the beginning of January 2007 the airline had two Embraer ERJ-145LU and three ATR 42-500 aircraft in its fleet. The airline also used Saab 340 aircraft on its routes, operated by the Swedish Golden Air.

The airline cooperates with Finnair Oyj as part of its international code-sharing partner network. At the time of the occurrence the airline was flying its ATR fleet from Helsinki to the following airports: Pori, Tampere, Lappeenranta, Savonlinna, Joensuu, Kuopio, Jyväskylä, Seinäjoki, Vaasa, Kokkola and Kuusamo.

Finncomm Airlines Oy has made changes to its organization several times during its existence, mainly due to business expansion. The organization chart in appendix 5 was valid at the time of the occurrence.

At the time of the occurrence the managing director was also the company's accountable manager. The following persons reported to him: the human resources director, the quality manager, the administrative director, the financial director as well as the post-holders in flight operations, including the flight operations manager, the continued airworthiness manager, the line maintenance manager, the operations control manager, the ground operations manager, the safety manager and the marketing director. The quality manager reported directly to the accountable manager.

The airline operated from two separate locations: Seinäjoki and Helsinki-Vantaa airports. Human resources management, financial management, administration and operations (OPS) control were located in Seinäjoki. The IT department which was part of OPS control maintained the company's intranet and provided support services to flight operations, among other things. The rest of the departments were based at the hangar and office spaces at Helsinki-Vantaa airport. These included the following: Flight operations, continuing airworthiness management, line maintenance, ground operations and emergency response/security. Apart from marketing, these functions were supervised by the quality management and jointly used the administrative services. The directors of the aforementioned departments reported directly to the accountable manager. The flight operations manager was the director of flight operations. The head of training, the flight safety manager, the chief pilot, the chief cabin attendant, the flight ops engineer and the flight ops support team reported directly to the flight operations manager. The investigation did not establish procedures related to continued airworthiness or line maintenance.

Training for type rating was the responsibility of Finncomm Training Academy, which was a separate subsidiary, based at Helsinki-Vantaa. The accountable manager and the quality manager of the airline also served in the same respective functions in the training academy. The director of the Type Rating Training Organization (TRTO) reported directly to the accountable manager.

Neither aircraft maintenance nor continuing airworthiness management issues were investigated. The investigation tried to assess the company's general style of management and administrative practices. According to the information provided by the company, steering group meetings had been held since 2003, attended by the managing director, the quality manager, the flight operations manager, the continued airworthiness manager, the training manager and the ground services manager. According to the company, records were kept of these meetings. In addition, records were kept of meetings of the operational management group and the financial management group. The airline did not provide any documents on the abovementioned meetings. Such documents would have enabled a more thorough evaluation. The assessments in the analysis are based on hearings and interviews as well as investigation commission observations.

1.17.2 Manuals and bulletins

As per section 2.2.1 in the company's OM-A, the airline maintains the following manuals approved by the authorities:

- Operations Manual (OM-A). The flight operations mgr is responsible for its contents,
- Type-specific Flight Operations Manuals (OM-B). Fleet chief commanders are responsible for their contents,
- Enroute Operations Manual (OM-C). The flight ops mgr is responsible for its contents,
- Training Operations Manual (OM-D). The flight ops mgr is responsible for its contents,
- Cabin Manual (CAM). The chief cabin attendant is responsible for its contents,
- Ground Operations Manual (GOM). The ground ops mgr is responsible for its contents,
- Safety Equipment Manual (SEM). The safety mgr is responsible for its contents,
- Flight Emergency Manual (FEM). The flight ops mgr is responsible for its contents,
- Continuing Airworthiness Management Exposition (CAME). The airworthiness mgr is responsible for its contents,
- Type-specific Maintenance Programmes (MP). The airworthiness mgr is responsible for their contents,
- Maintenance Organization Exposition (MOE). The repair station mgr is responsible for its contents, and
- Type Rating Training Organization Operations Manual (TRTO-OM). The TRTO mgr is responsible for its contents.

OM bulletins and operational bulletins supplement these manuals. The flight ops mgr publishes the bulletins and is responsible for their contents. Finncomm Oy uses *Jeppesen* instrument approach charts as such in its flight operations.

According to the company's OM-A, regular revisions are used to keep the manuals current. Temporary revisions are published when immediate action is required. If the changes are of a permanent nature, they are included in the next normal revision. Alert revisions are used to inform of changes which are not permanent.

Operational bulletins contain more detailed information for flight crews regarding company procedures and their justifications. They cannot conflict with the regulations or instructions in the manuals. Bulletins are promulgated by e-mail and hardcopies are kept in a briefing room folder.

The airline uses its own intranet to inform crews of daily work shifts, routes and tasks. In addition, every crewmember has his/her own company e-mail address. In practice, e-mail is the only information medium. When required, crews can use the mission-specific Crew Information System (CIS) in pre-flight planning. Finnair maintains this system. When it comes to the crew information system, Finncomm performs in-house updating. Flight crews and cabin crews take printouts of the CIS reports on flights.

1.17.3 Quality assurance system

The company's quality assurance system complies with the regulations included in JAR-OPS 1, PART M and PART 145. The Operations Manual (OM-A, chapter 3) includes a description of the quality assurance system, required by JAR-OPS 1.035. The description comprises the quality organization, the quality management programme, corrective action, management review, documentation and recording requirements, subcontractors' quality assurance, quality management training and the quality reporting system. There is no quality manual per se, but a "Quality Department procedures" -manual has been published to support daily operations .With regard to technical operations, the quality assurance system is further explained in the CAME and the MOE. The quality mgr is responsible for the system and supervision. The following illustrates the company's quality assurance system as it was described in the OM-A and the material provided by the company, valid at the time of the occurrence.

The key quality policy goals, in order of importance, are the following:

- Flight safety,
- Passenger satisfaction,
- Reliability,
- Economy, and
- Environmental aspects.

It was up to the quality mgr to supervise that all valid regulations and directives issued by the aviation authorities and the company were observed in flight operations, in continuing airworthiness management and training as well as in ground operations and line maintenance. Supervision also included the monitoring of postholders in their respective fields and the effectiveness of corrective action regarding nonconformities.

The quality mgr was also responsible for establishing and maintaining a quality management system as well as for seeing to it that matters related to the accident prevention programme and the flight safety programme were processed and brought to a conclusion. The quality assurance system also required that subcontractors be included under the company's quality control umbrella.

The quality management system included the following three fields: quality audits, quality checks and management reviews. The quality mgr and authorized auditors were allowed to conduct quality audits. The company had four auditors, two of whom participated in auditing JAR-OPS 1 activities. The remaining two auditors were designated to audit PART M and PART 145 activities. With regard to the above, the OM-A was not up to date because it only described one JAR-OPS 1 auditor, the wrong auditor for the

PART M side and no auditor at all for PART 145 activities. The JAR-OPS 1 auditors performed their tasks in addition to their regular duties.

Quality audits were conducted in accordance with the auditing plan. This ensured that all fields were audited at least once every 12 months. Flight operations, ground operations and training were divided into 20 audit scopes. The OM-A did not identify audit scopes for continuing airworthiness management or line maintenance. No scheduled intervals were established for quality checks. Instead, the requirement was that they be continuous. The quality mgr was informed of completed quality checks.

A Nonconformity Report was written on anomalies detected in audits. The seriousness of a report ranged from 1–serious to 2–minor and 3–comment. Corrective actions were established for serious and minor nonconformities. The deadline for completing an action was determined between the auditor and the person responsible for the field in question. The efficacy of corrective actions was to be monitored by follow-up audits or quality checks.

Postholders conducted quality checks within their respective fields of responsibility. The quality mgr and auditors were also allowed to make quality checks.

A Quality Report was written on nonconformities detected in quality checks and corrective actions were established. The quality mgr was responsible for follow-up monitoring. Flight operations, de-icing and anti-icing as well as flight support services, loading control, maintenance, technical standards, training standards and safety were typical fields in which quality checks were made.

Compliance with aviation regulations, manuals and directives was to be monitored by quality checks, corrective action and follow-up supervision. Proper requirements were in place for recording material, quality training and document control.

According to the OM-A, management reviews were to be conducted once every 6 months. The accountable manager was responsible for carrying out the management reviews. This included inviting the participants and drawing up schedules as well as archiving the records which were generated during the reviews. The purpose of a management review was to comprehensively assess the quality and prevailing trend of the company's functions as well as to prevent nonconformities, if possible. The review was also to take into consideration all changes affecting the quality system, if any. Furthermore, the efficiency of the company's JAR-OPS 1, PART M and PART 145 fields as well their nominated postholders were to be assessed.

The management review was to result in decisions and actions which could:

- Improve the quality system,
- Evaluate the structure and resources of the organization, and
- Help establish the future resource requirements.

The JAR-OPS regulations identify *resources* as economic, material and human (personnel) resources. Judging by the documents provided to the investigation commission, management reviews were conducted in the separate fields of operation on an annual basis. Due to personnel changes the company had rescheduled management reviews, thus extending the interval between the reviews.

In order to facilitate and improve operations, employees are encouraged to file reports on observed shortcomings. According to the OM-A, these include:

- Mandatory GEN M1-4 reports required by the authorities (accident reports, incident reports and bird strike reports),
- Reports of dangerous cargo,
- Occurrence reports (the captain's comments in the technical logbook),
- Quality reports
- Company-internal occurrence reports,
- Reports on malfunctions and faults required by the aviation authorities, and
- Nonconformity reports.

The mandatory reports which are required by the authorities are also to be delivered to the quality mgr. Feedback is provided to all who file reports. The secondary purpose of these reports is to try to estimate operational trends and to compile statistics. Approximately 50 nonconformity reports on the functioning of the organization and flight operations were filed within the observed 13-month period. Judging by the documents provided to the investigation commission, the reports had been used for creating statistics and illustrative images.

The quality assurance system includes supervision of employees' actual working time and rest periods. An information technology solution enabled the recording of irregular work and rest periods. With regard to crew resource management, individual employees shared some responsibility for recording nonconformities from planned work and rest periods into the OPS control's aircrew resource management system.

Even before the selected period of scrutiny, the quality system had recorded nonconformities on the lack of postholders' resource analyses. Records revealed several extensions of corrective action and overdue JAR-OPS 1 activities during the period of scrutiny.

According to the company, follow-up audits and quality checks were made in order to establish the efficiency of corrective action for nonconformities. However, they were not documented.

1.17.4 Human resources policy

The airline used a flight crew recruiting system, the criteria of which had been defined by the company itself. The company used its own Pilot Selection Group for hiring new pilots, assisted by a psychologist from the Finnish Institute of Occupational Health.

The company recruited pilots from the open market. Experienced captains mainly came from other airlines and co-pilots were recruited from flight academies. The company paid for the pilots' type conversion training. Pilots were expected to sign fixed-term contracts. Should a pilot leave the company before his contract ran out, he was to reimburse the company for the remainder of his contract. New pilots typically flew as co-pilots for 3-4 years. During this time they accrued experience and the 1500 flying hours which are required for a captain's rating. After this, they had the opportunity to be promoted to captain within the company.

There was no established procedure for the selection process of captains and route instructors. Instead, the flight operations manager selected them after consulting the fleet chief commanders.

According to the company's own admission, feeder traffic was largely the reason for higher than average annual pilot turnover rates, amounting to 10–15 % of the pilots working for the airline.

Postholders were mainly picked from within the company. The flight operations department and OPS control shared responsibility for the sufficiency of flight crews. OPS control was tasked to estimate the need for flight crews in view of medium-term route requirements. However, the investigation found no documentation on this. The airline felt that there was no need to set competence standards for the staff of OPS control. Staff training had begun in 2005 and was completed in 2007. In all, 45 hours of training were provided during this time and were documented iaw ICAO Doc 7192, D3. OPS control turnover rates were low and more staff was hired in 2007. The job description of OPS control personnel included being on duty and telecommuting.

1.17.5 The flight training system

The company has marketed an *ab-initio* type basic flight training system, in which preselected pilots are given preference in the recruitment phase. Even though the company recruited all of the co-pilots trained though this system, the process did not generate the required number of pilots.

Type rating training was given to selected pilots on type conversion courses approved by the authorities. Type rating training was outsourced from two providers. At the time of the incident the type conversion training was provided by the airline's own, separate, type training organization. The company had trained three type rating instructors in France. In addition to them, the company also used instructors from other airlines. Problems were created by dissimilarities between the ATR procedures observed by the guest instructors and Finncomm's own procedures. By 1 January 2007 the company's ATR pilots were trained as follows: 46 % at the ATR Training Center (France), 26 % at the Finnair Training Center and 28 % at Finncomm TRTO.

The company did not use its own flight examiners. The Finnish Civil Aviation Authority had not approved the company's candidates for training as flight examiners. Instead, according to information provided by the company, the CAA had recommended the use of outside, CAA-approved examiners.

The ATR 72-200 flight simulator used in type conversion training was also approved for ATR 42-500 instruction. Helsinki-Vantaa and Tampere-Pirkkala were the two most often used airports for simulator training. The airline also used its own ATR 42-500 fleet for the required training sorties. The pilots in this incident had completed the type rating training provided by the company's own TRTO. Four of the total eight simulator sorties had been instructed by the company's own personnel and the remaining four by outside instructors. According to the company, the fleet chief commander and line instructors were responsible for the broad outline of type rating training.

Line training is provided on a minimum of 20 instruction flights. These sorties, however, do not cover all of the sectors, airports and approaches used by the airline. Rather, experience is gained on scheduled line flights. This is also a common practice among airlines. Line training culminates in a line check. Once a pilot successfully passes the line check, he can operate as co-pilot. Judging by material made available to the commission, pilots averaged a little over 20 line instruction sorties.

Following the line training, co-pilots would fly with experienced captains. A pilot would be regarded as an "inexperienced pilot" until he had logged at least 100 flight hours on a minimum of ten sectors within the period of three months or, alternatively, 150 flight hours on a minimum of 20 sectors without any time limitation. After this, the pilot was considered capable of independent operation. Two inexperienced pilots were not permitted to be crewed together.

Once a co-pilot has logged a minimum of 1500 flight hours, he could enrol in a command course and, after a successful completion of a proficiency check flight, be promoted to captain. Nevertheless, a minimum of 100 flight hours with an experienced co-pilot was required before he could independently operate as captain. Pilots who already have a captain's rating on one aircraft type could fly as captains on another type after having completed type rating training and a line check.

The training department of the company was responsible for JAR-OPS-mandated refresher training. The head of training and his assistant constituted the department's in-house resources. OPS control was tasked to track the periods of rating validities. There was no procedure in place for harmonizing flight operations and training. It was established through interviews that OPS control – within their powers – had transferred pilots-in-training to flight operations without, however, informing the head of training of this. Nevertheless, no nonconformities were recorded, even though the validity of recurrent training had expired in some instances.

Recurrent training and competence checks were conducted in compliance with the authorities' regulations. The airline provided its own CRM and DGR training. Training received at other airlines was also accepted.

1.17.6 Commercial flight crew training in Finland

The investigation commission visited three flight academies which train most of the pilots for Finnish airlines. Each academy made its training syllabus and instructor lists available to the commission. Furthermore, the investigators assessed the training devices and equipment, training goals and student pilot assessment procedures. They also looked at the flight academies' in-house control arrangements. All of the training syllabi were approved by the authorities. The goal of flight training was a Commercial Pilot Licence (JAR-FCL CPL/IR (A)) with a multiengine rating. Holders of CPL (A) licences are permitted to operate as co-pilots in commercial aviation, among other things, and they can seek employment as airline co-pilots. Multi-crew cooperation, multiengine turboprop aircraft and all jet aircraft require appropriate type ratings. Airlines are of the opinion that a commercial pilot coming straight out of a flight academy is not sufficiently qualified to begin airline co-pilot type rating training without some additional training. Therefore, some airlines have provided extra training for the pilots they recruit. The syllabus of one flight academy also included Multi Crew Cooperation training.

Training was either modular or integrated, as per JAR regulations. Students paid for the training in full. One of the academies belonged to the Finnish adult education and training system, meaning that the Ministry of Education covers 90% of the tuition. Finnair is a major shareholder of this academy and supports its operation by providing instructors for classroom and flight training. The other academies also used airline pilots as their instructors.

With regard to CPL training, the key difference between the academies was the number and quality of multiengine aircraft available. One of the academies also arranged specific type conversion courses for airliners.

One academy had arrangements in place to improve students' skills when they migrated to a multi-crew environment. Student pilots were introduced to Multi Crew Cooperation on training flights by using appropriate cockpit procedures and by providing additional training, when required.

1.18 Additional information

The Accredited Representative of the French accident investigation authority BEA was responsible for collaborating with the aircraft manufacturer. In addition, the investigators met with the representatives of the ATR factory, who visited Finland. Training procedures were discussed with the instructors whom the company used. The function and nature of warning systems were established in the ATR simulator.

1.19 Methodological information

Standard methods were utilized in the investigation. As far as the test and research of the occurrence is concerned, flight data recorders and radar track recordings proved invaluable. The expertise and assistance of the Finnish Air Force Flight Test Centre in the analysis of the DFDR was appreciated. The investigation of the company's organization was carried out via document analysis and numerous interviews.

2 ANALYSIS

2.1 Background information of the incident flight

2.1.1 Recordings

The aircraft's maintenance memory was analysed at the ATR factory. Data analysis on aircraft behaviour and related warnings corroborate with the action of the pilots. The EGPWS system and the stall prevention system functioned as intended.

The Cockpit Voice Recorder (CVR) had functioned normally and the recorded information could be analysed. The commission went through the aircraft type's system warnings on the ATR simulator on 23 January 2007 and the data was recorded. The audio expert member of the commission analysed the recordings in order to establish the chronological sequence of events and warnings.

The Digital Flight Data Recorder (DFDR) was downloaded on 19 January 2007 at Helsinki-Vantaa with Finncomm's own equipment. A member of the investigation commission was present. The data was analysed at the Finnish Air Force Flight Test Centre in May 2007. The information was used to create a ground track of the aircraft's route superimposed on a map as well as to create a computer animation, synchronized with CVR data.

The DFDR recording shows that the onboard warning systems functioned as intended and that the EGPWS system functioned properly with regard to the aircraft's attitude, altitude and landing gear position.

2.1.2 The EGPWS system

The Enhanced Ground Proximity Warning System (EGPWS) warns with visual and audio messages if a likely future position of the aircraft will intersect with the ground. The basic system gives a warning in the following instances:

- Mode 1, Excessive descent rate

  Activates when the aircraft's sink rate is excessive in relation to the radio altimeter's reading (SINK RATE – PULL UP),
- Mode 2, Excessive terrain closure rate

  Activates due to an excessively high terrain closure rate as measured by the radio altimeter. The aircraft's configuration affects the activation of the warning (TERRAIN, TERRAIN – PULL UP). Mode 2 operates in two different sub-modes. During takeoff, cruise and the initial descent the system operates in mode 2A. When the flaps are fully extended, it automatically switches over to Mode 2B,
- Mode 3, Altitude loss after take-off

  (DON'T SINK),
- Mode 4, Unsafe terrain clearance

  Mode 4 activates if terrain clearance is insufficient during approach or takeoff. The configuration and airspeed affect the activation of the warning (TOO LOW TERRAIN, TOO LOW GEAR, TOO LOW FLAPS). Mode 4 has three sub-modes; 4A, 4B and 4C. Mode 4A is on during cruise and during approach when the landing gear is in the "up" position. Mode 4B is on during cruise and when the landing gear is in the "down" position and the flaps are not fully extended. Mode 4C is on during the initial climb and during a low level circling approach,

- Mode 5, Below glide slope

Activates when the aircraft sinks below 1.3 dots on the glide slope indicator during an ILS approach (GLIDE SLOPE), and

- Mode 6, Advisory callouts

Activates when specific altitude minima are passed (FIVE HUNDRED, MINIMUM – MINIMUM) or when bank angle limits are exceeded (BANK ANGLE, BANK ANGLE).

The "Enhanced" system also takes into consideration GPS-based obstacle clearance envelopes (Terrain Clearance Floor, TCF) in the vicinity of airports. The warning goes off if the aircraft descends below the calculated terrain clearance envelopes (TOO LOW, TERRAIN).

Another function is "Terrain Awareness", comprising Terrain Alerting and Terrain Display. If the aircraft proceeds to an altitude in which it is in a dangerous path heading towards terrain, warranting a caution, a callout (TERRAIN AHEAD, TERRAIN AHEAD) is generated and the terrain display on the horizontal situation indicator (HSI) shows the terrain in question in yellow. If the aircraft descends through this altitude, the system generates an audio warning (TERRAIN AHEAD, PULL UP) and the HSI shows the dangerous terrain in red. The activation of the terrain awareness system also alters the pilots' EFIS displays so that they begin to indicate relative terrain altitude within the radius of 10 NM. Relative terrain altitude is displayed in relation to the aircraft's altitude in three colours (green, yellow and red).

2.1.3 Crewing

The original crew was changed for this flight. The previous evening the co-pilot was asked to report to work a little earlier than usual. However, he was not told with whom he would be flying. This was not unusual because the company never provides information to pilots in the work roster with regard to the type of flight or with whom and where they are to fly. It is the opinion of the investigation commission that this does not provide sufficient time for the co-pilots to prepare, for instance, for flights to previously unvisited airports or for line training flights.

As per the company's OM-A valid at the time of the incident, a pilot is "inexperienced" if he has fewer than 100 flight hours on a minimum of ten sectors within the period of 120 days or, alternatively, 150 flight hours on a minimum of 20 sectors on a period longer than 120 days.

The captain and the co-pilot had been on the same type rating course and in simulator training together and they knew each other well. They said that they had talked about their respective type experience before the flight and the co-pilot estimated that he had already passed the 100 hour requirement on the ATR. The captain said that he took it for granted that the co-pilot was sufficiently rated. The company stated that every pilot should be aware of his/her flight experience at all times.

Investigation revealed that company regulation was not followed in crewing. Due to altered work shifts, the crew in question comprised of two inexperienced pilots. The co-pilot's yellow marker, which indicated an inexperienced crewmember, had been replaced by a red marker, indicating off-duty. The crew's inexperience went unnoticed by the OPS control duty officer. According to information received, OPS control regulations were sufficient, albeit poorly documented. The crewing program would not display two simultaneous colour codes, such as *inexperienced* and *off-duty*.

In order to prevent comparable errors in the future, the company implemented the following system update in November 2007:

- The training department maintains the list of inexperienced pilots,
- The list is a hardcopy, signed by the flight operations manager, and
- Only the flight operations manager is allowed to remove a pilot from the list.

The list is made available to the pilots and OPS control uses the list in crewing. The company believes that this eliminates the possibility of error that existed in the previous system.

2.1.4 Chronological sequence of events

The chronological sequence of the events discussed later in this report was as follows:

	UTC	LT
Leaving FL 200	15:43	17:43
OM PSJ outbound towards locator Oscar	15:48	17:48
Locator Oscar outbound	15:49.30	17:49.30
1. First EGPWS warning, missed approach	15:54.18	17:54.18
2. Locator Oscar, end of missed approach	15:56.25	17:56.25
3. Glide commences (between O and PSJ)	15:58.00	17:58.00
4. Second EGPWS warning, missed approach	15:.59.32	17:59.32
5. Stall warning and stick pusher		
- Stall warning, AP disengaged	16:01.02	18:01.02
- First stick pusher	16:01.08	18:01.08
- Second stick pusher	16:01.13	18:01.13
- Missed approach begins	16:01.20	18:01.20
6. Reaching FL 70	16:04.13	18:04.13
7. Glide commences (PSJ)	16:09.17	18:09.17
8. Third EGPWS warning (Too low, gear)	16:14.30	18:14.30
- Detection of wrong altimeter setting	16:17	18:17
9. Glide commences (PSJ)	16:22.40	18:22.40
10. Fourth EGPWS warning (Too low, gear)	16:23.34	18:23.34
- Gear down (circling approach)	16:23.54	18:23.54
11. Fifth EGPWS warning (Bank angle)	16:24.49	18:24.49
12. Sixth EGPWS warning (Bank angle)	16:25.36	18:25.36
13. Flight to Vaasa, landing at	16:50	18:50

The course of the flight, including warnings, is illustrated as a ground track as well as a printout of the DFDR recording in appendix 4, sections 4.1-4.4.

2.2 Incident analysis

2.2.1 Pre-approach action

The company's pre-approach procedures include determining the conditions at the destination and, thus, deciding on the runway and approach to be used, computing the landing values on the aircraft's laptop computer, programming the FMS system, conducting the approach briefing, checking the appropriate IAL chart and conducting the approach check. Some of these items are completed before the flight. When the approach briefing is started early enough, the crew does not run out of time.

This time the approach preparation was started when the captain radioed Seinäjoki airport for weather and runway information. Based on the information received, the crew decided to fly an NDB approach to runway 14. The captain had previously flown such approaches with SAAB aircraft, but not with ATRs. The co-pilot had not flown them at all.

Once they had selected the approach method they proceeded to compute landing performance values. This is the task of the PNF. The PF is responsible for programming the FMS. This routine can, however, be altered. The flight crew tried to follow the aforementioned practice on this flight. In practice, both pilots conducted the computation.

They used quite a bit of time in landing performance computation. During this time they received updated runway condition information from Seinäjoki. According to CVR recordings, they first attempted to simultaneously calculate landing and takeoff values, which is impossible. The anti-icing system was on and the co-pilot checked that the system used the speeds intended for icing conditions. Computation began at approximately 17:35 and ended about six minutes later, at 17:41. The computation provided the correct approach speeds.

The co-pilot programmed the FMS. Judging by the CVR data, the co-pilot seemed very accustomed with FMS programming, which took approximately four minutes and was completed at around 17:45. While they were still programming the system, they left FL 200 at 17:43. It was at this stage when they should have called out the altimeter setting transition (*Transition, QNH 978*). Nevertheless, possibly because of having devoted their attention to the FMS, they did not make the callout. As per company regulation the PNF sets the auxiliary altimeter after having listened to the ATIS information. The captain does not recall whether he did this or not.

Computation and FMS programming took so much time that they only made it through the first part of the pre-approach checks, i.e. the approach briefing. The rest of the checks, especially the altimeter transition, were not made. In view of a successful approach, the crew demonstrated inadequate cockpit procedures and Crew Resource Management.

According to the captain's account, they received a warning for icing during the descent. However, as per DFDR data, the icing detectors did not sense any ice. Neither was an "icing" warning recorded on CVR data. According to the co-pilot's altimeter, the aircraft reached 2500 ft (750 m) at 17:47. The actual altitude, as recorded by the DFDR, was 1300 ft (450 m). They crossed over the outer marker PSJ at 17:48.

The approach briefing and the approach check were started approximately one minute prior to passing the outer marker (OM). Nevertheless, they aborted the approach check almost immediately and only checked the speed bugs. The altimeter check was the next item on the list but this was not completed. It was at this point that the standard pressure setting 1013.2 hPa remained on the co-pilot’s altimeter, even though it should have been set to Seinäjoki QNH 978 hPa. It is also possible that the standard pressure setting remained on the captain’s altimeter. The co-pilot was under the impression that the captain would have routinely set the QNH to his altimeter when they left FL 200. After all, the intention was to descend directly to the minimum sector altitude through the transition level. At any rate, the captain had no recollection of having altered his altimeter setting.

It is the opinion of the investigators that they should have conducted the approach briefing much earlier and, absolutely, by following the approach checklist. They should have called out the altimeter transition when they passed the transition level, at the latest. For the sake of safety, both pilots should have individually checked their own altimeters. Nonetheless, this was not company procedure at the time. Because of the erroneous altimeter setting, they now continued to fly 950 ft (ca. 300 m) lower than they thought.

2.2.2 The approach

The NDB approach is a nonprecision approach. In an NDB approach to runway 14 at Seinäjoki the minimum altitude after crossing over locator O is 1700 ft QNH. The outbound bearing with an aircraft of this class is 292° and the duration of the outbound leg 2 minutes. The approach continues with a right base turn towards the final approach bearing 130°. Locator O determines the final approach course. One may commence the descent to the Minimum Descent Altitude (MDA) once the aircraft is established on the final approach course. The aircraft is considered established on final when it is within ±5 degrees from the required course in relation to locator O. Locator O is also the missed approach point (MAPt).

When the aircraft crossed over the outer marker PSJ, they discontinued with the checklist and, hence, the approach briefing was cut short. The PNF should have seen to it that the checklist be completed. They would have had enough time by flying an extra holding pattern, for example.

The co-pilot flew using the autopilot. As they started the approach he told the captain that he had never flown an NDB approach to runway 14 in Seinäjoki and asked the captain to read the outbound bearing and duration, even though they were marked in the IAL chart which he had in front of him. He also repeatedly asked when he could commence the descent as well as which sink rate he should use. The co-pilot later said that he knew the two-beacon NDB procedure well, but that he did not remember the single-beacon procedure at all.

They crossed over locator O at 17:49:30 in the outbound bearing. The base turn commenced at 17:51:30. Judging by radar tracks and DFDR recordings, the outbound leg was inadvertently extended by some three miles (5 km) mainly because of the strong tailwind and the too-long outbound time. According to the co-pilot's altimeter, they reached 1700 ft approximately 15 seconds before reaching the final approach course at 17:52:30, slightly north of the final approach course. After they corrected their heading they ended up clearly south of the course, slowly returning towards the final approach course. As per DFDR, their altitude was approximately 600 ft (180 m) and both pilots later said that they maintained ground visibility. The co-pilot added that their altitude seemed strangely low and that they were at times below the clouds. According to the weather report, it was partly cloudy at 800 ft and overcast at 1400 ft. However, cloudiness and cloud base can vary in places and, therefore, reported cloud information should always be treated with caution.

CVR records showed that the co-pilot hesitated to commence the descent for the final approach. Both pilots tried to get the runway in sight. However, at that point they were almost 9 kilometres away from the runway and due to the 3.5 km horizontal visibility it was impossible to see it. It is the opinion of the crew that the absence of distance information to runway 14 makes the NDB approach especially difficult. When the captain told the co-pilot to commence the descent the aircraft was in the landing configuration. They initiated the descent at approximately 17:54.

2.2.3 First EGPWS warning

The aircraft began to descend in landing configuration from the actual altitude of 600 ft. Almost immediately, the overhead speakers sounded the caution ”FIVE HUNDRED”. At this time, the aircraft was 8 kilometres from the runway 14 threshold. The glide continued and they received the warning “TOO LOW, TERRAIN”, followed by the autopilot disengaging. According to DFDR data, the aircraft was at 340 ft (105 m). The co-pilot began to hand-fly the aircraft and climbed approximately 300 ft. However, he did not perform a missed approach. The company's rules for this case are as follows:

- Initiate missed approach immediately,
- Report this to the ATS immediately, and
- Notify the occurrence to the company and to the authorities.

These rules were not followed. The captain was still hoping to make visual contact with the runway so it took ca. 30 seconds from the time of the warning for him to call a missed approach. Once the order was given, the co-pilot immediately performed the missed approach.

In spite of the fact that they had maintained ground visibility, they did not notice that they were too low. Neither pilot paid any attention to the radio altimeter reading, indicated (in small size numbers) on both pilots' upper multifunction displays. If the captain had set his altimeter to Seinäjoki QNH 978, the position of his altimeter pointer displaying hundreds of feet would have been almost identical to the position of the co-pilot's respective altimeter pointer position at the setting 1013.2 hPa. However, the difference could have been detected from the altimeter's numerical display in the window indicating thousands of feet.

The flight crew concentrated on being established on course centreline in order to make a successful approach and believed that they were at a safe altitude. When they received the warning, the captain first supposed that there was a fault in the aircraft's systems instead of analysing the actual cause of the warning, such as flying at too low an altitude. This, it seems, was caused by their having to work under pressure. Nevertheless, it also implies quantitative and qualitative shortcomings in type rating training.

It appears that the altitude warning was generated by the "Terrain Awareness" function in the EGPWS system. This function activated when the aircraft descended too much below the warning altitude and below the pre-programmed obstacle clearance.

Radar tracks show that the approach could have been successful, had they not ended up dangerously low. This caused the warnings and the approach had to be aborted.

2.2.4 Second EGPWS warning

The missed approach for runway 14 at Seinäjoki after crossing over locator O includes a climb to 1700 ft QNH towards the outer marker PSJ in the bearing of 130°, taking into account wind compensation.

The co-pilot flew the missed approach manually. According to DFDR data, the climb was unsteady and their heading, airspeed, rate of climb and power settings varied quite a bit. Although they received an excessive airspeed caution during the climb, their speed also dropped rather low (100 kt). Their intention was to climb to 1700 ft towards PSJ. Instead, the co-pilot climbed to 3000 ft where he re-engaged the autopilot. At that time, the aircraft was at locator O.

According to the co-pilot, the suddenness of the go-around caused the unsteady missed approach. He had not prepared to execute a missed approach at this phase of the approach. After the autopilot was engaged the flight path of the aircraft stabilized. However, they continued to climb to 3500 ft. The captain set the power control lever at MCT (maximum continuous). When engine power is reduced at this setting, propeller pitch causes a rapid reduction in airspeed.

The AFIS officer requested the aircraft to report their position. The captain replied that they had initiated a missed approach because they lost visual contact with the runway in a snow flurry. He did not, though, mention the EGPWS warning. He then said that they intended to perform an ILS approach to runway 32, followed by a circling manoeuvre to runway 14.

The crew reduced altitude in order to descend to 1700 ft. Approximately 30 seconds after crossing over PSJ they reached 1700 ft, but they continued to descend and then received the warning "FIVE HUNDRED, TOO LOW, GEAR". Nevertheless, they kept descending, which generated the warning "TERRAIN AHEAD, PULL UP" at 17:59:30. The autopilot disengaged and the co-pilot initiated a missed approach, intending to climb to

2500 ft. The lowest altitude during this approach was 425 ft. As per the captain's account, at this time his Electronic Flight Information System (EFIS) display went blank.

The crew believed that they were still at a safe altitude and, therefore, the captain was convinced that there was a malfunction in the aircraft's electrical system. He did not comprehend that they had received the EGPWS warning for flying too low, which is why his flight information display also changed colour.

The warning first consisted of the mode 4 "Unsafe Terrain Clearance", when they descended too far below the warning altitude when not in landing configuration. Right after this the "Terrain Alert" warning was activated because the aircraft continued to descend. Proximity to the ground caused the colour change in the EFIS.

The company has put forward that the EGPWS system did not function properly on the OH-ATB. In support of this they presented the following evidence:

On 11 January 2007, at the altitude of 200 ft, during a visual approach at Pirkkala, the OH-ATB received a "TERRAIN AHEAD, PULL UP" EGPWS warning. Simultaneously the co-pilot's EFIS terrain display turned purple. The warnings disappeared only after the aircraft was powered down and being parked. The EGPWS processor was replaced.

On 5 March 2007 during a visual approach at Vaasa, the OH-ATB received a similar false EPGWS warning, including the purple indication on the co-pilot's flight instrument. This time they suspected the Navigation Processing Unit (NPU) and sent it to Honeywell for inspection. Examination revealed that the unit's GPS card was defective and provided incorrect positional information to the EGPWS. The NPU was replaced.

Nevertheless, DFDR data in this investigation proves that the aircraft descended too low and that the ensuing warnings were valid and accurate. As per the EGPWS manual, the purple terrain indication on the EFIS was nominal.

2.2.5 Stall warning and stick pusher

The ATR's stall prevention system consists of the stall warning system and the stick shaker and stick pusher functions. When the angle of attack (AOA) reaches a given value, the system generates a stall warning and activates the stick shaker. If the angle of attack continues to increase, the stick pusher activates and pushes the control yoke forward. Consequently, the nose goes down, the AOA decreases and airspeed increases. This reduces the likelihood of a stall.

During the missed approach the aircraft stayed within the boundaries of the approach pattern and reached 2700 ft. DFDR data shows that the actual altitude was 1500 ft. When the co-pilot initiated the base turn toward the ILS localizer, he reduced power. Due to the MCT power control setting their airspeed rapidly fell from 150 kt to below 130 kt. According to information received by the investigation commission, airspeed should not have been allowed to decrease below a certain number when the anti-icing system was on. In this case it was 155 kt in the clean configuration. Because of the drop in airspeed they received a stall warning, the AP disengaged and the stick pusher activated twice.

When the anti-icing system is on, the stall warning and the stick pusher are programmed to activate at a lower-than-normal AOA. System activation is not dependent on icing. In the clean configuration, the functions activate at the following angles of attack:

	Stall warning	**Stick pusher**
Anti-icing OFF	12.3 degrees	14.6 degrees
Anti-icing ON	7.2 degrees	9.5 degrees

The co-pilot began to hand-fly the aircraft. The nose dropped in a turn and the co-pilot had to pull on the yoke. DFDR data shows that twice he pulled quite forcefully, resulting in the rapid increase of the AOA to 10 degrees.

The aircraft did not stall; the warning systems simply functioned. There was no ice on the aircraft. DFDR data shows that they had lost approximately 250 ft in altitude, descending to 1250 ft (385 m) at their lowest altitude. The crew did not understand what had happened and both pilots agreed that they had not even been anywhere near stall speeds. The captain thought that their electrical systems were malfunctioning and decided to climb to a higher altitude to solve the matter.

The AFIS officer had notified the ACC of the situation and the aircraft was visible on the ACC radar as well as on the AFIS officer's monitor. The aircraft flew over the municipality of Jalasjärvi, which is ca. 25 km south-southwest of Seinäjoki and beyond the lateral limits of the Seinäjoki Flight Information Zone (FIZ)

2.2.6 ILS approach and the third EGPWS warning

When the crew could not find the cause of the presumed malfunction, at 18:05 they decided to return to PSJ. The aircraft started to ice up and, as per DFDR data, ice detectors turned the icing caution lights on three times. The captain noticed that the "icing" light was on.

The co-pilot flew the aircraft back to PSJ and entered the holding pattern. They crossed over PSJ at 18:09 to the heading of 100 degrees. They did not compensate for wind and, hence, they drifted to the north - away from the holding pattern. Wind at this altitude was 185 degrees 27kt. The aircraft intercepted the inbound track at about a 40 degrees' angle. They continued to descend in the holding pattern, albeit to the erroneous outbound heading of 100 degrees. Their intention was to perform an ILS approach to runway 32 for a circling approach to runway 14.

The AFIS officer reported 5 km visibility, cloud 5/8 at 700 ft and 7/8 at 1300 ft. The weather permitted the planned circling approach. As they continued to descend, they left the icing conditions and no ice was detected during the remainder of the flight.

An ILS approach is a precision approach. In an ILS approach to runway 32 at Seinäjoki the minimum is 1700 ft QNH after crossing over the outer marker (OM) PSJ. The outbound bearing is 100° ± the wind correction angle and the duration of the outbound leg 1½ minutes ± wind compensation. The approach continues with a procedure turn to the heading of 310° towards the ILS localizer (LLZ). The descent may be commenced once the aircraft is established on the LLZ. The glide slope altitude at OM is 1545 ft. The Decision Altitude (DA) for a missed approach is 485 ft.

When they reached the initial approach altitude 1700 ft at 18:14:30, they received yet another warning: “FIVE HUNDRED, TOO LOW, GEAR”. Their actual altitude according to DFDR was 460 ft. The co-pilot pulled up and decided to climb to 2700 ft, staying within the holding pattern. This was not reported to the AFIS officer. The crew were still in the dark with regard to the cause of the low altitude warning.

The warnings seem to have been generated by EPGWS Mode 4 (Unsafe Terrain Clearance) activation. This occurs when the aircraft descends too low when not in landing configuration.

2.2.7 Detection of the erroneous altimeter setting

After this missed approach they were still within the holding pattern, albeit quite a ways to one side. CVR data shows that the captain looked at his altimeter and said “978”. He does not recall at which stage he set his altimeter to QNH. CVR data also shows that when they climbed to FL 70, he read altitudes on the radio which corresponded to a standard pressure setting. It is possible that he routinely set his altimeter to QNH only after having left FL 70.

The co-pilot checked his own altimeter and noticed that it was set to 1013 hPa. He changed this to the QNH 978 hPa and descended to 2700 ft. According to DFDR data, their altitude was 2300 ft, which matches with their indicated altitude when taking the elevation of Seinäjoki aerodrome into account. The co-pilot asked the captain to go through the checklist. However, the captain replied that they had already completed the list. The co-pilot requested the approach check yet another time and this time the captain completed it.

2.2.8 Circling approach

The aircraft again intercepted the LLZ at a high relative angle and crossed over PSJ for another holding pattern with the still incorrect outbound bearing. They joined the final approach course at an approximately 45-degree angle. When they made visual contact with the runway, the co-pilot descended to 800 ft according to the radio altimeter. At this time they received the warning “TOO LOW, GEAR”. Once they had extended the landing gear the warning ended.

A circle-to-land (circling) manoeuvre is a visual phase after an IFR approach that makes it possible to land on a runway where a straight-in approach would otherwise be impossible. The circling approach radius is a segment where obstacle clearances have been calculated. For the approach category of an aircraft such as the ATR, the circling minimum at Seinäjoki is 810 ft.

The company's OM-B states that circling is performed with the gear down and flaps at 15 degrees. The MDA marked in the IAL chart is to be abided by. The initial turn in the circling approach is determined by the direction of the base turn. In other words, the initial turn is made towards the reverse of the base turn. The approach must be briefed so as to ensure that both pilots are aware of the technique. When the runway is properly in sight, the PF turns 45 degrees, continues to that heading for 30 seconds, whereafter he turns to the downwind leg. After passing the threshold at the upwind runway end he flies straight for 20 seconds and completes the final check. The initial bank angle in the turn towards the base leg must be 25 degrees, at minimum. Flaps are selected to 35 degrees upon intercepting the extended centreline of the runway. The approach must stabilize at 300 ft AGL, at the latest.

Unless specifically prohibited, it is permissible to perform either right turn or left turn circling manoeuvres. The circling minima take both sides into account. It is important to select the circling manoeuvre side which makes the base turn be on the PF's side so that he can see the runway as well as possible.

The co-pilot hand-flew the aircraft to ca. 1000 ft and, at 18:23, commenced a right turn into a left hand circling approach. Hence, the co-pilot was on the outside of the circling pattern and thus lost sight of the runway. When asked, he said that he only remembered the OM-B's illustration, showing a left turn approach. Furthermore, the configuration illustrated in the manual does not correspond with the text, which is why the co-pilot had the wrong configuration on the downwind leg, which in turn caused the warning.

He was unsure about where the point he could start the turn toward the runway was. At 18:24 the captain told him to initiate the turn. During the base turn the aircraft twice banked 50 degrees left. Onboard systems sound warnings of excessive bank angles. Due to the steep bank angle, the nose dropped and the aircraft lost altitude. The co-pilot initiated a missed approach towards PSJ and 1700 ft, but even at this stage his flying was very imprecise. He flew the missed approach for approximately one minute while still in landing configuration. As per the co-pilot's account, he was already fatigued but the captain did not take over. When asked, the co-pilot said that while the captain's assistance would have been welcome, on the other hand, he might have taken it as a vote of no confidence. They now flew to the heading of 050 degrees, instead of homing towards PSJ heading 130 degrees. They selected 2800 ft as their target altitude and reengaged the AP. The captain now decided to request clearance at Vaasa, which he received at 18:29 for FL 60. By now the aircraft was over the Hirvijärvi reservoir, ca. 20 km northeast of the Seinäjoki aerodrome. This airspace is within the Kauhava MILCTA but, at that time, the MILCTA was not active. The ACC maintained radar contact with the aircraft and the AFIS officer monitored them on his display.

2.2.9 The leg to Vaasa

The flight to Vaasa at FL 60 was uneventful. Procedures were completed according to the checklists. The crew still thought that the electrical system was malfunctioning and that all of their problems were due to that. The captain told this to the ATC and the passengers. He was still extremely wary when they were landing in Vaasa and provided instructions to the co-pilot, just in case there was another EGPWS warning during the approach.

2.2.10 The actions of the AFIS officer

The AFIS officer's actions followed regulations. These regulations are published in appendix B of the Air Traffic Controller's Manual (Lennonjohtajan käsikirja, LJKK). As per the regulation, the AFIS officer shall provide information and reports related to the safe conduct of flight of aircraft in his area. However, the AFIS officer does not provide ATS clearances. All required enroute clearances are issued by area control or approach control and the AFIS officer only relays them to the aircraft. Nevertheless, the AFIS officer may enquire of an aircrew's intentions or the situation onboard and, in this manner, focus their attention on an unusual situation. This is especially the case when an AFIS officer can monitor the conduct of the flight either visually or on the radar display.

As per current regulation the radar monitor is only a source of information for the AFIS officer, it is not to be used for traffic guidance purposes. Finavia has published radar monitor instructions for air traffic controllers. No comparable instruction exists for AFIS officers. Due to the lack of instructions, AFIS officers have not developed any routines for asking aircrews for explanations about nonstandard procedures based on radar monitor observations. This option would be conducive to flight safety. Finavia and CAA Finland should consider issuing such instructions, including the required additional training, if any.

An AFIS aerodrome manual, including radiotelephony phraseology, was issued in 2002. However, recent accident investigations have repeatedly established that some of the phrases should be reviewed with regard to clarity and the avoidance of misunderstandings. One of the examples involves the terms "preferred runway/runway in use". Finavia should consider reviewing the AFIS phraseology so that it would better correspond to standard ATS phrases.

2.3 Crew experience and level of training

The captain's total flying experience was 3513 hours. He received his flight training and pilot's licence in the United States in 1995, where he also worked as a commercial pilot and flight instructor. He received his JAR ATPL licence on 2 July 2003, at which time he was recruited to Finncomm from Golden Air. He has been the company's ATR fleet chief commander since November 2006. He received the type rating for the SAAB 340 on 26 November 2003 and for the ATR 42/72 on 15 November 2006. Finncomm Airlines Oy gave him ATR type conversion training from 9 Oct.–24 Nov. 2006. Line checks had also been flown by then. During the training he was rated as "good" or "excellent". His instrument flying competence and knowledge of approach procedures, as well as his past experience, were considered good. Half of his total flight hours, i.e. approximately 1600 hours, had been logged on the SAAB 340. He had only flown 51 hours on the ATR. During the line training flights no approaches were flown to runway 14 at Seinäjoki. Nevertheless, due to his previous experience he was familiar with the circling approach and the NDB approach to runway 14. Even so, investigation revealed that he had flown only few single-beacon NDB approaches, all of which were on SAAB 340s to runway 14 at Seinäjoki.

The co-pilot's total flying experience was 365 hours. He received his pilot's licence on 14 July 2004 and his JAR ATPL licence on 10 April 2006. He received the type rating for the SAAB 340 on 11 July 2006 and for the ATR 42/72 on 15 November 2006. Finncomm Airlines Oy gave him ATR type conversion training from 8 Sept.–30 Nov. 2006. Line checks had also been flown by then. During the training he was rated as "good". His flying experience on the ATR was 82 hours. Three of the line instruction flights had been flown to Seinäjoki, however, none to runway 14. He had received procedures training on the commercial pilot course. Because of his relatively short flying experience, his familiarity with procedures was a little shaky. He no longer remembered how to fly a single-beacon approach because a year had gone by since the training and he had never flown one on an airliner.

Both pilots received good marks during their ATR conversion training. Simulator training and line check evaluations were good. Nevertheless, simulator training had not included the operation of the EGPWS system nor its effect on the flight instruments because the system was out of service during the training flight. The training flight was not repeated. No written evaluation exists on aircraft system familiarity. Neither pilot was particularly familiar with the EGPWS system. Due to inadequate training, they did not know the way the system worked, the factors affecting its activation or which indications appear during system activation. They were not sufficiently informed about the anti-icing system's effect on the stall warning and activation of the stick pusher.

The captain completed a Crew Resource Management (CRM) course in 2005 and his CRM skills were rated "excellent" on a line check flight on 24 November 2006. The co-pilot received his CRM training on a commercial pilot course in 2006 as well as during the SAAB type conversion training in 2006. His CRM skills were rated "excellent" on a line check flight on 30 November 2006.

According to the company's definition, the crew was inexperienced because neither pilot had logged more than 100 hours on the ATR. It is the opinion of the investigators that even if the co-pilot had had the required 100 hours on the type, it would not have essentially changed the situation. The sequence of events would have probably been the same. Inadequate compliance to cockpit procedures seems to have been the root cause of the incident. This made the procedural error possible and caused it to remain undetected. Insufficient training compounded the situation, preventing the crew from grasping the reason for the system warnings.

2.4 The significance of the altimeter setting

Standard barometric pressure (QNE), 1013.2 hPa, is used as the altimeter setting en-route. The respective aerodrome's QNH is used during takeoff and landing. This altimeter setting will cause the altimeter to read the height of the aerodrome above the mean sea level, or airfield elevation, when on the airfield. Pressure settings are changed between QNH and QNE when the aircraft climbs through the Transition Altitude or descends through the Transition Level. The change is executed by the callout *“Transition”*. Altimeter settings are checked at the approach briefing checklist item *Altimeters*. QNH callouts were not company procedure at the time of the incident. It was the task of the PNF to check all three altimeters, completed by the callout “checked”. This meant that the PF’s altimeter was also checked. The investigators believe that this procedure is error-prone, nor does it promote crew cooperation.

Seinäjoki QNH was 978 hPa at the time of the incident. The difference from standard pressure, without accounting for temperature lapse rate, was 35.2 hPa. Given that 1 hPa is equivalent to a 27 ft difference in height, the difference in height was 35 hPa x 27 ft (8.23 m) = 950 ft (290 m). Since the co-pilot flew the aircraft according to his altimeter, set to QNE, the actual altitude of the aircraft was 950 ft below the one indicated by his altimeter. The elevation of Seinäjoki aerodrome (EFSI) is 302 ft (90m). Therefore, when the aircraft maintained, for example, the Minimum Sector Altitude 2500 ft, their actual height was 2500–950–302 ft = 1248 ft (380 m). During the base turn at the altitude at which the approach begins, which is 1700 ft, their actual height was only 1700–950–302 ft = 448 ft (136 m). This does not take treetops into account. According to DFDR data, the aircraft descended to 342 ft (104 m) at its lowest altitude. At that time, the co-pilot’s altimeter indicated 1650 ft at the pressure setting 1013.2 hPa.

2.5 Human factors

2.5.1 General

The following individual characteristics, among other things, are categorized under human factors:

- Personal capacity, learning capability, memory and vigilance,
- Reliability, conception of reality, decision-making capability, fallibility, self-discipline,
- Personality, communication and attitude, and
- Stress and fatigue.

With regard to the incident being investigated, these factors were affected by the company’s rapid business expansion, management culture, in-house communication, tight schedules, time allotted for pre-flight briefing, work and rest period practices, flight crew resources, cockpit procedures, proficiency tracking as well as evaluation and management of risks.

2.5.2 Sensory and cognitive factors

The aircrew’s limited experience on the ATR as well as inadequate system familiarity affected the preparation for the approach, which started late and progressed slowly.

They could only start the actual approach briefing right before crossing over PSJ and, therefore, it was not completed. Hence, the crew began to run out of time. A rush is usually a factor which decreases meticulousness and attentiveness. The checklist was inadequately completed, resulting in the omission of the altimeter check. They did not double-check for error. Although the co-pilot wondered about their seemingly low altitude and the fact that they were flying below cloud, contrary to the weather report, he did not say anything. The captain was unaware of their low altitude. Neither did he notice the incorrect outbound bearing from PSJ when they flew in the racetrack pattern.

Cumulative distractions caused an increase in the aircrew's workload, resulting in a diminished ability to process and use available information.

2.5.3 Prevailing conditions

This flight was a routine flight to an aerodrome they knew well. Meteorological and runway conditions favoured an NDB approach to runway 14. The co-pilot was not sufficiently familiar with the approach procedure, which increased the captain's workload. As per the captain's account, his awareness of the fact that an aircraft had veered off the runway on 11 December 2006 during a downwind landing to runway 32 as well as his limited type experience caused him to select the approach to runway 14 instead.

Seinäjoki aerodrome is the company's administrative home base. On the basis of this and previous incident investigations, it seems that flight crews may have felt compelled to always manage a landing at Seinäjoki.

2.5.4 Proficiency

The captain's experience in commercial flying, both in the United States as well as for Finncomm Oy in Finland, was fairly extensive. He had always received high marks from training and check flights. The co-pilot was trained in Finland. He, too, had received fairly high marks. The pilots' experience on the ATR was limited, compounded by the co-pilot's low total flying hours.

As regards familiarity with the ATR's flight management system, the performance computation program, anti-icing-altered performance limitations and the EGPWS system, neither of the pilots was sufficiently knowledgeable.

Whilst neither pilot had performed many NDB approaches on the ATR, the captain had flown them on the SAAB fleet. The co-pilot was unfamiliar with the single-beacon approach, implying shortcomings in instrument flight training. During the approaches, both pilots concentrated on programming the FMS instead of using the autopilot's basic functions.

The captain decided that he did not need more time for properly completing the approach briefings and checklists. The mental strain caused by the initial EGPWS warnings reduced the flight crew's ability to reassess the situation.

2.5.5 Risk assessment and decision-making

From time to time the pilots' attention was concentrated on immaterial questions. They did not pay sufficient attention to the checklist during the first approach; they mainly concentrated on intercepting the final approach course, while ignoring many other vital aspects related to a successful approach and landing. After this, the rapidly changing situations, including several warnings, decreased their risk assessment abilities as well as their judgement of what the warnings entailed and why they had been generated.

Previous incidents in which the company was involved, including the publicity they had generated, may have put extra pressure on the company's management as well as on captains. Awareness of the previous occurrences may have caused the captain to consider irrelevant matters and to overlook some procedural issues.

2.5.6 Crew Resource Management

Aircrew communication did not work in the best possible manner during this incident. Neither pilot brought his actions clearly to the attention of the other pilot. Cockpit coordination was ambiguous. This is particularly evident in the use of the Flight Management System and in performance computation, neither of which were conducted as per the manual. The captain was not actively in charge of the flight, neither was tasking explicit. The flight crew did not use all available information when they pondered the cause of the EGPWS warnings. For instance, they did not monitor the radio altimeter reading, nor did they crosscheck the altimeters. It is apparent that the company had not provided sufficient CRM training.

The company originally chose to follow the "silent cockpit" concept, aimed at reducing the need for speech in the cockpit. The checklists were based on the airline manufacturer's lists which, in turn, were harmonized with the EMB 145 fleet procedures. The ATR lists covered all phases of a typical flight. The aim was for pilots to individually complete the checklists, removing the other pilot's requirement to comment on all of the items on the list. The main objective was to eliminate the need for unnecessary speech and double-checking. Great trust was placed on the aircraft's warning systems.

This, however, does not work well with the ATR fleet. When checklists were curtailed, neither the specific features of the type in question nor other operators' experiences were sufficiently taken into account. The persons who prepared the checklists were not rated on the ATR. As a result, the condensed checklists did not function as intended and the investigators learned that omissions or misunderstandings in crew cooperation were not infrequent. The checklists and the way they were used did not provide inexperienced pilots, in particular, with the required support nor the assurance that they had completed all of the essential items and in the correct order. In practice, the airline has returned to the customary practice of calling out checklist items.

When the co-pilot's performance deteriorated, the captain, as the more experienced crewmember, should have taken over the flight controls. However, he failed to do so and, when asked, was not able to say why he did not take over. The explanation may have been the company's culture, which sets an excessively high threshold for transferring responsibility during a flight. It is also possible that he associated the situation with simulator training. During simulator training the pilots had worked as a pair, creating the impression that simulator competence equals identical aircraft skills. On the other hand, the CVR recording implies that he was acting as a flight instructor by providing guidance and pointing out mistakes, but not taking over. All of these three things may have influenced the situation.

2.5.7 Shortcomings in the Flight Management System

The nonprecision approach to runway 14 at Seinäjoki was not included in the FMS database. According to the manufacturer, it was not practicable to program it into the system.

2.6 Organizational and management information

2.6.1 Organization and management

When feeder traffic began, the company operated from two locations. The board, the managing director and administration as well as OPS control were located in Seinäjoki. The flight operations department, ground services management, line maintenance and continued airworthiness monitoring as well as training operated at Helsinki-Vantaa.

Administration was kept in Seinäjoki because of lower fixed costs and salaries compared to Helsinki, as well as better staff availability. The managing director retained management, operational policies, human resources policies, financial planning and public relations. Hence, the management model became authoritarian. This was the result of a desire to minimize expenses and streamline the organization. Based on information received, board meeting minutes were cursory and superficial. Since decisions were not documented, it was difficult to analyse the grounds for business decisions. This also affected the company's middle management. The significance of the decisions of the board and the accountable manager remained vague.

At the time of the incident the responsibilities of the Seinäjoki-based OPS control, reporting to the managing director, included route planning, crew resource management and crewing as well as filing the flight plans of all Finncomm's scheduled flights.

OPS control had the capability to compute loading figures as well as mass and balance calculations and performance values for the entire fleet. They also participated in schedule preparation and monitored on-time performance. On the basis of information received, management held the view that, weather minima permitting, a landing should be possible. It was often the case that diversions to alternate aerodromes had to be justified. Management attached great importance to on-time performance, so as to maintain the punctuality of connecting flights.

OPS control staff had not received formal dispatcher training; neither did they have the equivalent qualifications. According to Finncomm, OPS control staff do not carry out dispatcher duties. Instead, they act as Flight Operations Officers. According to the airline, OPS control staff have been trained iaw ICAO Doc 7192. However, this training is still ongoing. The staff had been given a 45-hour training package within a period of a year and a half, the first phase of which has also been documented. The volume of the training falls below the level of the recommendations issued in the aforementioned document. The airline holds that this is due to the fact that part of the package is on-the-job training, which is not reflected in the classroom syllabus plan. Nevertheless, based on information received, the duration of on-the-job training fell short of the recommendation.

In view of the tasks and capabilities as well as the JAR-OPS 1.205 regulation, OPS control staff should have received suitable training, appropriately tailored iaw ICAO Doc 7192, D3. This training should also have been documented in the airline's OM-D. Prior to commencing independent work, training was to be verified and skills be demonstrated.

As for management and cooperation, a company can split its organizational structure between two separate locations for business reasons when communication between the different departments is continuous and straightforward. Investigation revealed that cooperation between the departments at Seinäjoki and Helsinki-Vantaa was not satisfactory.

Company management did not stay abreast of the rapid business expansion. Postholders were not given sufficient authority to develop activities. Resource planning was unrealistically optimistic, lacking the required range of vision. Training was neither consistent nor sufficient and it was not given the required resources.

2.6.2 Quality assurance

General

The company's quality management organization and directives, described in the OM-A, are considered appropriate. The airline employed a full-time quality manager and by the end of 2006 had enough auditors. The analysis of the quality assurance system does not extend to an assessment of technical and ground services systems. On the basis of information received from the company, it can be noted that quality assurance was systematic. The quality report, which resulted from the reporting procedure, provided feedback to company personnel of airline activities.

The company provided additional material in the form of, among other things, e-mail correspondence. This material included documentation on nonconformity analysis and corrective action plans as well as related implemented measures.

Quality nonconformities should be corrected through thorough analysis, followed by corrective action plans. An accountable person, normally the person in charge of the activity in question, and a schedule should be designated. Implementation should be monitored by follow-up audits, at the very least, at the next suitable point in time. The extent of the aforementioned process varies case-by-case. Success, on the other hand, largely depends on an organization's resources as well as on how motivated the postholders and management are to support the improvements generated by the quality assurance system. Investigation revealed that causal analysis was seldom used and follow-up audits were not recorded. However, nonconformities were monitored in later audits.

Functioning of the quality assurance system

It was sometimes difficult for the postholders to get corrective action completed in time. Corrective action often amounted to revisions that issued new instructions The material provided to the commission did not explain how the organization ensured that company personnel adopted the content of these, sufficient as such, actions. Delays in corrective action often imply insufficient resources. Nonconformities have been filed on postholder resources or designation, resulting in a more detailed look at the use of their time. Nevertheless, on the basis of interviews the commission has come to the conclusion that no final solutions were reached on obtaining or rearranging the actual additional resources. It was impossible to verify this from documentation. However, since corrective action schedule overruns had occurred during several years, the problem was not entirely unexpected.

It is the impression of the commission that some training deficiencies were not recorded as nonconformities. Therefore, certain organizational culture shortcomings seem to have gone unnoticed. Based on interviews, the commission believes that training events, as such, were not audited.

Work and rest periods were audited according to the auditing plan. Nonconformities were recorded. Judging from the interviews, the commission came to believe that employees worked longer hours than those reflected in the records. It took specific initiative and interaction with OPS control to enter work and rest periods that deviated from the shift roster into the system.

Quality system auditors also entered remarks, best characterized as comments. Some of the comments later turned into nonconformities. Quality reports compiled by personnel were directly designated to the appropriate postholders. The quality assurance department used these as material for statistics and illustrative images for future assessment. Looking at the material delivered to the commission, it was impossible to establish what conclusions were eventually made.

Judging by the nature and volume of recorded nonconformities, it is the understanding of the commission that the quality assurance system worked in a satisfactory manner. Nevertheless, as business rapidly grew and some corrective actions were overdue, the transformation of operations was not necessarily appropriate in the new situation.

Investigation established that the quality assurance system did not use all available opportunities. On the basis of interviews, for example, no inter-departmental dialogue existed with regard to audit reports or nonconformities and related corrective actions. Yet, this was included as a topic in the steering group's agenda, made available to the commission. Airline departments usually work in close cooperation and the performance of one department has direct bearing on the functioning of other departments.

Management evaluation

For the sake of coherence, from 2005 on management evaluations were conducted once every 6 months on each licence. With the consent of the flight safety authority, the second evaluation for 2005 was moved to 2006. Since then, according to the airline, evaluations have been conducted in all fields on a biannual basis. The quality manager carried out the management evluations and archived the records.

The company's documents do not explain how they prepared for the rapid expansion of flight operations. JAR-OPS 1.035 AMC also requires the evaluation of economic, material and personnel resources. The airline has said that the accountable manager and the flight operations manager had discussed the additional resources required by the rapid business expansion.

Investigation established that quality assurance was systematic and capable of detecting nonconformities. The rapidly expanding company should have used causal analyses more often, so as to develop activities through quality assurance documents in parallel with the business expansion. Investigation was hampered by the fact that some quality assurance documentation was in the form of e-mails instead of genuine quality documents. This made it impossible to ascertain the level of follow-up action.

2.6.3 Training

Flight academies

Flight academies providing basic flight training operate within the rules of their licences and by following approved syllabi. Nevertheless, all academies do not follow exactly the same syllabi or proficiency tracking. Due to economic reasons, the amount of training meets, but does not exceed the standards. Approved training and check flights do not necessarily guarantee that student pilots really grasp all of the key points of the training. In-depth expertise is accrued via the company's type conversion training as well as through actual flight operations. Even so, type rating training does not include such thorough instruction of instrument approach procedures to enable the full absorption of their basic principles. Training focuses mainly on precision approaches, leaving less time for practicing non-precision approaches. This is justified by the fact that almost all aerodromes have precision approach systems. The drawback is that the basic familiarity with approach procedures remains inadequate. Experience only increases gradually in actual flight operations and inexperience may lead to unexpected situations.

According to regulations, graduates of flight academies may operate as co-pilots in commercial flight operations. However, accident and incident investigations show that they do not necessarily have the full faculties for this. Even if airlines incorporate training requirements for their new pilots, these do not always suffice. Therefore, an airline should ensure that their new pilots are up to the intended tasks and, when required, provide additional training. Challenges particularly include the multi-crew environment, operational procedures and limitations as well as the potentially significant differences between the multi-engine aircraft used by the flight academy and the airline.

In-house training

Finncomm Oy would normally recruit young pilots from flight academies because pilots are not readily available from elsewhere. More experienced pilots, such as captains, were recruited from other airlines and from the Air Force. Pilot selection was based on the company's own criteria. Selection comprised of application screening, a written day-long test in a large group and a small group test culminating in an interview. Psychological testing was done at the Finnish Institute of Occupational Health. Even though a matriculation examination (high school diploma) was required, exceptions were made.

When airlines procure new aircraft they must provide type conversion training or hire already type rated crews. Typically, aircraft sales include a limited volume of type conversion training, which Finncomm decided to make use of in connection with their ATR procurement. In such cases the manufacturer normally designates the training organization. This time it was the ATR Training Center. As ATR sales skyrocketed, the manufacturer's training organization ran into capacity problems, involving differences of opinion related to training. Therefore, negotiations were started with the objective of moving training to Finland. In the end, it was decided that the Finnair Training Center and Finnair's own instructors would take over the training. Again, the difficulty involved Finncomm's own procedures. When Finnair decided to terminate ATR type conversion training, Finncomm applied for a type-rating training licence and established its own type rating training organization (TRTO). The company compiled its own syllabus, which was the briefest in the business.

It did not include the company's own OM-D conversion training. The objective was to use the airline's own instructors for training the company's own procedures. Lack of instructors was a particular challenge and, hence, instructors from other airlines had to be used. Due to a shortage of crews, pilots had to interrupt their recurrent training from time to time to go fly scheduled routes. Yet, nonconformities were not recorded. This being the case, the nonconformities did not result in a review of the training system. The company provides in-house recurrent training, such as crew resource management (CRM) and dangerous goods regulations (DGR). Even so, the commission has learned that the training was not always appropriate. Presently, the company outsources this training.

Due to several incidents, the Civil Aviation Administration ordered additional training for Finncomm's pilots in order to eradicate the shortcomings in training. Finnair instructors provided this training at the ATR simulator.

The highest turnover rates have involved co-pilots and the youngest captains. At the time of the incident the average age of captains corresponded to the age of the airline itself as a scheduled route operator. However, shortcomings in flight training as well as the high pilot turnover rate have effectively prevented a situation in which a dedicated cadre of senior pilots would maintain an established flight safety culture in the company and transfer it to younger pilots. Therefore, pilot procedures and practices are not always uniform throughout the airline.

2.7 Co-operation with the aviation authorities

The aviation authorities audited the airline on 14 February 2005 at Helsinki-Vantaa, followed by an audit on 1 December 2006. Neither audit established any specific irregularities.

The authorities granted Finncomm an ATR type rating training licence and the Finncomm Training Academy (TRTO) began type rating training on 2 October 2006 as a subsidiary. Instructor resources were scarce, however, and the syllabus did not include conversion training.

At the turn of 2006–2007 the airline was involved in incidents as follows:

- On 11 December an ATR veered off the runway during landing at Seinäjoki, resulting in broken runway edge lighting (Incident report C7/2006L)
- An ATR was involved in a serious incident at Seinäjoki with a high risk for accident (Incident report C1/2007L)
- During takeoff at Helsinki-Vantaa an ATR was in a situation where the autopilot was not engaged and no-one was steering the aircraft (Incident report D1/2007L).

Because of the first two incidents, the CAA heard Finncomm's flight operations manager on 5 January 2007 and requested a report on measures which the airline had already taken or was about to take as a result of the two serious incidents. On 8 January the airline provided the report which the CAA approved and ordered it to be implemented.

It is the understanding of the commission that cooperation between the airline and the CAA has been satisfactory. Nevertheless, the company has been unhappy with the CAA's stance on check instructors. In order to become check instructor-rated, a pilot must receive CAA-approved training. An airline should have a sufficient number of its own type rating instructors and check instructors so as to guarantee flight safety and to ensure uniform practices across the airline. However, according to Finncomm, the CAA has not approved their candidates for check instructor training. Instead, the CAA has recommended that Finncomm use third party flight instructors and examiners.

In March 2008 the airline, together with some other operators, approached the Ministry of Transport and Communications which, consequently, required a report and an action plan from the CAA. Complaints mainly focused on the activity of the CAA's Training and Licensing Section. The investigators have the impression that cooperation within the CAA between the Training and Licensing Section and the Flight Operations Section is insufficient, which prevents a wide-ranging review of an airline. It seems that the Training and Licensing Section does not necessarily have an adequate ability to assess the training requirements of commercial aviation. When the investigation was completed, this issue was still pending.

2.8 Already implemented measures

- The CAA-imposed limitations and amendments were adopted in the company's OM, effective 9 January 2007, as follows: The term "inexperienced crew member" now also included the following rules:
  - If a pilot's experience on airliners totals fewer than 1000 flying hours, he is considered inexperienced until he has successfully completed the first Operational Proficiency Check (OPC) and flown a minimum of four months as a co-pilot on the type after the Type Proficiency Check (TPC), and

        - If a pilot's experience on airliners exceeds 1000 flying hours, he is considered inexperienced until he has flown 200 hours on the type after the Line Check (LC).
    - The captain's experience requirements were:
        - A minimum of 1000 flying hours on a twin-engine aircraft in a multi-crew environment, and
        - A minimum of 500 flying hours on airliner-class aircraft.
    - The following wind limitations were added:
        - Crosswind limits must be reduced by 10 kt on runways narrower than 40 m, and
        - The tailwind limit is 10 kt on runways shorter than 2000m.
- Weather minima for inexperienced pilots:
    - The minimum RVR for precision approaches is 1400 m,
    - The nonprecision approach minimum altitude is MDA+200 ft; add 100 m to the required minimum visibility, and
    - Crosswind and tailwind components may not exceed 50 % of those allowed.
- The following requirements were added to line training:
    - A person who has previously been a captain on another type must fly a minimum of 30 sectors, and
    - An NDB approach to runway 14 at Seinäjoki is mandatory.
- Review of procedures
- The following regulations were reassessed:
    - The monitoring task of the PNF,
    - An altimeter check,
    - The co-pilot's operation as the PF, and
    - Instructions on taking over the flight controls.

Most of the limitations have since then been permanently adopted in the OM.

As long-term measures, the company reported planning the following reforms:

- Improving the ATR type training by adding MCC training to it,
- Ensuring the availability of experienced type instructors and increasing the experience of the company's own instructors,
- Improving in-house training by introducing CBT-training,
- Auditing the flight academies,
- Improving system familiarity by training TAWS-, TCAS- and GPS-systems to pilots,
- Improving guidance and supervision by introducing flight chief commander symposiums, and
- Improving pilot selection by adding a simulator test and a written proficiency test to the process.

The CAA-mandated additional training was provided during the spring of 2007 to a total of 53 pilots. This training included:

- A one-day system review as per the ATR syllabus,
- Two demanding simulator flights,
- An Operational Proficiency Check (OPC) in a simulator,
- Six line training flights, and
- A Line Check (LC).

While the investigation was ongoing, on 1 October 2007 the company implemented organizational and operational changes as follows:

- On 21 May 2007 the duties of the managing director and the accountable manager were separated and a new accountable manager was appointed,
- The training manager changed,
- A new flight safety manager was appointed. He is responsible for assessing the flight safety of the entire airline and reports directly to the accountable manager,
- On 1 August 2007 the ATR fleet chief commander changed and a deputy fleet chief commander was nominated,
- In order to strengthen the standing of fleet chief commanders, the position of chief pilot was abolished,
- The technical pilots in the ATR and EMB fleet were transferred to report to their respective fleet chief commanders, and
- The position of crew resource manager was established,
- The TRTO organization was transferred to flight operations and it was reorganized as follows:
    - The positions of head of training and deputy head of training were established,
    - The following now report directly to the head of training:
        - The training planner who, in cooperation with crew resource management, is responsible for the training of all flight crews,
        - The training assistant, and
        - Chief instructors for type rating and cabin crew training.
- The position of “Network Planning Advisor” was established. The person appointed had previous experience in this task and his duties entail traffic planning on the basis of resources provided by the crew resource manager,
- On 15 December 2007 the previously mentioned amendment on the OPS control’s crew monitoring (inexperienced crews) was implemented in the OM and the minimum total flight experience required of captains was raised to 2000 hours.

In order to solve the acute shortage of instructors, the airline started its own type rating training in the autumn of 2007, applying the CAA-approved Finnair training syllabus and using Finnair instructors.

After evaluating the lessons learned of other operators, ATR procedures have been revised. Pilots require approximately 100 hours of annual training, which the OPS control must take into account when planning scheduled traffic. In conjunction with the review process, the company’s operations Manual (OM-A), the ATR flight manual (OM-B) and the Enroute Operations Manual (OM-C) are to be reviewed.

2.9 Business expansion

The company has rapidly expanded from when it began operations. Once they managed to become a feeder airline for Finnair, the clear business goal for expansion was to establish a sufficiently widespread network to transport passengers for Finnair’s international traffic. Judging by the number of orders, the ATR 72-500 will comprise the company’s main fleet, complemented by the ATR 42-500 fleet.

The increasing number of aircraft has also translated into the need for more staff. More technical personnel and administrative staff have been hired, although not without difficulties. For instance, it has been difficult to recruit experienced airline pilots and, therefore, from time to time the company has resorted to using temporary pilots. It takes approximately 2-3 years for a pilot to reach the qualification of co-pilot. The flight experience requirement for captain is now 2000 total flight hours. This will slow down the process of generating captains from within the company's aircrews. According to international estimates, an airline must hire ten new pilots for every additional aircraft. A rapidly expanding airline should have its own type rating and simulator instructors as well as flight examiners.

3 CONCLUSIONS

3.1 Findings

1. The airworthiness certificate and the certificate of registration were valid.

2. The pilots had valid licences and the required qualifications.

3. The AFIS officer had a valid licence and an AFIS officer qualification for Seinäjoki aerodrome.

4. Meteorological conditions permitted the flight. Runway conditions were degraded by slush, but braking action was good. Upper winds were strong.

5. It was possible to clearly establish the track of the aircraft as well as events during the flight from the flight recorders (DFDR and CVR) as well as from the ACC's (EFES) Eurocat radar recordings.

6. The AFIS officer was able to track the aircraft on his radar monitor almost the entire time, apart from the time when it was flying exceptionally low.

7. No AFIS officer regulations exist for using the radar monitor.

8. The Seinäjoki communications recorder did not record the AFIS officer's telephone conversations or the timestamp.

9. Due to work shift alterations a mistake was made in crewing, which resulted in a crew which was inexperienced, as per company definition.

10. The co-pilot was the Pilot Flying (PF) and the captain the Pilot Not Flying (PNF). Control over the autopilot and the Flight Director had been selected to the co-pilot's side.

11. Crew Resource Management was inadequate. Checklists were not always completed as per the company's regulations, and some checks were not completed.

12. The standard pressure setting 1013 hPa (QNE) remained on the co-pilot's altimeter at the onset of the approach. This was not noticed until the third approach attempt.

13. The flight crew were not entirely familiar with the functioning of the EGPWS system, but instead, they suspected a malfunction in the aircraft's electrical system and they did not fully comply with valid regulations when they received the low altitude warning.

14. Because power control was set to MCT during the missed approach, airspeed rapidly decreased when they reduced power.

15. The flight crew did not know or recognize the effect of the anti-icing system on the activation of the stall warning and stick pusher at lower-than-normal angles of attack.

16. The leg to Vaasa and landing were uneventful and occurred as per regulations.

17. The company's organization is geographically split between Seinäjoki and Helsinki-Vantaa. Interdepartmental communication was found to be inadequate between the two locations.

18. Postholders did not have sufficient resources to implement the activities required by the rapid business expansion.

19. Corrective action was behind schedule.

20. The company was unprepared for the rapid introduction of the ATR fleet. Neither was it capable of drawing on the quality assurance system to develop its expanding activities.

21. The aircrew work shift monitoring system was inadequate.

22. Work shift changes were routine. Information provided to aircrews on shifts, routes and crewing was inadequate.

23. The company had too few type rating instructors, simulator instructors and flight examiners.

24. The company's ATR type conversion syllabus was condensed and only included the absolute necessities. Hence, pilot training and, especially, system familiarity was lacking.

25. Sufficient attention was not paid to the consistency of recurrent training and aircrews had to interrupt training sessions to go fly scheduled routes.

26. The company was unable to breed a dedicated cadre of senior pilots to maintain the company's flight safety culture.

27. Due to incidents, the company has reorganized itself, changed postholders, developed its training and quality systems as well as reviewed internal directives and regulations.

3.2 Probable causes

A chain of events caused the incident. The immediate factors were the following:

- Because of an incomplete approach check, the standard pressure setting 1013 hPa remained on the co-pilot's altimeter. Therefore, they flew 950 ft (290 m) lower than they thought they were flying,
- The erroneous altimeter setting was not detected in time and, therefore, the aircraft descended to a dangerously low altitude three times during approach attempts. The EPGWS system activated, telling the pilots to pull up,
- The power control setting was erroneous, resulting in a rapid reduction in airspeed when they reduced power in a turn. These, combined, activated the stall prevention system (stall warning and stick pusher), The pilots' type experience was limited and, due to shortcomings in training, they did not fully master the aircraft's systems nor the cause of the warnings the onboard systems generated.

Contributing factors included:

- A mistake in crewing, which resulted in a crew which was inexperienced, as per company definition,
- The cockpit procedures in use at the time made the error possible and allowed for it to remain undetected,
- Company procedures or specific operational procedures were not sufficiently well revisited in refresher training,
- The level of the company's training system, competence requirements and the level of the instructors' experience was too low. This made it impossible to ascertain that pilots with varying skills and backgrounds received the required level of training, and
- The company had no established safety culture.

4 RECOMMENDATIONS

The investigation commission considers that the measures implemented by Finncomm Oy are appropriate and focus on the problems the commission pointed out. Furthermore, the company has attempted to eradicate the observed shortcomings. Therefore, the investigation commission only makes the following recommendations:

1. Even though airlines incorporate training requirements for their new pilots, these do not always suffice. Therefore, an airline should ensure that their new pilots are capable of handling their designated tasks and, when required, provide additional training.

It is recommended that Finncomm Airlines Oy review the substance and scope of their type rating syllabus in order to ensure sufficient training for new pilots with varying skills and backgrounds.

2. The investigation revealed that the refresher training of Finncomm Airlines Oy did not provide pilots with consistent and recurring opportunity to rehearse and review company-specific procedures and specific operational features.

It is recommended that the company review the structure and substance of recurrent training so as to include company-specific procedures and specific operational features often enough.

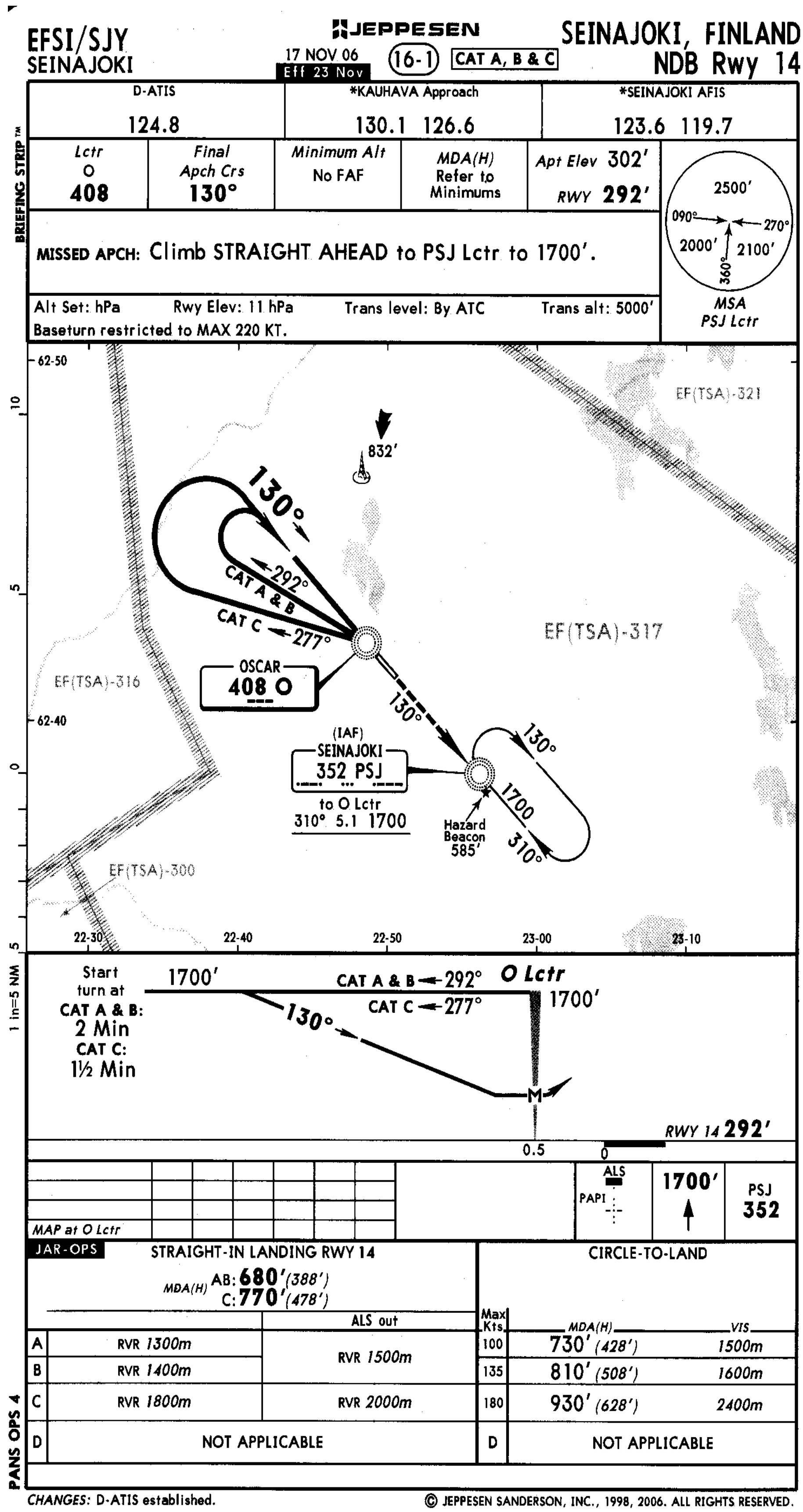
3. As per current regulation the radar monitor is only a source of information for an AFIS officer, not to be used for any kind of traffic guidance purposes. Finavia has published radar monitor usage instructions to air traffic controllers. No comparable document exists for AFIS officers. Due to the lack of instructions, AFIS officers have not developed any routines for asking aircrews for explanations on nonstandard procedures based on their radar monitor observations. In a letter dated 4 May 2007, Finavia commented on AIB Finland's investigation report D17/2006L, in which the same thing was mentioned. Their comment was "As applicable, Finavia shall consider issuing instructions to AFIS officers with regard to the use of air traffic controllers' IAM RAC 89 radar display information. Prior to operational introduction, the instruction must be approved by CAA Finland".

It is recommended that the Finnish Civil Aviation Authority and Finavia draw up the aforementioned instruction and approve them for operational use.

Helsinki 8 April 2008

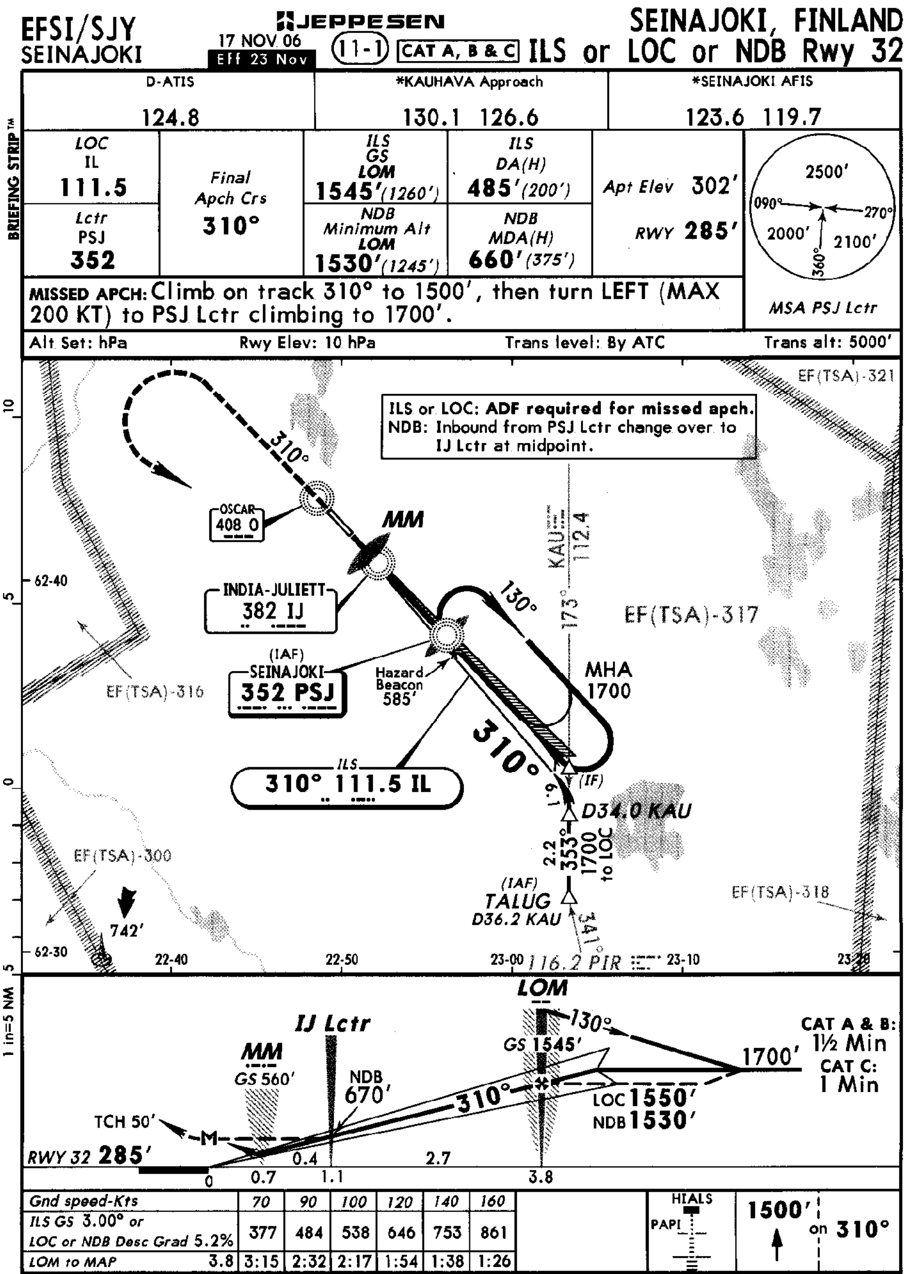
Jouko Koskimies Hannu Melaranta Markku Roschier

Appendix 1 IAL SEINÄJOKI NDB 14
Courtesy of Jeppesen/Sanderson, Inc



NOT FOR NAVIGATION

Appendix 2 IAL SEINÄJOKI ILS or NDB 32
Courtesy of Jeppesen/Sanderson, Inc



Gnd speed-Kts	70	90	100	120	140	160
ILS GS 3.00° or LOC or NDB Desc Grad 5.2%	377	484	538	646	753	861
LOM to MAP 3.8	3:15	2:32	2:17	1:54	1:38	1:26

HIALS, PAPI — 1500' on 310°

JAR-OPS — STRAIGHT-IN LANDING RWY 32

	ILS DA(H) 485'(200') FULL	ILS ALS out	LOC (GS out) MDA(H) 660'(375')	LOC ALS out	NDB MDA(H) 660'(375')	NDB ALS out	Max Kts	CIRCLE-TO-LAND MDA(H) VIS
A	RVR 550m	RVR 1000m	RVR 900m	RVR 1500m	RVR 900m	RVR 1500m	100	730'(428') 1500m
B	RVR 550m	RVR 1000m	RVR 1000m	RVR 1500m	RVR 1000m	RVR 1500m	135	810'(508') 1600m
C	RVR 550m	RVR 1000m	RVR 1000m	RVR 1800m	RVR 1000m	RVR 1800m	180	930'(628') 2400m
D	NOT APPLICABLE						D	NOT APPLICABLE

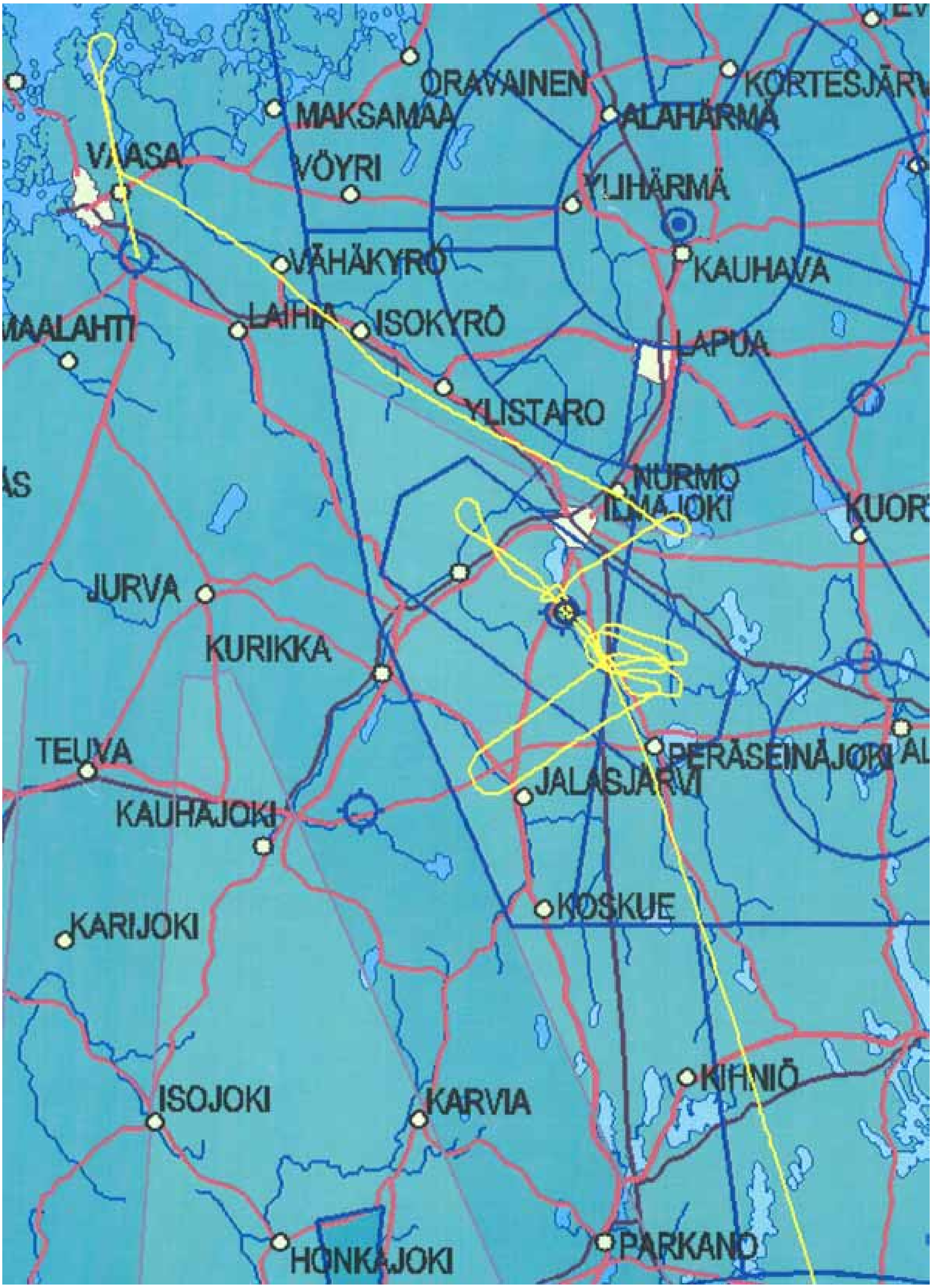
PANS OPS 4

CHANGES: D-ATIS established.

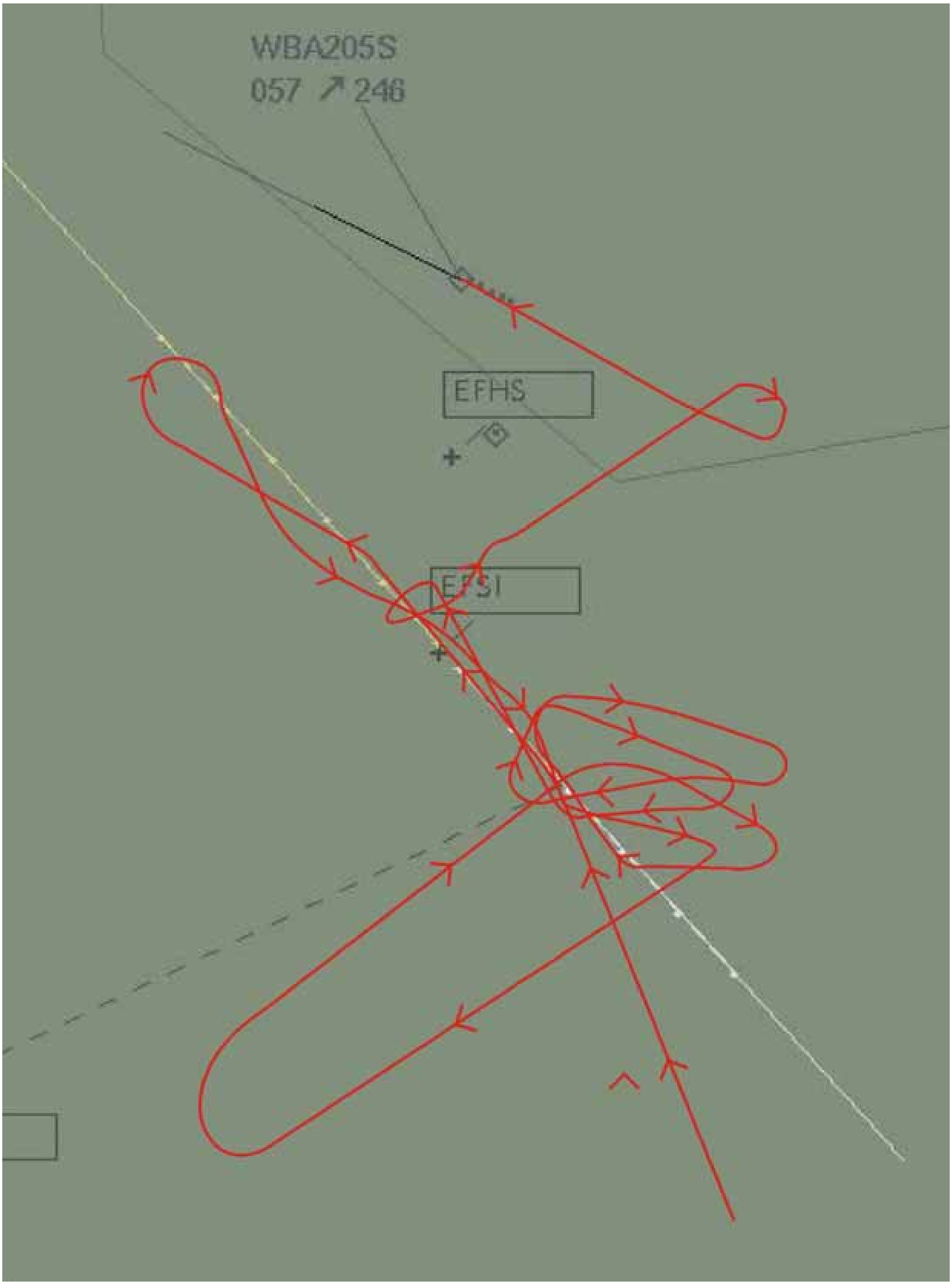
NOT FOR NAVIGATION

Appendix 3 OH-ATB flight route according to DFDR and radar

3.1 OH-ATB flight according to DFDR data

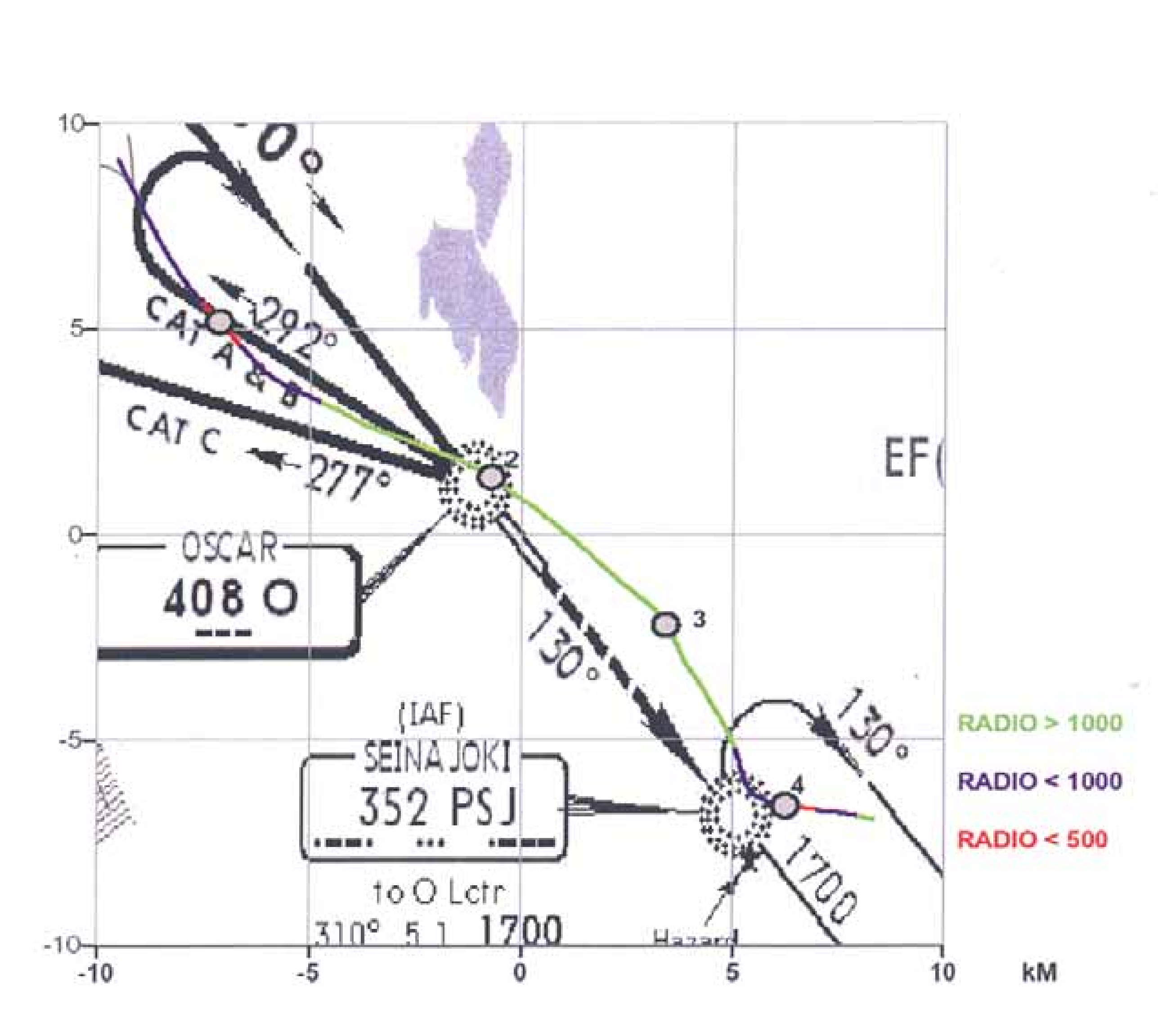


3.2 OH-ATB flight route at Seinäjoki airspace according to EFES MSSR data

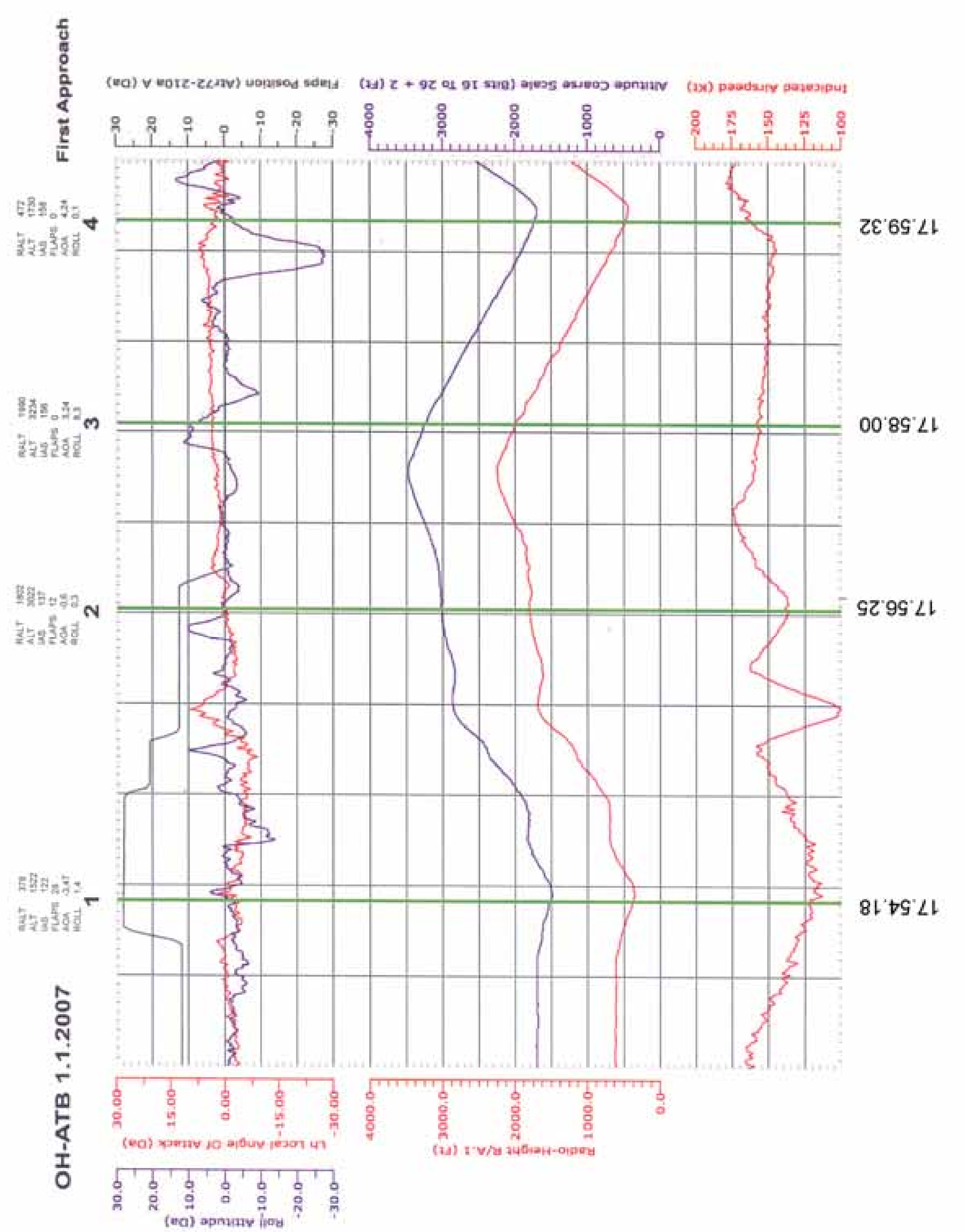


Appendix 4

Appendix 4 OH-ATB flight route, flight data and EGPWS warnings
4.1. First approach and go-around, map figure

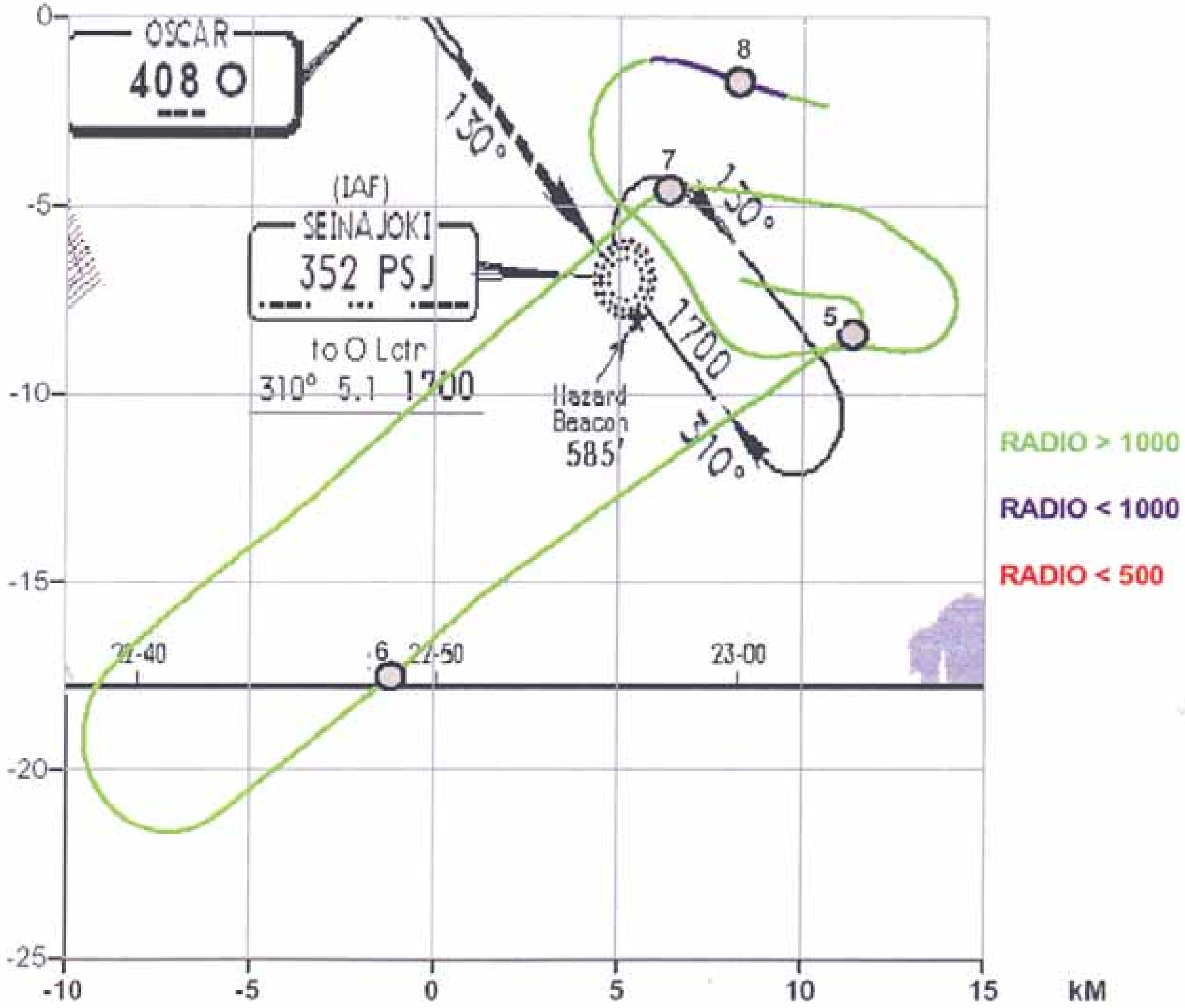


4.1 DFDR data diagram

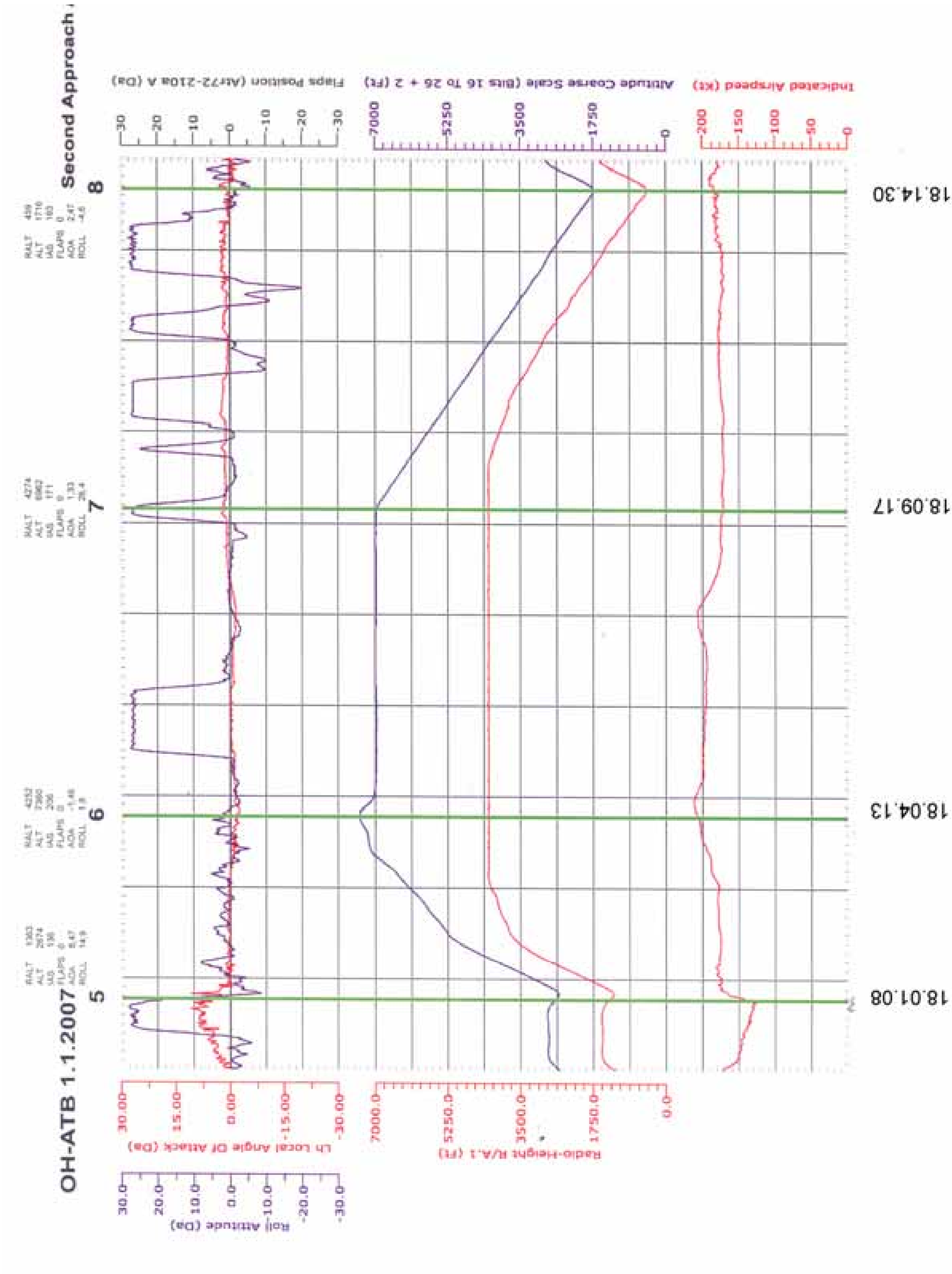


Appendix 4

4.2 Climbing to FL 70 and return to the racetrack, map figure

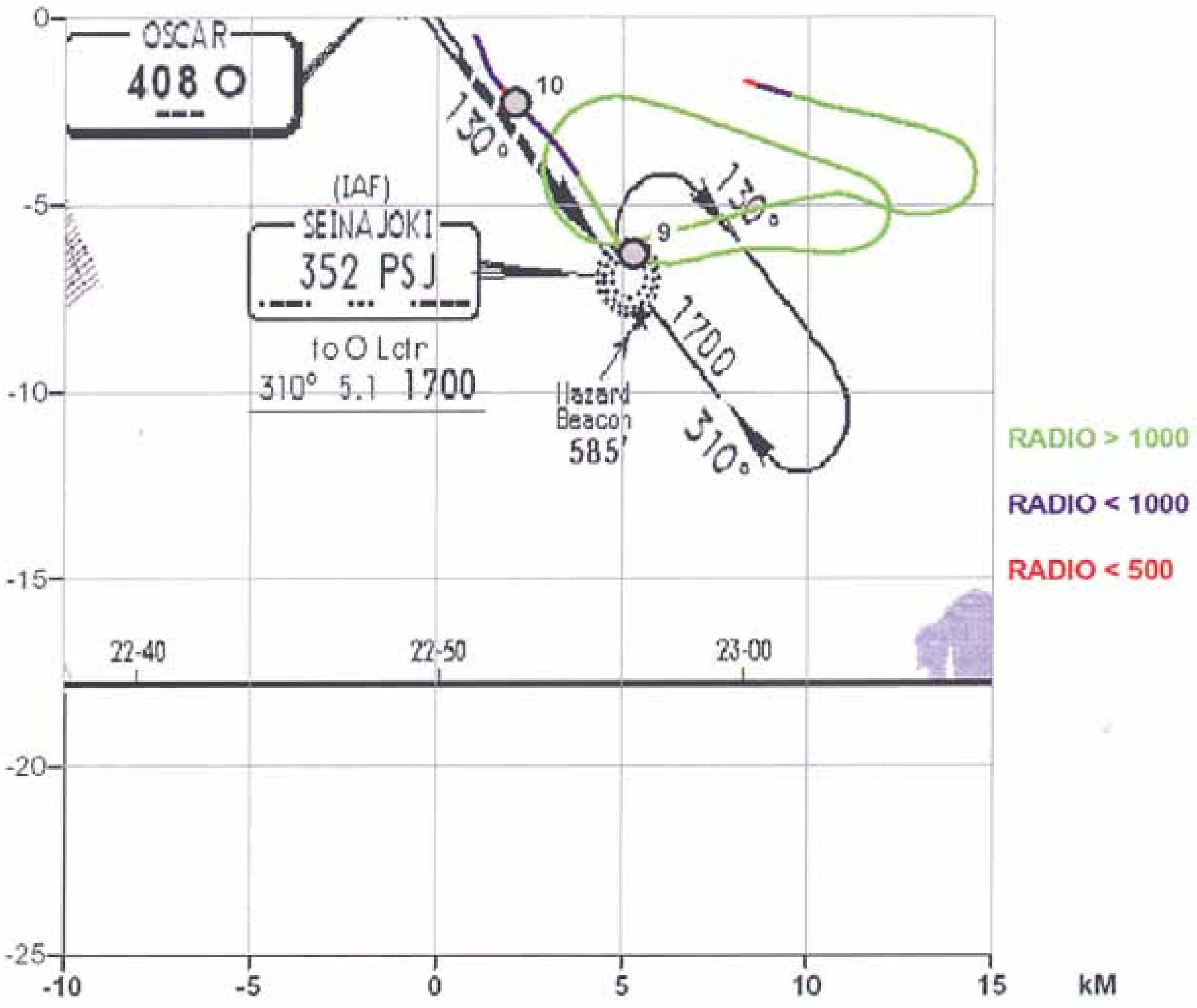


4.2. DFDR data diagram

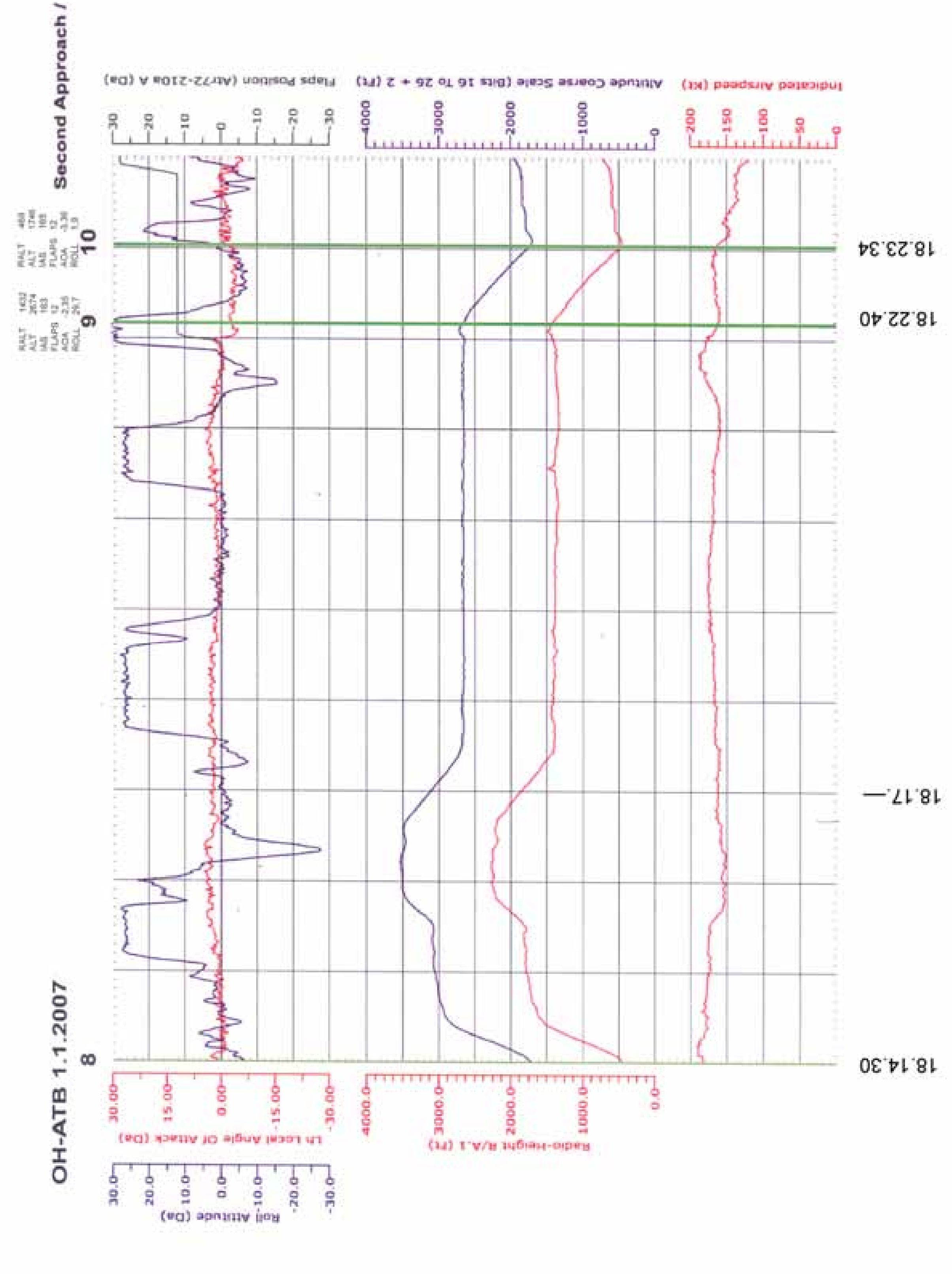


Appendix 4

4.3 Second approach, map figure

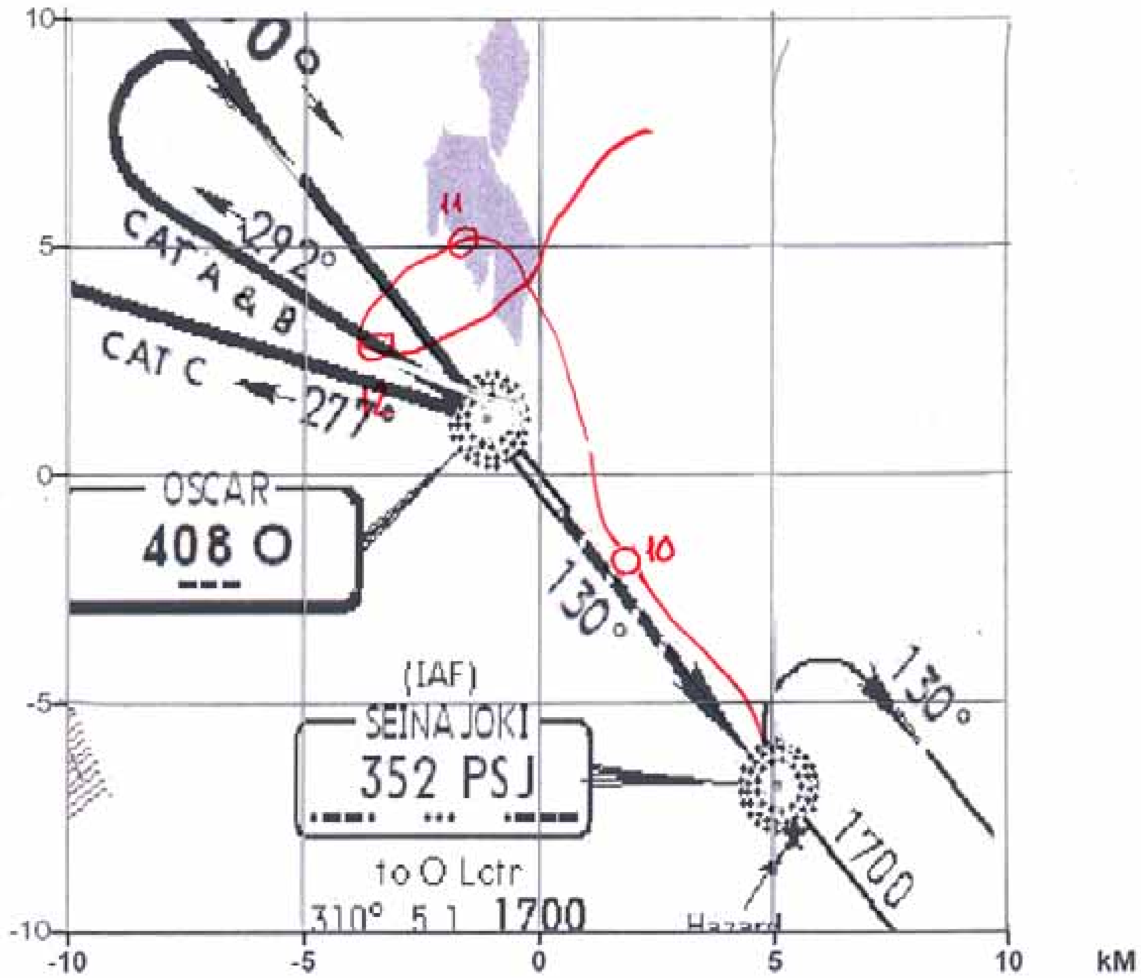


4.3. DFDR data diagram

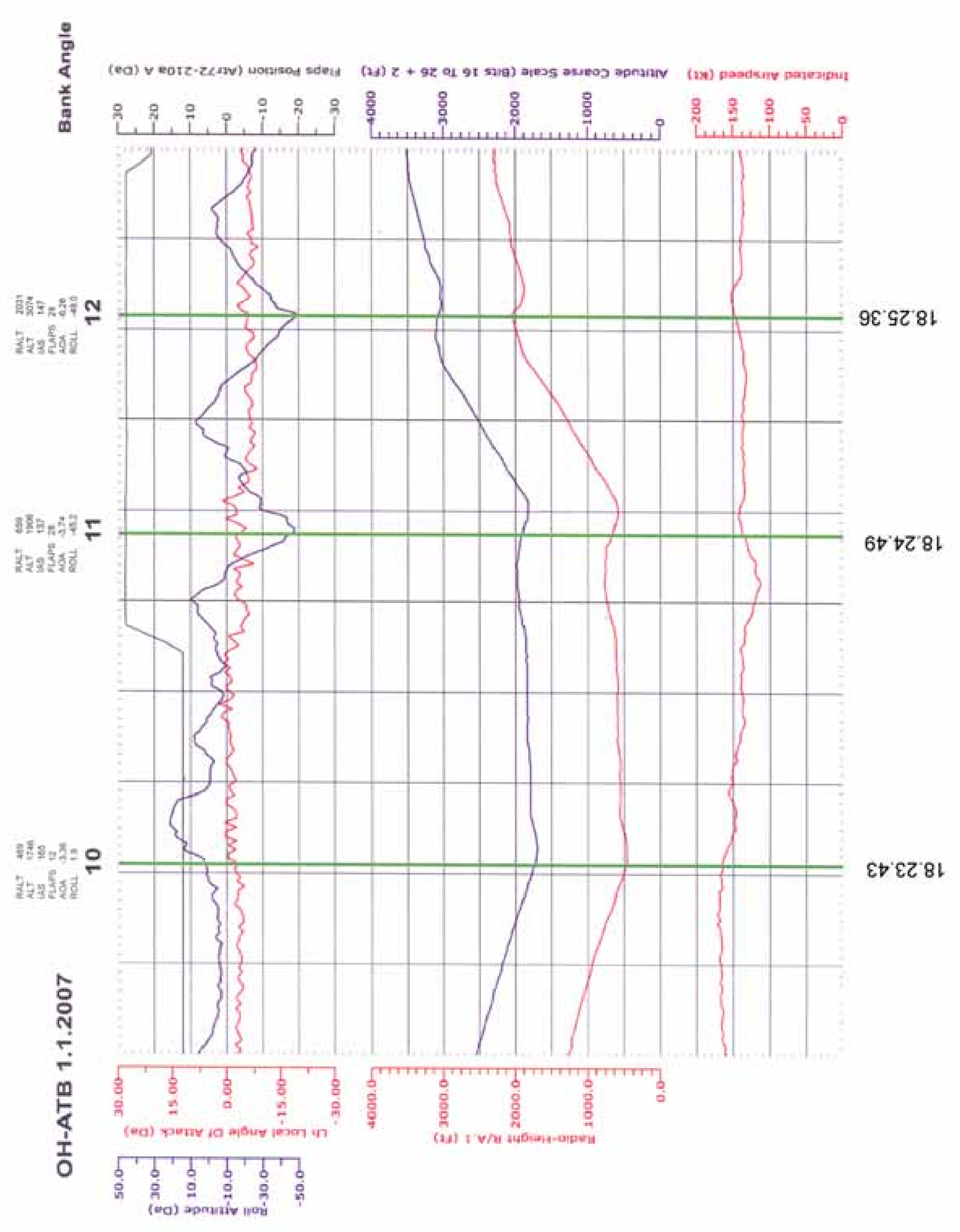


Appendix 4

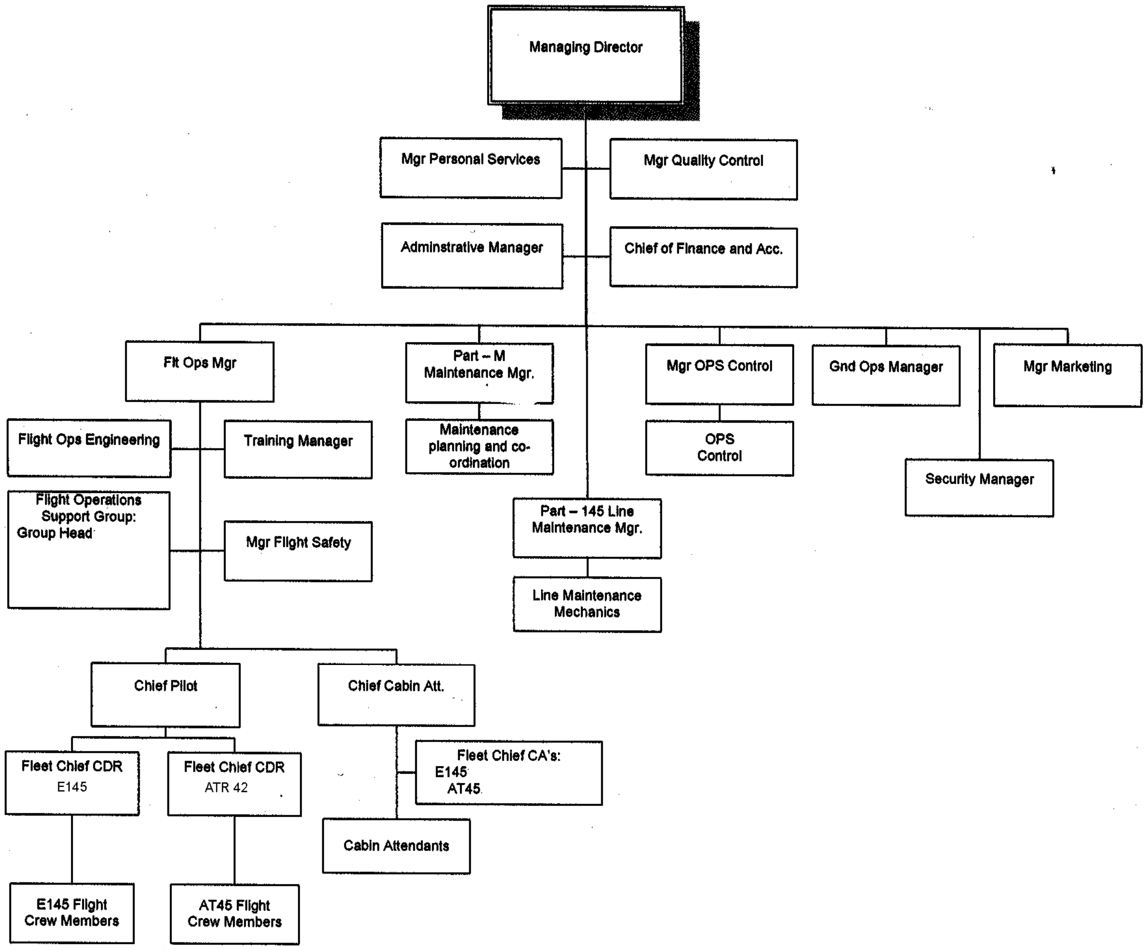
4.4 Circling approach and diversion to Vaasa, map figure



4.4 DFDR data diagram



Appendix 5 Organisation of Finnish Commuter Airlines on 1.1.2007



Appendix 6 Organisation of Finnish Commuter Airlines on 1.11.2007