Investigation report

L2012-02

Risk of an Airliner Colliding with Terrain in the Vicinity of Mariehamn Airport on 14 February 2012

Translation of the original Finnish language report

YL-RAG

Saab 340A

Onnettomuustutkintakeskus
Olycksutredningscentralen
Safety Investigation Authority, Finland

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SUMMARY

A serious incident occurred to the Latvian RAF-AVIA Airlines' Saab 340 aircraft, registration YL-RAG, on 14 February 2012 at 6:45 Finnish time as it was approaching Mariehamn airport. It was dark at the time of the occurrence. The aircraft was on a Nordflyg cargo flight, NEF021, from Helsinki-Vantaa (EFHK) to Mariehamn (EFMA). NEF021 had two crew members and cargo on board.

NEF021 intercepted Mariehamn's ILS z approach for RWY 21 but deviated from the initial approach route. The aircraft ended up in an unusual flight attitude (upset) where the maximum bank angle was 50 degrees to the left and the maximum pitch angle was 19 degrees, nose down. The captain managed to recover the aircraft at 150 FT AGL (approximately 46 m). NEF021 landed in Mariehamn at 6:46.

The investigation revealed shortcomings in crew cooperation. The flight crew did not verify the position of the aircraft with all available navigation aids once they noticed they were not intercepting the ILS localizer normally. Furthermore, the captain did not comply with the Company's Operations Manual.

The serious incident was caused because the captain of NEF021 continued the approach in a situation which did not meet the requirements of a successful approach and landing. This degraded the flight crew's situational awareness to the extent that the captain flew the aircraft into an unusual attitude and the crew lost control of the aircraft. This resulted in the risk of colliding with terrain. The Ground Proximity Warning System warnings were also ignored.

Safety Investigation Authority, Finland (SIAF) issued three safety recommendations: two of which were directed at the Latvian Civil Aviation Agency (LV CAA) and one at Finavia Oyj.

SIAF recommend that LV CAA make certain that RAF-AVIA pilots possess sufficient crew resource management skills, and that they are familiar with the operating principles of the Ground Proximity Warning System.

SIAF recommend that Finavia Oyj update its regulation IAM RAC 89 (15 Nov 2006) "The use of radar monitors at ATS units" so that the air traffic controller also has the option of notifying the pilot when the information on the ATS monitor and the pilot's position report diverge.

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ABBREVIATIONS

AGL	Above Ground Level
AOC	Aircraft Operator Certificate
APA	Altitude Preselector Alerter
ATS	Air Traffic Service
B-RNAV	Basic Area Navigation
CFIT	Controlled Flight into Terrain
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
EASA	European Aviation Safety Agency
GPWS	Ground Proximity Warning System
FDR	Flight Data Recorder
GP	Glide Path
FMS	Flight Management System
IAF	Initial Approach Fix
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
LOC	Localizer
METAR	Aviation Routine Weather Report
MSA	Minimum Sector Altitude
MSL	Mean Sea Level
NM	Nautical Mile
PAPI	Precision Approach Path Indicator
PNF	Pilot Not Flying
PF	Pilot Flying
RNAV	Area Navigation
RWY	Runway
TWR	Aerodrome Control Tower
UTC	Co-ordinated Universal Time
VOR	Very High Frequency Omnidirectional Radio Range

SYNOPSIS

A serious incident occurred to a Latvian RAF-AVIA Airlines' Saab 340 aircraft, registration YL-RAG, on 14 February 2012 at 6:45 Finnish time as it was approaching Mariehamn airport. It was dark at the time of the occurrence. The aircraft was on a Nordflyg cargo flight, NEF021, from Helsinki-Vantaa (EFHK) to Mariehamn (EFMA). NEF021 had two crew members and cargo on board.

The air traffic controller at Mariehamn TWR reported the occurrence as per Aviation Regulation GEN M1-4, and notified Area Control Center (ACC) Finland of the incident. The pilot-in-command of NEF021 wrote a brief incident report for the Company, which Safety Investigation Authority, Finland (SIAF) received on 17 February 2012. The Company's Safety Manager filed an Aviation Safety Report with Latvian Civil Aviation Agency (LV CAA), incorrectly dated 14 October 2011.

SIAF were informed of the occurrence on 14 February 2012 at 7:59 and immediately acted to preserve the flight recorder recordings. The recordings were made available to the investigation group.

The investigation group received the radiotelephony and telephone recordings of Mariehamn air traffic control. The accident investigation authorities of Latvia (TAIIB) interviewed the pilots of NEF021 in Riga. Despite its attempts to interview the captain the investigation group did not succeed in doing this. For the purpose of the investigation it would have been important to hear the account of the captain. The investigation group interviewed the co-pilot in Riga and in Vantaa. The air traffic controller on duty at Mariehamn TWR was interviewed in Helsinki.

Pursuant to Section 2 of the Safety Investigation Act (525/2011), SIAF decided to initiate safety investigation L2012-02. Mr Risto Timgren was appointed as team leader for the investigation group, accompanied by Mr Hannu Halonen as a member of the investigation group. On 21 June 2012 SIAF relieved Risto Timgren from his duties when he accepted a position at the Finnish Transport Safety Agency. Mr Lars Levo was appointed as the new team leader. Messrs Mika Kosonen and Tauno Ylinen joined Mr Hannu Halonen as additional members in the investigation group. Chief Air Safety Investigator Ismo Aaltonen acted as investigator-in-charge.

SIAF notified the ICAO (International Civil Aviation Organization), the EASA (European Aviation Safety Agency) as well as the accident investigation authorities of Latvia (Traffic Accident and Incident Investigation Bureau TAIIB) and Sweden (Statens Haverikommission SHK).

The TAIIB designated Visvaldis Trubs, chief of the aircraft accident and incident investigation department, as their Accredited Representative to the investigation. The SHK designated Senior Air Accident Investigator Nicolas Seger as their Accredited Representative. Saab designated Mr Bo-Göran Windoff, Manager Flight Safety, as their representative to the investigation.

The investigation group requested comments on the draft final report from RAF-AVIA Airlines, the accident investigation authorities of Latvia and Sweden, the UK Air Accident Investigation Branch (UK AAIB), Saab, the Finnish Transport Safety Agency, Finavia Oyj, the EASA and interested parties. The investigation group included the comments deemed appropriate in the final report. The investigation was completed on 18.9.2013.

All times in this report are in Finnish standard time (UTC+2).

The material used in the investigation is archived at Safety Investigation Authority, Finland (SIAF).

1 FACTUAL INFORMATION

1.1 History of the flight

A serious incident occurred on Tuesday, 14 February 2012 at 6:45 Finnish time to the Latvian RAF-AVIA Airlines' scheduled cargo flight NEF021 from Helsinki-Vantaa (EFHK) to Mariehamn (EFMA). The Saab 340 aircraft, registration YL-RAG, had two crew members and cargo on board.

The captain of NEF021 was the Pilot Flying (PF) and the co-pilot the Pilot Not Flying (PNF).

At 6:33 NEF021 contacted Mariehamn TWR and received an arrival clearance to PEX-UT via initial approach route of ILS z approach and to descend to 1800 FT MSL. NEF021 had the autopilot selected on and was following the course entered into the Flight Management System (FMS).

At 6:38 NEF021 crossed Initial Approach Fix (IAF) ARMIT and turned to the right, intercepting the 10 NM DME arc prescribed for ILS z approach.

At 6:41, contrary to the approach procedure and the ATC clearance, NEF021 turned left, away from the DME arc. NEF021 continued to fly towards the runway threshold with the approximate heading of 240 degrees, which is approximately 40 degrees off of the final approach track prescribed for the approach.

From the ATS monitor the air traffic controller noticed that NEF021 had turned left. The controller asked the flight crew to confirm that they were following the initial approach route. The crew replied that they were on the initial approach route. Following this the symbol of the aircraft on the monitor faded below the radar horizon.

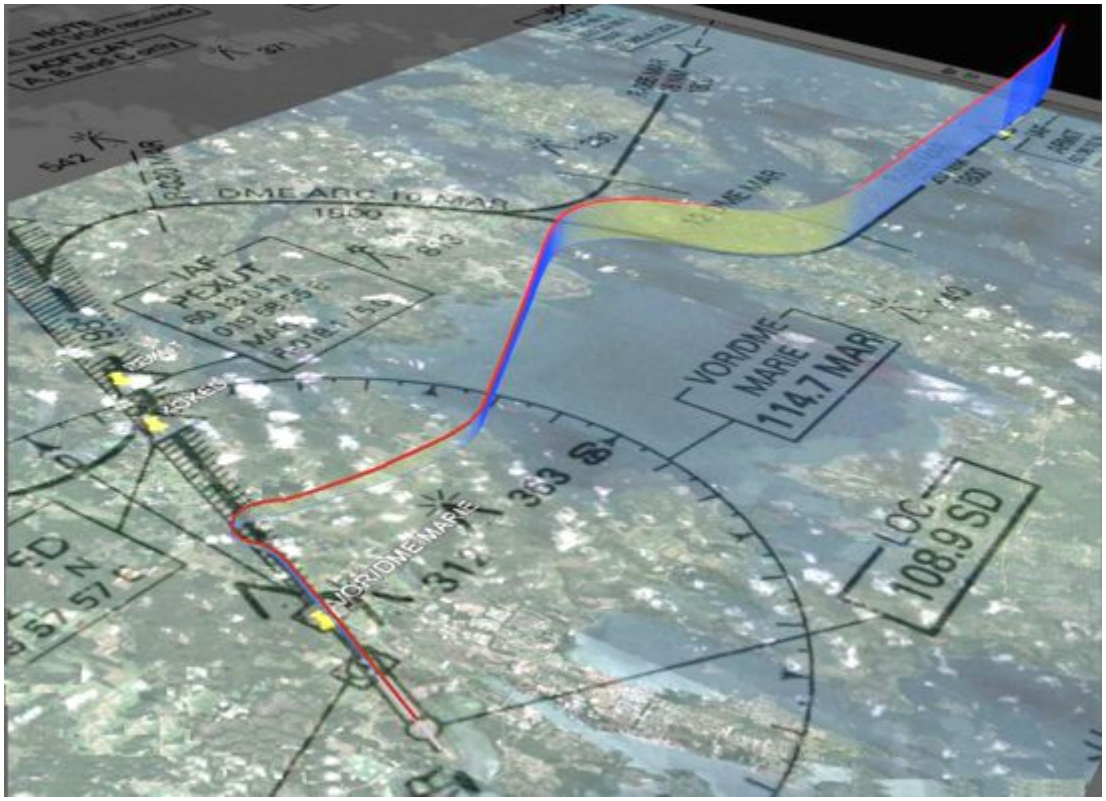

Figure 1. The flight track of NEF021 © Finavia, permission 4/590/2007.

At 6:43 NEF021 passed 1800 FT MSL and continued to descend at approximately 400 FT/min. The captain of NEF021 disconnected the autopilot at 1600 FT MSL and continued to fly manually. Then the captain turned to the right to a heading which is at a 90 degree angle in relation to the final approach track and descended to 1000 FT MSL. NEF021 crossed the final approach track at 3.1 NM (approximately 5.7 km) from the threshold of RWY 21. The crew of NEF021 did not have the runway in sight.

At 6:44 the air traffic control cleared NEF021 to land, at which time the captain informed the co-pilot of the decision to land. The co-pilot replied that they did not have the runway in sight. Nor did the crew receive indication from ILS localizer (LOC) or glide path.

At 6:45, after crossing the final approach track, the co-pilot noticed from the instruments that they were within the ILS LOC beam, and advised the captain to turn to the left. The captain made a rapid deflection with the aileron and the rudder to the left, in addition to which the captain deflected the elevator down. NEF021 ended up in an unusual flight attitude in which the maximum bank angle was 50 degrees to the left and the maximum pitch angle was 19 degrees, nose down. The aircraft went into a sideslip with a rapidly accelerating sink rate. The Ground Proximity Warning System (GPWS) activated, warning the crew of an excessively steep bank angle, excessive deviation below the ILS glide slope and an excessive terrain closure rate. The sink rate of NEF021 peaked at approximately 5000 FT/min (25 m/s) at the height of 300 FT (90 m).

The air traffic controller saw the NEF021 making a steep turn towards the runway, following which the aircraft disappeared behind the rising terrain and the trees.

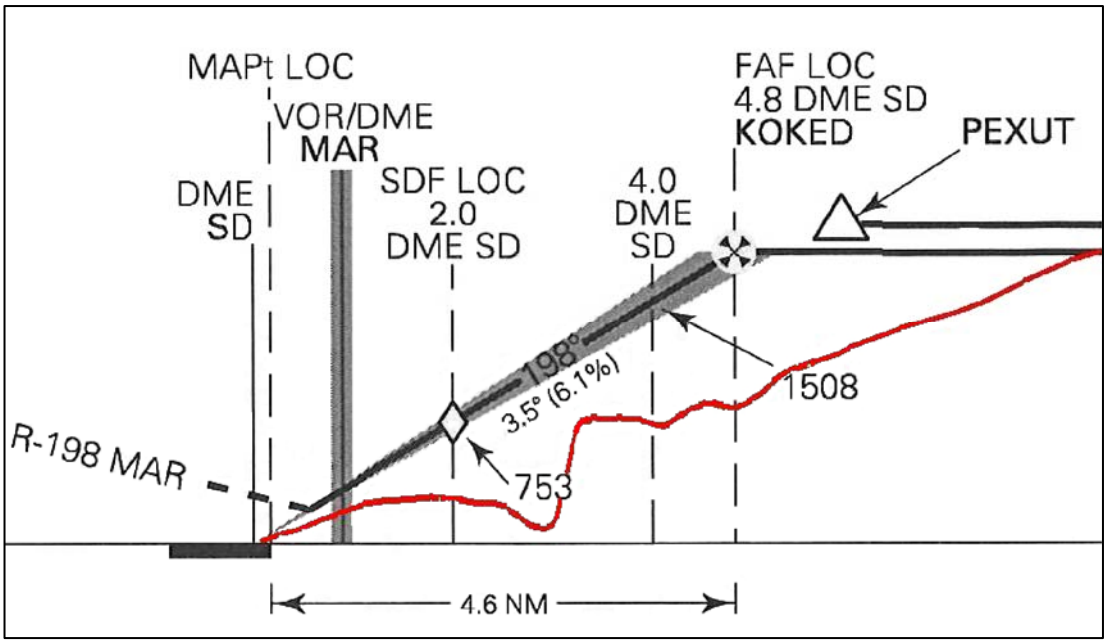

Figure 2. The flight path of NEF021 in relation to the ILS approach.
© Finavia, permission 4/590/2007.

In the aircraft the "WHOOP, WHOOP, PULL UP" warning, the mode alerting of excessive terrain closure rate, was repeated eight times, but the crew did not react to this. The captain managed to recover the aircraft about two seconds before they would have collided with the ground, at approximately 150 FT (46 m) AGL. During the recovery the co-pilot saw treetops that were illuminated by the aircraft's landing lights.

Following the recovery the captain increased the altitude only a little and continued the approach below the ILS glide path. Due to the low altitude the "TERRAIN, TERRAIN WHOOP WHOOP, PULL UP" warning of the GPWS activated, but the flight crew did not react to this. The captain of NEF021 did not have the runway in sight. Rather, the captain flew the aircraft by following the co-pilot's guidance.

As per the captain's written statement, the captain of NEF021 got the runway in sight on the short final, saw four red PAPI lights. This means that the aircraft was clearly too low. The captain continued the approach and landed at 6:46.

1.2 Injuries to persons

There were no injuries to persons.

1.3 Damage to aircraft

The maximum load factor of the aircraft was exceeded.

1.4 Other damage

There was no other damage.

1.5 Personnel information

Pilot-in-command:	Age 57.
Licences:	Airline Transport Pilot's Licence (A), valid.
Medical certificate:	Class 1, valid. Eye glasses or contact lenses must be worn. A spare set must be readily available.
Ratings:	Saab 340, Type Rating, valid.
	Flight experience on all types 15270h.
	On Saab 340: 200h.
Co-pilot:	Age 34.
Licences:	Commercial Pilot Licence (A), valid.
Ratings:	Saab 340 Type Rating, valid.
Medical certificate:	Class 1, valid. Eye glasses or contact lenses must be worn. A spare set must be readily available.
	Flight experience on all types 390h.
	On Saab 340: 180h.
Air traffic controller:	Age 25.
Licences:	Air Traffic Controller's Licence, valid.
Ratings:	ADI/TWR EFMA and APP EFMA.
Medical certificate:	Air Traffic Controller's medical certificate, valid.

1.6 Aircraft information

The Saab 340 is a twin-engine, low-wing turboprop airliner.

Type:	Saab 340A
Nationality and registration:	YL-RAG
Manufacturer:	Saab Aircraft AB
Maximum Takeoff Mass:	12 700 kg
Takeoff Mass on the occurrence flight:	11 723 kg
Owner/operator:	RAF-AVIA Airlines
Certificate of Airworthiness:	Valid until 27 July 2012

According to the load sheet the mass and the centre of gravity were in the permissible range.

1.7 Meteorological information

Mariehamn aerodrome Aviation Routine Weather Reports (METAR):

At 6:20: Wind 210 deg 11 KT, visibility over 10 km. Scattered clouds at 1400 FT (420 m) and broken clouds at 5000 FT (1500 m). Temperature -1°C, dew point -3°C. QNH 1005 hPa.

At 6:50: Wind 210 deg 10 KT, visibility over 10 km. Light snow. Few clouds at 1200 FT (360 m), broken clouds at 2000 FT (600 m) and broken clouds at 6500 FT (2150 m). Temperature -1°C, dew point -2°C. QNH 1004 hPa.

1.8 Aids to navigation

Mariehamn aerodrome has a Very High Frequency Omnidirectional Radio Range (VOR), fitted with Distance Measuring Equipment (DME), and two Locator Outer Markers. There is an instrument landing system (ILS) for RWY 21.

The navigation aids functioned normally at the time of the occurrence. Finavia had flight-calibrated the approach systems on 9 February 2012. The ILS system met its signal requirements in the range specified in ICAO Annex 10. The horizontal service volume of the localizer (LOC) is ± 35 degrees on either side of the runway centreline and in this area no side lobes have been detected which could distract the pilot or the autopilot. However, narrow side lobes at 42 degrees on both sides of the localizer signal are a typical feature of the system. In theory, it would be possible to try to intercept and track the lobes. As a result, the approach attempt would occur at a 42 degree lateral angle off the final approach track.

The air traffic controller at Mariehamn has an ATS monitor which receives its information from the MSSR radar network. According to Finavia's regulation the ATS monitor can be used, for example, as an aid in traffic situation awareness, in making visual contact with an aircraft and in providing assistance to lost aircraft. Furthermore, the monitor can be used to improve flight safety by inquiring about an aircraft's position or other activity. Should the pilot's reply confirm, for example, assumed incorrect positional information, Finavia's regulation states that the pilot must be notified of this.

The occurrence aircraft is fitted with a Flight Management System (FMS) and instrument approach equipment. In addition, the aircraft is certified for Basic Area Navigation (B-RNAV).

All aircraft systems operated normally during the occurrence.

1.9 Communications

During the en-route phase of the flight the aircraft remained on the frequency of ACC Finland. The communication between the aircraft and the ATC during the course of the incident took place on the Mariehamn TWR frequency 119.600 MHz.

Radiotelephony and telephone communications functioned normally at the time of the occurrence.

1.10 Aerodrome information

The elevation of Mariehamn aerodrome is 17 FT (5 m). Runway 03/21 (BRG MAG 018/198 degrees) is 1903 m long and 60 m wide. For the purpose of IFR operations the runway is fitted with suitable approach and lighting systems.

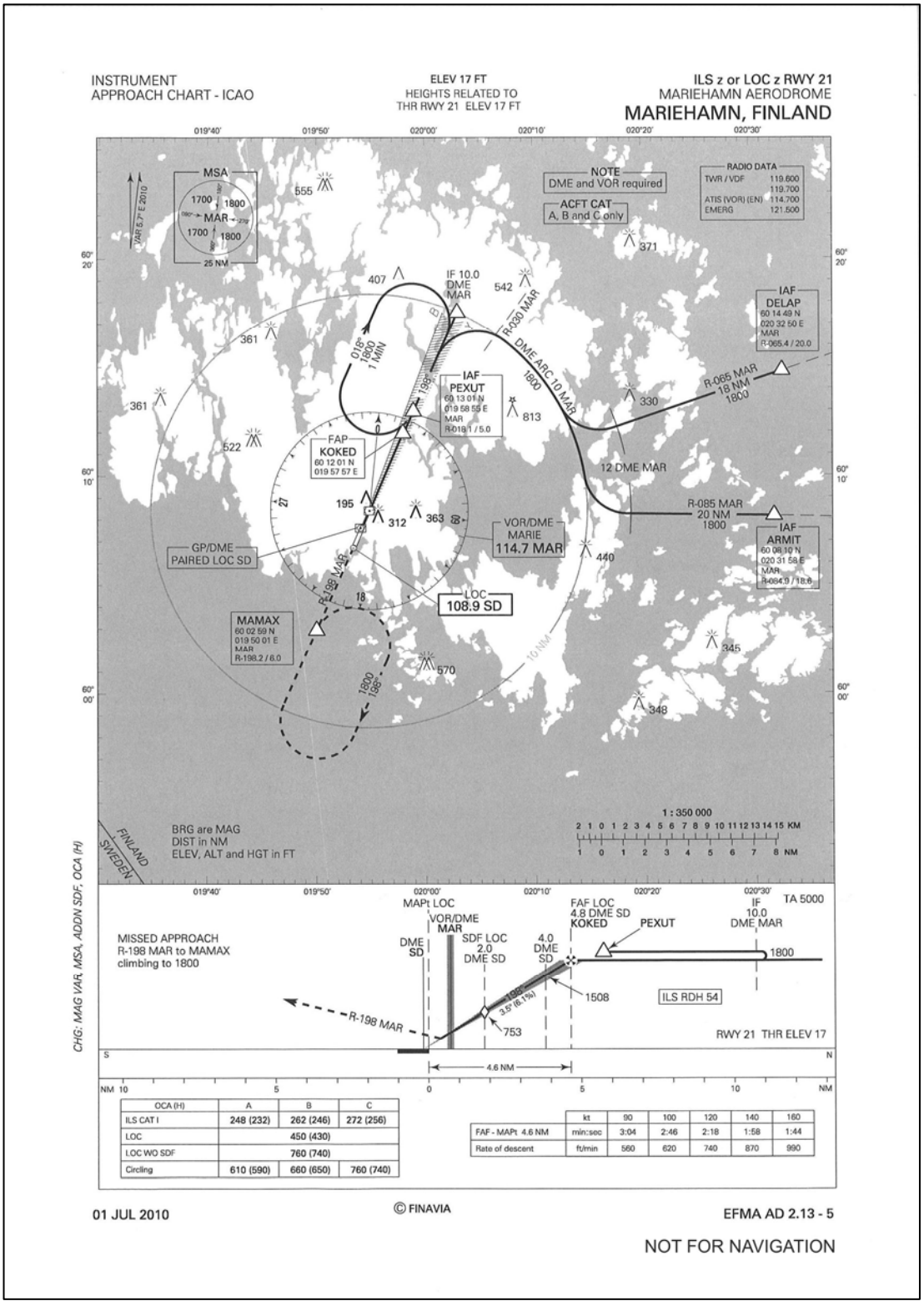

Figure 3. Instrument Approach Chart EFMA ILS z RWY 21.
© Finavia, permission 4/590/2007.

1.11 Flight recorders

The aircraft was fitted with a Loral/L3/Fairchild 93A100-83 Cockpit Voice Recorder (CVR) and a Lockheed 10077A500-803 Flight Data Recorder (FDR). The recorders operated normally and the data therein were made available to the investigation group.

The UK Air Accident Investigation Branch (AAIB) downloaded the CVR and FDR recordings. The recordings were useful for the investigation.

1.12 Wreckage and impact information

The occurrence site, where NEF021 experienced the risk of colliding with terrain, is close to *Ingbyberget*, approximately 2.7 NM (5.0 km) from RWY 21. The highest point in the terrain there is at approximately 67 m MSL.

During the recovery the maximum load factor (2.0 g) specified for the aircraft was momentarily exceeded, being 2.06 g. Following a technical inspection carried out on 16 February 2012 the aircraft was pronounced airworthy.

1.13 Medical and pathological information

No medical or toxicological tests were conducted.

1.14 Fire

There was no fire.

1.15 Survival aspects

No rescue action was required, nor was the rescue service alerted.

1.16 Tests and research

The investigation group conducted a flight simulation in a Saab 340 simulator in Stockholm, Sweden.

1.17 Organisations and management

RAF AVIA Airlines

RAF-AVIA Airlines is a Latvian airline. The Latvian Ministry of Transport issued the airline an Aircraft Operator Certificate (AOC), which is valid until 28 March 2013. RAF-AVIA Airlines was founded in 1990 and, for the most part, operates cargo flights from its home base in Riga, Latvia.

In Finland RAF-AVIA operates, among other things, Nordflyg cargo flights between Helsinki-Vantaa and Mariehamn. According to its statistics its fleet transported approximately 5 000 tonnes of cargo in 2010, amassing approximately 4800 flight hours in total.

The fleet of RAF-AVIA comprises eight aircraft: five AN26, one AN74-100 and two Saab 340 aircraft.

Reporting

In accordance with RAF-AVIA's Operation Manual the pilot-in-command or some other member of the crew must report an incident to the Company as soon as possible after the flight. The Flight Operations Manager must deliver the report to LV CAA and, if required, to the accident investigation authority of Latvia (TAIIB).

The pilot-in-command of NEF021 submitted a short report of the incident which the Safety Investigation Authority, Finland (SIAF) received on 17 February 2012. The report was informal, omitting, among other things, the date, signature and meteorological information. The Company's Safety Manager filed an incorrectly dated (14 October 2011) Aviation Safety Report to LV CAA.

1.18 Additional information

During the course of the investigation, SIAF were informed of an incident which occurred on 25 May 2012 at 10:07 Finnish time to a RAF-AVIA Saab 340A aircraft as it was approaching Helsinki-Vantaa airport.

The aircraft had been cleared for an RNAV approach to RWY 04R. The flight crew approved the clearance even though RAF-AVIA, according to its Aircraft Operator Certificate, is not certificated for RNAV approaches. During the approach the aircraft left the intermediate approach altitude 2120 FT (650 m) prior to crossing the Final Approach Fix and descended to 1400 FT (430 m). The horizontal distance between the aircraft and a 1214 FT (370 m) tall radio mast which it passed on the final approach track was approximately one nautical mile (1.8 km) and the required obstacle clearance was violated.

1.19 Useful or effective investigation techniques

The aircraft manufacturer's test pilots, FDR analysts and the flight safety director provided assistance to the investigation group in a Saab 340 simulator in Stockholm (CAE Oxford Aviation Academy). The investigation group simulated the flight of NEF021 so as to establish why the aircraft, flying on autopilot and in violation of the approach procedure, turned away from the DME arc.

2 ANALYSIS

2.1 Flight crew action

NEF021 was cleared to reporting point PEXUT via the initial approach route of the ILS z-approach. In violation of the approach procedure and the ATC clearance, it turned left from the DME arc towards the threshold of RWY 21. Autopilot was selected on. NEF021 turned to the approximate heading of 240 degrees, which is approximately 40 degrees off of the final approach track specified for the approach. As per the approach procedure it should have followed the DME arc until lead radial 030.

The captain's statement said that the premature turn was caused by a problem in the FMS. The co-pilot believed that the cause may have been that the captain, having received the approach clearance, selected the autopilot into the APPR mode, which then caused the aircraft, as per the operating logic of the autopilot, to turn to the selected heading.

The investigation could not categorically establish why, in violation of the procedure, the aircraft turned left, off of the DME arc. The investigation group tested several options in the Saab 340 flight simulator: on the basis of these tests an FMS fault or the chain of events described by the co-pilot were deemed as unlikely. However, the investigation established that the aircraft turned away from the DME arc before receiving the approach clearance, and that the APPR mode was only selected after that.

The simulation found a possible chain of events where the aircraft began to track a VOR radial, rather than the course in the FMS. When radial 030, the lead radial prescribed for the instrument approach, was selected as the VOR course, NAV mode was replaced by the VOR mode. Then the aircraft began to intercept the selected radial at a 30 degree angle, flying a heading of 240 degrees.

The flight crew of NEF021 did not notice that the aircraft was approximately 40 degrees off of the correct final approach track. The narrow side lobes at 42 degrees on both side of the ILS localizer signal may have contributed to this: the side lobe may have momentarily given the captain the false impression of being on the correct course.

The flight crew did not monitor the continuance of the flight on the DME arc until the lead radial 030, or verify their course and position from other available navigational aids. They concentrated on clearing the FMS problem.

NEF021 continued to descend to 1800 FT MSL, below the Minimum Sector Altitude (MSA), with a heading which was approximately 40 degrees off the final approach track prescribed for the approach procedure. NEF021 should have maintained 1800 FT MSL. Since the aircraft was not stabilised on the approach track, they should have aborted the approach. NEF021 did not comply with the instrument approach procedure, nor did they have the runway or the approach lights in sight. The initial approach altitude prescribed for the approach is 1800 FT MSL; it is also the MSA. Descending below this altitude re-

quires that the aircraft is established on the approach track and the glide path, or that the crew have the runway, its immediate surroundings or the approach lights in sight.

The Altitude Preselector Alerter (APA) gave an audible tone when NEF021 passed 1800 FT MSL. According to its operating logic the APA gives an audible tone 1000 FT before the selected altitude. It is possible that the captain had changed the selected altitude to 800 FT, the minimum descent altitude of a circling approach.

The captain turned off the autopilot at 1600 FT MSL, turned right and manually continued to fly a heading which is at a 90 degree angle in relation to the final approach track, and descended to 1000 FT MSL. The pilots of NEF021 tried to get the runway in sight, but without success. While it might have been possible to see the runway in the prevailing conditions, their degraded situational awareness led them to look in the wrong direction for the runway.

The air traffic controller issued NEF021 a landing clearance which the co-pilot read back. The captain informed the co-pilot of the decision to continue the approach. The co-pilot replied that the runway is not in sight. This being the case, the captain did not have the grounds for making this decision. The co-pilot noticed that they had arrived on the final approach track at a 90 degree angle in relation to it and advised the captain to make a left turn. At this time they were 3.1 NM (approximately 5.7 km) from the threshold of RWY 21, flying at 1000 FT MSL.

The captain made a strong deflection with the aileron and the rudder to the left, in addition to which the captain deflected the elevator down. As a result of the flight control inputs the crew lost control of the aircraft and ended up in an unusual flight attitude in which the maximum bank angle was 50 degrees to the left and the maximum pitch angle was 19 degrees, nose down. The aircraft went into a sideslip with a rapidly accelerating sink rate. The Ground Proximity Warning System (GPWS) activated, warning the crew of an excessively steep bank angle, excessive deviation below the ILS glide slope and an excessive terrain closure rate. The sink rate of NEF021 peaked at approximately 5000 FT/min (25 m/s) at 300 FT AGL (90 M).

The captain managed to recover the aircraft at approximately 320 FT (98 m) MSL, i.e. approximately 150 FT (46 m) AGL. This happened about two seconds before they would have collided with the ground. They were 2.7 NM (5.0 km) from the threshold at this time.

The Operations Manual of RAF-AVIA calls for prompt evasive action to be initiated immediately upon receiving a GPWS warning and for immediate corrective action to clear the situation. In spite of this, the flight crew did not react to the GPWS warnings. Furthermore, according to the captain's report, the captain did not hear the warning, nor, according to the captain's view, was the aircraft too low.

Following the recovery the captain of NEF021 increased the altitude only a little despite still not having the runway in sight.

2.2 Crew Resource Management (CRM) and Airmanship

Crew cooperation, i.e. Crew Resource Management (CRM), encompasses, among other things, interaction between the crew members as well as leadership and decision-making in the air. Both pilots on the occurrence flight had participated in the operator's CRM-training sessions.

A flight crew's decision-making relationship and respective authority can be expressed with the term 'cockpit authority gradient'[1]. A suitably appropriate cockpit authority gradient enables smooth and safe crew cooperation. However, an authority gradient which is too abrupt creates a rigid and authoritarian atmosphere on the flight deck.

In the Finnish language 'airmanship' is often translated as 'best practices in aviation' or 'good pilot practices'. Best practices in aviation incorporate the attitudes, knowledge and skills associated with the profession of pilot. Not only does airmanship involve technical expertise, it also incorporates the pilot's awareness of his aeroplane, environment and resources. The basic elements of airmanship comprise, among other things, skill, professionalism, situation awareness, and self-discipline which come together in a safe and efficient manner.

Airmanship emerges from people's personal traits. Pilots accumulate it in different ways through prevailing attitudes, training and experience. Collectively, they spawn a sound approach to flight safety and good airmanship.

The investigation group believes that the cockpit authority gradient between the captain and the co-pilot of NEF021 was non-synergetic. The captain did not sufficiently communicate the autopilot mode selections to the co-pilot. The shortcomings in communication contributed to the inadequate airmanship, which materialised in degraded situational awareness and decision-making. Crew Resource Management was poorly handled and the captain did not comply with the Company's Operations Manual. The captain continued the approach even though the aircraft was not established on the instrument approach, as is required. The captain ignored the co-pilot's remark that the continuation of approach was not possible because the runway was not in sight. Continuing the approach in the prevailing conditions degraded the crew's situational awareness to the extent that the captain lost control of the aircraft.

The co-pilot actively attempted to comply with the Company's standard operating procedures. The co-pilot, as per the interview, wanted to abort the approach but, according to previous experience, the co-pilot did not believe that the captain would agree to this. It is likely that the co-pilot's limited flight experience also factored in. Moreover, the co-pilot believed that any attempts to actively interfere with the captain's flying, such as taking over the controls, would have spelled trouble later on.

[1] "Human Performance & Limitations", Vapaavuori & Sorsa

2.3 Air traffic controller action

In accordance with Finavia's regulation IAM RAC 89 (15 Nov 2006), the ATS monitor can be used to improve flight safety, among other things, by querying the aircraft's position.

As per the air traffic controller's statement, NEF021 appeared to be turning approximately 90 degrees to the left after it was cleared for approach, as seen on the ATS monitor. Since the air traffic controller assumed that NEF021 had deviated from the route given in the air traffic control clearance the controller requested the crew of NEF021 to confirm that they were tracking the initial approach route. However, the crew replied that they were on the initial approach route. Soon after this the symbol of the aircraft on the monitor became imprecise as regards azimuth information, and then it faded out below the radar horizon. At this time the controller could only assume that NEF021 was trying to follow the route given in the air traffic control clearance.

The air traffic controller saw NEF021 crossing the final approach track at a 90 degree angle in relation to the final approach, following which it made a steep turn towards the left and disappeared behind the terrain and trees. At this time the controller believed that NEF021 would collide with the ground. Nonetheless, NEF021 re-appeared from behind the treeline. The air traffic controller did not want to distract the pilots by ordering a go-around.

At the time of the occurrence the air traffic controller was controlling an aircraft which was departing to the southwest from RWY 21. The fact that NEF021 deviated from the initial approach route also created the risk of losing minimum separation between NEF021 and the departing aircraft.

3 CONCLUSIONS

3.1 Findings

1. The flight crew and the air traffic controller had valid licences and the required ratings.
2. The flight experience of the captain of NEF021 was 15270 hours, of which 200 hours was on the type. The flight experience of the co-pilot was 390 hours, of which 180 hours was on the type.
3. The aircraft was airworthy.
4. Navigational aids and systems operated normally during the occurrence.
5. In violation of the air traffic control clearance the aircraft turned left, off of the initial approach route.
6. The air traffic controller requested the crew to confirm that they were following the initial approach route.
7. The crew confirmed, incorrectly, that they were on the initial approach route.
8. The aircraft descended below the minimum flight altitude even though they were not established for the approach.
9. The co-pilot noticed that they had arrived on the final approach track at a 90 degree angle in relation to it and advised the captain to make a left turn.
10. As a result of the inappropriate flight control inputs of the captain the aircraft ended up in an unusual flight attitude. The aircraft went into a side-slip with a rapidly accelerating sink rate.
11. The Ground Proximity Warning System (GPWS) alerted the crew several times of an excessive terrain closure rate.
12. The crew did not react to the GPWS warnings.
13. The captain managed to recover the aircraft about two seconds before they would have collided with the ground. The minimum height of the aircraft was 46 m AGL, approximately five kilometres from the threshold.
14. Following the recovery the captain of NEF021 increased the altitude only a little and continued the approach below the ILS glide slope.
15. The captain did not have the runway in sight, but the captain flew the aircraft towards the runway by following the co-pilot's guidance.
16. The aircraft landed on runway 21 at Mariehamn airport.

3.2 Probable cause and contributing factors

The serious incident was caused because the captain of NEF021 continued the approach in a situation which did not meet the requirements of a successful approach and landing. This degraded the flight crew's situational awareness to the extent that the captain flew the aircraft into an unusual attitude and the crew lost control of the aircraft. This resulted in the risk of colliding with terrain.

As regards contributing factors Crew Resource Management was poorly handled, and the captain did not comply with the Company's Operations Manual. Additionally, the crew did not follow the instrument approach procedure and ignored the warnings of the Ground Proximity Warning System.

4 SAFETY RECOMMENDATIONS

4.1 Action already implemented

The Latvian Civil Aviation Agency (LV CAA) were informed of serious incidents which involved RAF-AVIA's Saab 340A airliners on 29 December 2011 at Helsinki-Vantaa and on 14 February 2012 at Mariehamn.

On 15 February 2012 LV CAA organised a meeting with RAF-AVIA to ensure that the company continue to operate in a safe manner. In that meeting LV CAA focused attention, among other things, on Saab 340 pilot training and miscommunications with the air traffic control. LV CAA compiled a list of the detected anomalies.

The next meeting took place on 13 March 2012. The goal of the meeting was to go through the corrective action already implemented by RAF-AVIA, and the action plan to correct the remaining anomalies. During this meeting LV CAA issued six recommendations to RAF-AVIA, which the company accepted. In addition to the recommendations LV CAA carried out a quality audit on RAF-AVIA on 28-29 March 2012.

According to one of the recommendations RAF-AVIA were to stand down Saab 340-operations, effective 19 March 2012, until such date when all Saab 340 pilots had completed language and refresher training and proficiency checks. These measures were to be achieved prior to each pilot's next operation on the Saab 340. RAF-AVIA complied with the recommendation and stood down Saab 340 operations, effective 19 March 2012. LV CAA permitted RAF-AVIA to continue with Saab 340 operations, effective 30 April 2012.

4.2 Safety recommendations

1. The investigation revealed non-synergetic crew cooperation between the members of the crew of NEF021. Among the shortcomings that were found were the captain's insufficient communication to the co-pilot of the FMS mode selections and the flight crew's failure to check their position from the other navigational aids when they questioned the functioning of the Flight Management System.

   Safety Investigation Authority, Finland recommend that the Latvian Civil Aviation Agency ensure that RAF-AVIA pilots receive additional Crew Resource Management training.

2. RAF-AVIA's Operations Manual calls for prompt evasive action to be initiated immediately upon receiving a GPWS warning and for immediate corrective action to clear the situation. Nevertheless, the flight crew did not react to the GPWS warnings.

   Safety Investigation Authority, Finland recommend that the Latvian Civil Aviation Agency ensure that RAF-AVIA pilots receive additional training as regards the operating procedures of the Ground Proximity Warning System.

3. Finavia Oyj has published regulation IAM RAC 89 (15 Nov 2006) “The use of radar monitors at ATS units” (this investigation report uses the term *ATS monitor*). The regulation lists the processes in which air traffic controllers can use ATS monitors. When an air traffic controller notices from the ATS monitor that an aircraft significantly deviates from the air traffic control clearance the controller may ask the pilot of the aircraft for verification. Should the pilot’s reply confirm the assumed incorrect positional information, the pilot must be notified of this.

   Safety Investigation Authority, Finland recommend that Finavia Oyj update its regulation IAM RAC 89 (15 Nov 2006) “The use of radar monitors at ATS units” in such a manner that the air traffic controller also has the option of notifying the pilot when the information on the ATS monitor and the pilot’s position report diverge.

Helsinki 18.9.2013

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Appendix 1

SUMMARY OF THE COMMENTS RECEIVED ON THE DRAFT FINAL REPORT:

FINAVIA Corporation

Finavia states that, despite the fact that the quality of the radar monitor system used by their ATS units has improved, the technical design of radar equipment as such has hardly changed during the past 20 years. Technical limitations must always be taken into consideration when interpreting a target's positional information.

Finavia also regards that operational use of the radar monitor demands deeper insight into radar technology in all cases and, therefore, states that the IAM guide in this respect is up-to-date. Finavia has aimed to regulate the use of radar monitors so as to prevent any erroneous impression on the part of the pilot that the air traffic controller was providing ATS surveillance services.

Finavia proposes that the safety recommendation issued to them be removed, or at least changed into an observation. SIA, Finland has taken the proposal into account by altering the contents of the safety recommendation.

Finnish Transport Safety Agency (Trafi)

No comments.

RAF-AVIA

No comments.

Latvian Civil Aviation Agency (LV CAA)

No comments.

Transport Accident and Incident Investigation Bureau (TAIIB)

No comments.

Swedish accident investigation authority (SHK)

Observations and suggestions were taken into account.

Saab Group

Observations and suggestions of alternative wording were taken into account.

UK Air Accidents Investigation Branch (UK AAIB)

No comments.

European Aviation Safety Agency (EASA)

No comments.