Investigation report

L2013-02

Serious Incident Involving Three Airliners in the Vicinity of Helsinki-Vantaa Airport on 6 February, 2013

Translation of the original Finnish language report

G-EUUK	Airbus 320
OH-LKO	Embraer 190
OH-BLQ	Boeing 717

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SUMMARY

SERIOUS INCIDENT INVOLVING THREE AIRLINERS IN THE VICINITY OF HELSINKI-VANTAA AIRPORT ON 6 FEBRUARY, 2013

A serious incident involving three airliners occurred near Helsinki-Vantaa Airport on 6 February 2013 at 16:07. Flybe Finland flight FCM746L from Warsaw and British Airways flight BAW79H from London were arriving at Helsinki-Vantaa. At the same time Scandinavian Airlines flight SAS717, operated by Blue1, was departing from Helsinki-Vantaa for Stockholm.

At the time of the occurrence Helsinki-Vantaa had segregated parallel operations in use. Runway 04L was used for arrivals and RWY 04R for departures. It was snowing and visibility varied.

FCM746L, an Embraer 190, and BAW79H, an Airbus 320, were flying instrument approaches to RWY 04L. When BAW79H was at approximately 4 NM from the threshold of RWY 04L the arrival controller told it to go around because its distance to the preceding FCM746L on the approach decreased below the required minimum separation. Soon after this the flight crew of FCM746L, too, decided to go around because the TWR controller had not issued them a landing clearance, as the aircraft that landed before them was still on the runway. The minimum distance between the aircraft going around was 1.5 NM (2.8 km); both of them were flying at 3000 ft (900 m). In accordance with the heading issued by the arrival controller BAW79H turned to the left and the distance between the two aircraft began to increase.

Simultaneously, as FCM746L was aborting its approach to RWY 04L, SAS717, a Boeing 717, took off from adjacent parallel runway 04R. The TWR controller cleared FCM746L to turn right heading 050, and a little later to 040 degrees, i.e. on the runway heading. The aircraft flew abreast of each other in the same heading for one minute and ten seconds; the distance between them was 0.9 NM (1.7 km). FCM746L was maintaining 3000 ft (900 m) and SAS717 was in an initial climb to 4000 ft (1200 m), as per the Standard Instrument Departure. During its climb SAS717 passed through the altitude FCM746L was maintaining.

The minimum radar separation for the area of responsibility of Helsinki-Vantaa ATC is 3 NM (5.6 km). The minimum vertical separation is 1000 ft (300 m). The required separation minima were clearly infringed in both of the aforementioned instances.

Radar recordings showed that the ATC system warned the air traffic controllers of potential collisions between the aircraft by annunciating STCA alerts. The air traffic controllers did not adequately react to the alerts.

The serious incident involving the flights of British Airways and Flybe Finland developed when the arrival controller issued a clearance to the British Airways flight which took it almost directly above RWY 04L. For this reason the Flybe Finland flight no longer had sufficient airspace for flying a missed approach procedure in accordance with the instrument approach chart. The TWR controller cleared the Flybe Finland flight, flying a go-around, to maintain the runway heading. While

issuing this clearance the controller did not notice the Scandinavian Airlines flight that had departed from RWY 04R, which in turn caused the serious incident involving the flights of Flybe Finland and Scandinavian Airlines. Contributing factors included the arrival controller's delayed decision-making in an untypical traffic situation, the TWR and APP controllers failing to prioritise their tasks, and shortcomings in coordination between the controllers' working positions.

On the basis of the investigation Safety Investigation Authority, Finland issued four safety recommendations to Finavia Corporation: three of them concern the Helsinki-Vantaa ATC Ops Manual and one the use of the Surface Movement Radar system.

Safety Investigation Authority, Finland recommends that the Helsinki-Vantaa ATC Ops Manual be augmented with an operational instruction for controllers in case the STCA system annunciates an alert. The instructions related to missed approaches and non-standard go-around clearances must be made more detailed and comprehensive. The instructions on segregated parallel operations must be augmented with regard to when the criteria of segregated parallel operations are no longer met. When it comes to the use of the Surface Movement Radar (SMR), the recommendation to Finavia Corporation entails taking measures which make it possible to use the SMR in establishing that the runway is free when aircraft are being cleared onto the runway.

TABLE OF CONTENTS

ABBREVIATIONS

AIP	Aeronautical Information Publication
APP	Approach Control
ARR-E	Arrival Controller, East
ARR-W	Arrival Controller, West
GND	Ground Control
HK-TKK OPS	Helsinki-Vantaa ATC Ops Manual
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
LJKK	Finnish Air Traffic Control Manual
LVP	Low Visibility Procedures
NM	Nautical Miles
RAD-E	Radar Controller, East
RAD-W	Radar Controller, West
RWY	Runway
SMR	Surface Movement Radar
STCA	Short Term Conflict Alert
TMA	Terminal Control Area
TAR	Terminal Area Surveillance Radar
TCAS	Traffic Alert and Collision Avoidance System
TWR	Aerodrome Control Tower
TWR-E	Aerodrome Control Tower, East
TWR-W	Aerodrome Control Tower, West
TWR-SUP	Supervisor, Aerodrome Control Tower
UTC	Co-ordinated Universal Time

SYNOPSIS

Safety Investigation Authority, Finland (SIAF) categorised the infringement of separation minima involving three airliners on 6 February, 2013 near Helsinki-Vantaa Airport as a serious incident. Pursuant to Section 2 of the Safety Investigation Act (525/2011), SIAF decided to initiate safety investigation L2013-02. Mr Timo Heikkilä was appointed as team leader for the investigation group, accompanied by Mr Kari Kallio and Mr Tauno Ylinen as expert members of the investigation group. Chief Air Safety Investigator Ismo Aaltonen acted as investigator-in-charge.

The flights involved in the serious incident were BAW79H (British Airways) and FCM746L (Flybe Finland), both of which were flying missed approach procedures to RWY 04L, and SAS717 (Scandinavian Airlines), which had taken off from RWY 04R. The required separation minima between the aircraft were infringed. The investigation report also assesses the action of NAX3MU (Norwegian Air Shuttle) because it had landed a moment earlier and was still taxiing when the serious incident occurred. While the separation minima to NAX3MU were not infringed, it was still important to evaluate the action of its flight crew in order to consider the situation as a whole.

SIAF notified the International Civil Aviation Organization (ICAO), the European Commission (EC), the European Aviation Safety Agency (EASA), Accident Investigation Board Norway (AIBN) and the UK Air Accidents Investigation Branch (UK AAIB) of the occurrence.

SIAF requested comments on the draft final report from Finavia Corporation, the Finnish Transport Safety Agency, the EASA, the AIBN, the AAIB and interested parties. The investigation group included the comments deemed appropriate in the final report. A summary of the comments to the draft final report is included in Appendix 1.

The course of events was established from the Air Traffic Control's communications recordings, radar recordings, from the written reports of interested parties and their interviews.

This investigation report refers to the aircraft by their flight designator, which combines the three-letter ICAO airline designator and the flight number.

The Finnish language investigation report is the original version. The report and the material used in the investigation are archived at Safety Investigation Authority, Finland.

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

1 FACTUAL INFORMATION

1.1 History of the flight

British Airways' Airbus 320 (BAW79H) and Flybe Finland's Embraer 190 (FCM746L) were flying an instrument approach to RWY 04L. The arrival controller told BAW79H to go around because its distance to the preceding FCM746L fell below the required 3 NM minimum separation. While passing over the threshold of RWY 04L the flight crew of FCM746L, too, decided to abort the approach because the aerodrome (TWR) controller could not clear them to land, as Norwegian Air Shuttle flight NAX3MU that had landed before them was still on the runway. The minimum distance between the two aircraft going around was 1.5 NM (2.8 km). At this time both of them were flying at 3000 ft (900 m). In order to establish proper separation the radar controller told BAW79H to turn left at which time the distance between the two aircraft began to increase.

Simultaneously, while FCM746L was flying a missed approach procedure on RWY 04L, a Scandinavian Airlines Boeing 717 (SAS717) took off from runway 04R. SAS717 followed the Standard Instrument Departure according to which it was to track the runway heading at first. At first, the TWR controller cleared FCM746L to turn right heading 050 degrees, and a little later to 040 degrees, i.e. on the runway heading. The two aircraft flew abreast of each other, in the same direction, for one minute and ten seconds; the minimum distance between them was 0.9 NM (1.7 km). During its climb SAS717 passed through the altitude FCM746L was maintaining.

1.1.1 Traffic situation at Helsinki-Vantaa and the runways in use at the time of the occurrence

Traffic at Helsinki-Vantaa (EFHK) is at its busiest from approximately 14:00–18:00 in the afternoon. At first, from 14:00–16:00, most of the traffic represents arrivals, after that the number of departures is greater.

During this serious incident EFHK had segregated parallel operations in use. RWY 04L was reserved for arrivals and RWY 04R for departures.

Segregated parallel operations may be conducted on parallel runways provided the nominal departure track follows the runway heading or diverges immediately after take-off by at least 30 degrees from the missed approach track of the adjacent approach (HK-TKK OPS[1] 4.5.13.1).

The required working positions at the approach control and aerodrome control TWR were manned at the time of the occurrence.

[1] Helsinki-Vantaa ATC Ops Manual

1.1.2 A description of ATC work processes as regards the occurrence

Approach Control: RAD working position

The area of responsibility of the RAD working position is a geographical sector delineated within the Terminal Control Area (TMA) which varies according to the runways in use (Figure 1). The main task of RAD is to provide air traffic control services to arriving and departing traffic, and to traffic that passes through its sector in the TMA. In addition, RAD is responsible for coordination with the sectors of the Area Control Centre (ACC) and Arrival Control (ARR), among other things.

As regards arrivals, RAD plans a preliminary approach sequence, primarily on the basis of the Maestro traffic management system's proposals (HK-TKK OPS 6.4.5.3).

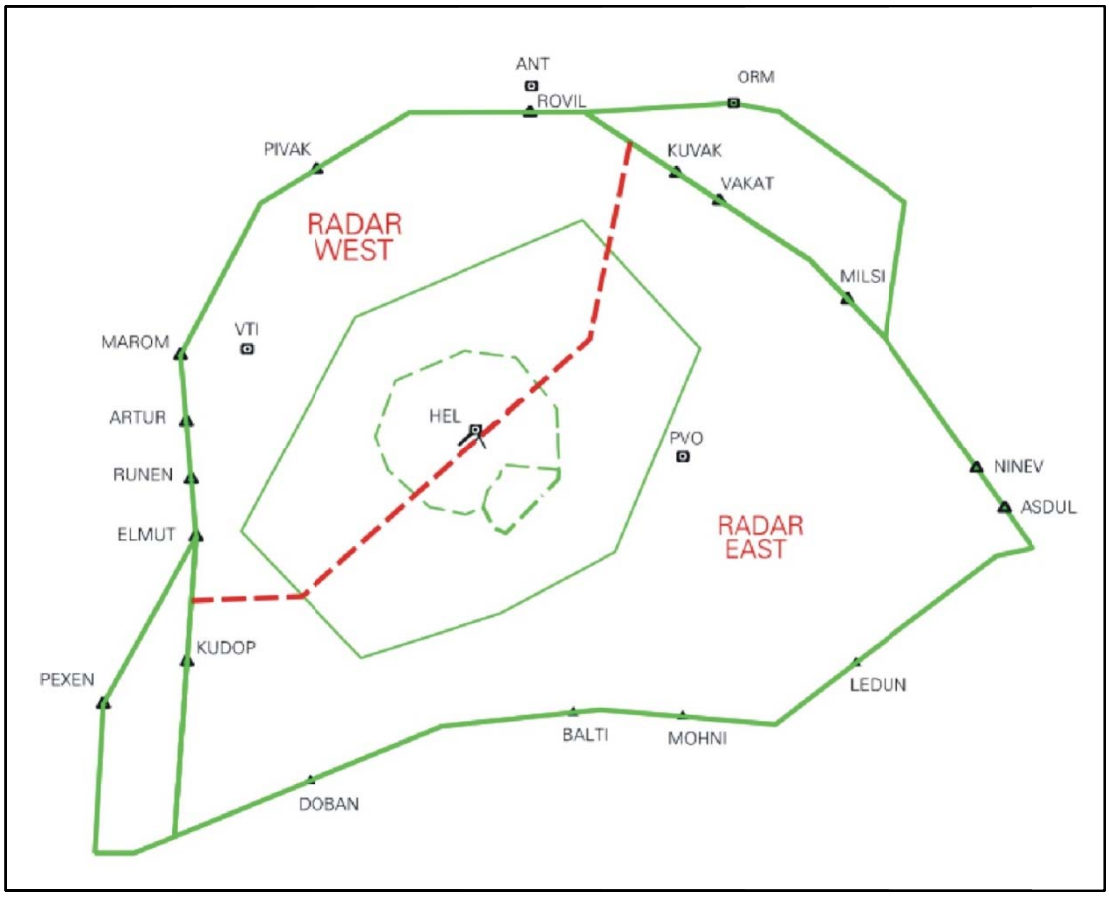

Figure 1. Geographical sectors within EFHK TMA (HK-TKK OPS 6.9.1).

Approach Control: ARR working position

The ARR working position does not have any specific geographical sector of responsibility. Its task is to provide ATC services to arriving traffic. Whereas RAD prepares a preliminary landing sequence, ARR determines the final sequence (HK-TKK OPS 6.4.5.3). ARR vectors the aircraft for an approach at the desired sequencing to the runway in use (HK-TKK OPS 6.5.2.4). ARR cooperates with TWR, RAD-E/W and another ARR position (HK-TKK OPS 6.5.1.2).

The arrival controller is responsible for maintaining the separation minima of arriving aircraft to touchdown. ARR is responsible for maintaining at least the required wake turbulence separation minima between successive approaching aircraft, and for ensuring that the succeeding aircraft not close on the preceding aircraft. If the succeeding aircraft closes on the preceding aircraft, it must maintain at least the wake turbulence separation minimum to the touchdown point until the preceding aircraft lands or aborts its approach (HK-TKK OPS 6.5.2.8).

Aerodrome Control: TWR working position

The primary task of the aerodrome control's TWR working position is to provide ATC services to traffic in its area of responsibility. In addition, its tasks include coordination with the other positions at aerodrome control and the ARR (HK-TKK OPS 4.2.1).

At the time of the occurrence the primary task of TWR was to provide ATC services to arriving traffic approaching RWY 04L. ARR-E transferred the traffic to TWR-W which was to issue landing clearances or, if necessary, missed approach clearances. The approaching aircraft were only released to TWR for landing or missed approaches (HK-TKK OPS 4.5.3.3). TWR-W is also responsible for issuing taxi clearances within its area of responsibility.

TWR is to immediately notify ARR when it observes that an aircraft aborts its approach. TWR can deviate from the published missed approach procedure, should safety so require. TWR must report the issued clearance to ARR (HK-TKK OPS 4.5.3.4).

When parallel runways are in use, the boundary between the areas of responsibility of TWR-W and TWR-E working positions runs parallel with and between the runways (Figure 2).

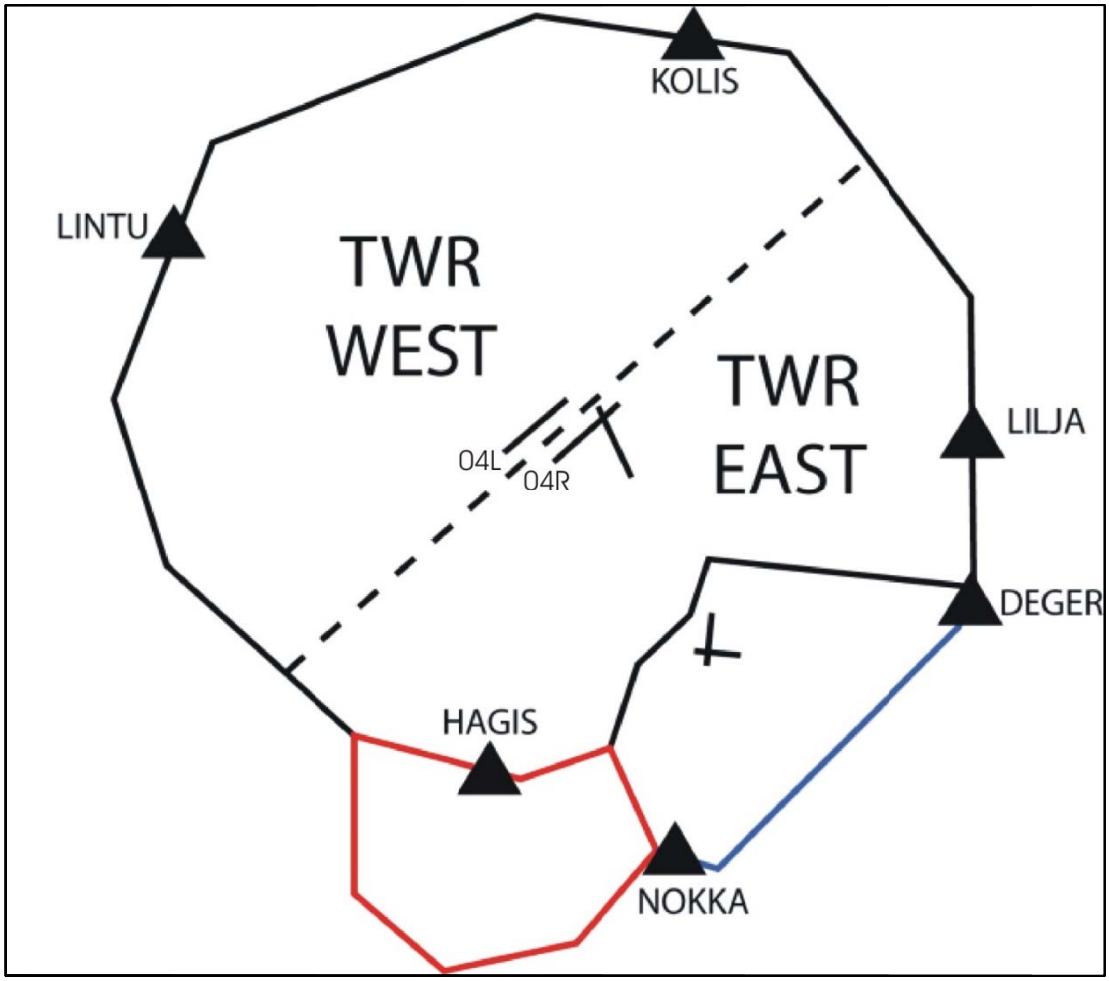

Figure 2. EFHK CTR sectors, sector concept 2 (HK-TKK-OPS 4.3.).
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Aerodrome Control Supervisor (TWR SUP)

In addition to being responsible for management at aerodrome control, the job description of the TWR SUP is the same as that of the TWR coordinator (TWR COR): i.e. mainly to assist TWR-E. Among other things, during winter operations the TWR SUP and the foreman of aerodrome maintenance coordinate the timing of the snow removal and sweeping of the movement area. The TWR SUP enters the agreed maintenance schedules into several ICT systems.

Together with the approach control supervisor, the TWR SUP determines the desired sequencing for arriving traffic. Both supervisors had decided that the desired sequencing for arriving traffic be 5 NM. Desired sequencing stands for the horizontal spacing between aircraft that the approach control aims to achieve when it hands over traffic to the TWR. Relevant factors that affect said sequencing include overall meteorological conditions, wind direction and strength and runway condition.

1.1.3 Radar track labels on the controller's display

Aircraft information is presented in the form of a radar track label on the air traffic controller's display (Figure 3). The information therein is compiled from the data which the air traffic control's secondary surveillance radar (SSR) receives from the aircraft transponder, the radar system's own processing and the associated flight plan in the ATC system.

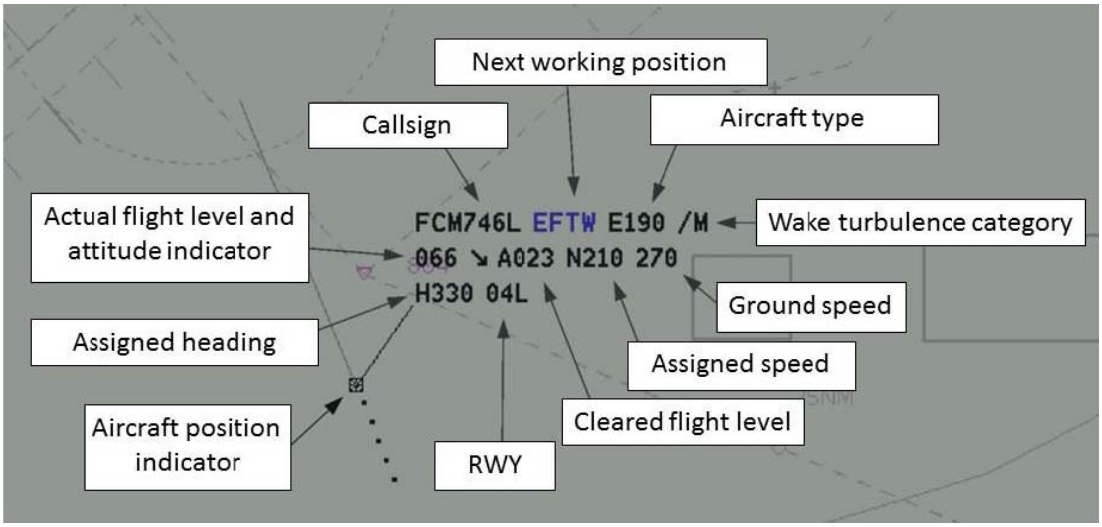

Figure 3. Radar track label data blocks at EFHK approach control and the aircraft's (combined track) position symbol (Eurocat2000 2.2.2).
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ATC systems predominantly maintain and transfer information in electronic format. Radar track labels are transferred from one working position to another as the flight progresses, and the label must be updated before the transfer. Electronic transmission of data aims to improve ATC safety and efficiency, and increase its capacity.

1.1.4 Action of the RAD-E controller

Upon arriving at the TMA, or soon thereafter, RAD-E gave the following airspeed instructions to the aircraft: NAX3MU "no speed restriction", FCM746L "keep up speed until further" and BAW79H "at further free speed". For this reason BAW79H maintained a high airspeed. Right before instructing BAW79H to contact ARR-E, RAD-E told it to reduce speed to 230 KT. At that time BAW79H was flying 50 KT faster than the preceding NAX3MU. With such a difference in airspeed their mutual distance was decreasing by nearly one NM per minute.

1.1.5 Action of the ARR-E and TWR-W controllers

Of the flights involved in this investigation NAX3MU was the first to arrive in EFHK TMA. At 15:56:20 ARR-E issued it an approach clearance. Because of successive traffic the controller told NAX3MU to maintain 190 KT or greater until eight NM (14.8 km) from RWY 04L. NAX3MU reported that it was maintaining 210 KT, which was its airspeed at the time.

BAW79H, coming from the same direction, was trailing NAX3MU. Both aircraft had entered EFHK TMA from a direction which leads fairly straight to the approach course of RWY 04L. When BAW79H contacted ARR-E the distance from it to NAX3MU, flying ahead, was approximately 10 NM (18.5 km); there were still 24 NM (44.4, km) to go to the threshold. FCM746L was approaching from the south and ARR-E continued the radar vectoring that had been started by RAD-E, with the intention of merging FCM746L between NAX3MU and BAW79H (Figure 4).

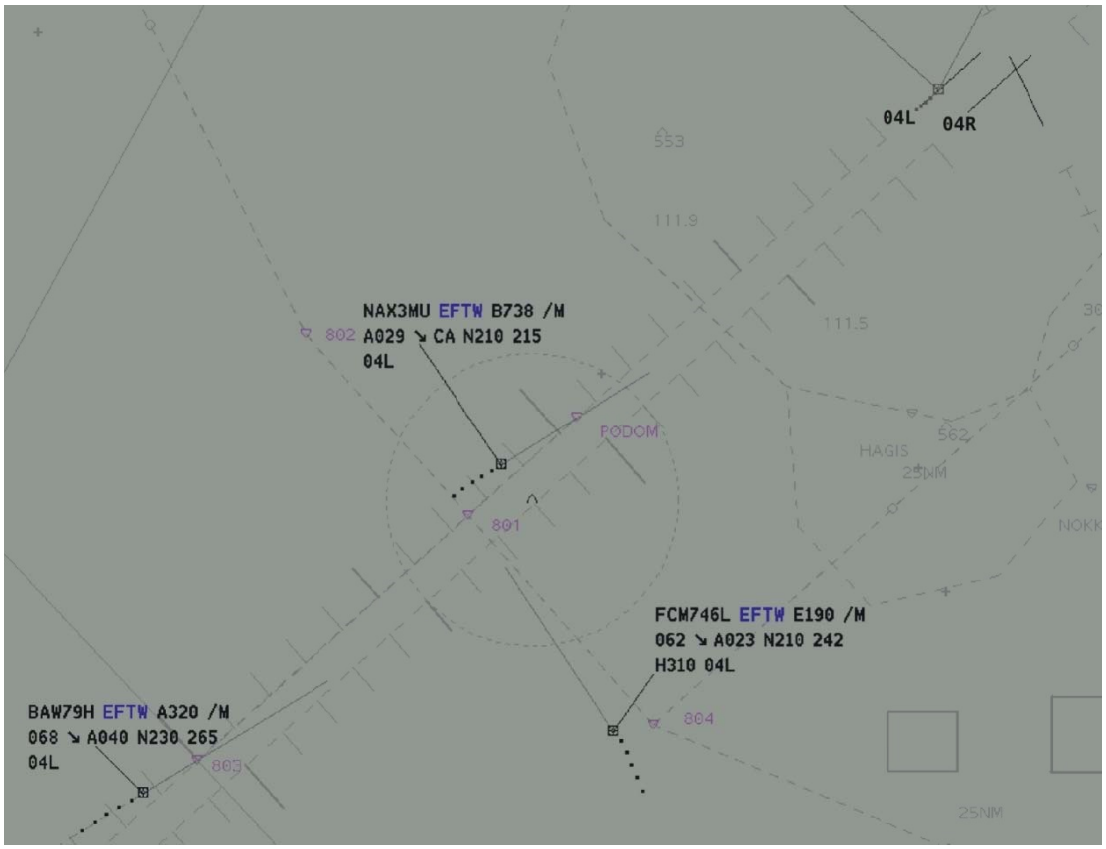

Figure 4. NAX3MU and BAW79H are approaching from the southwest. The distance between them is 10 NM. FCM746L is approaching from the south, maintaining the heading 310 degrees. © Finavia, permission 4/590/2007.

At 16:01:13 ARR-E issued an approach clearance to BAW79H and immediately thereafter to FCM746L. A moment later, as FCM746L was intercepting the final approach course the distance from it to NAX3MU, flying ahead, was 4.6 NM (8.5 km) and to BAW79H, trailing behind, 3.8 NM (7 km). Because of their diverging airspeeds the distances between the aircraft continued to decrease (Figure 5).

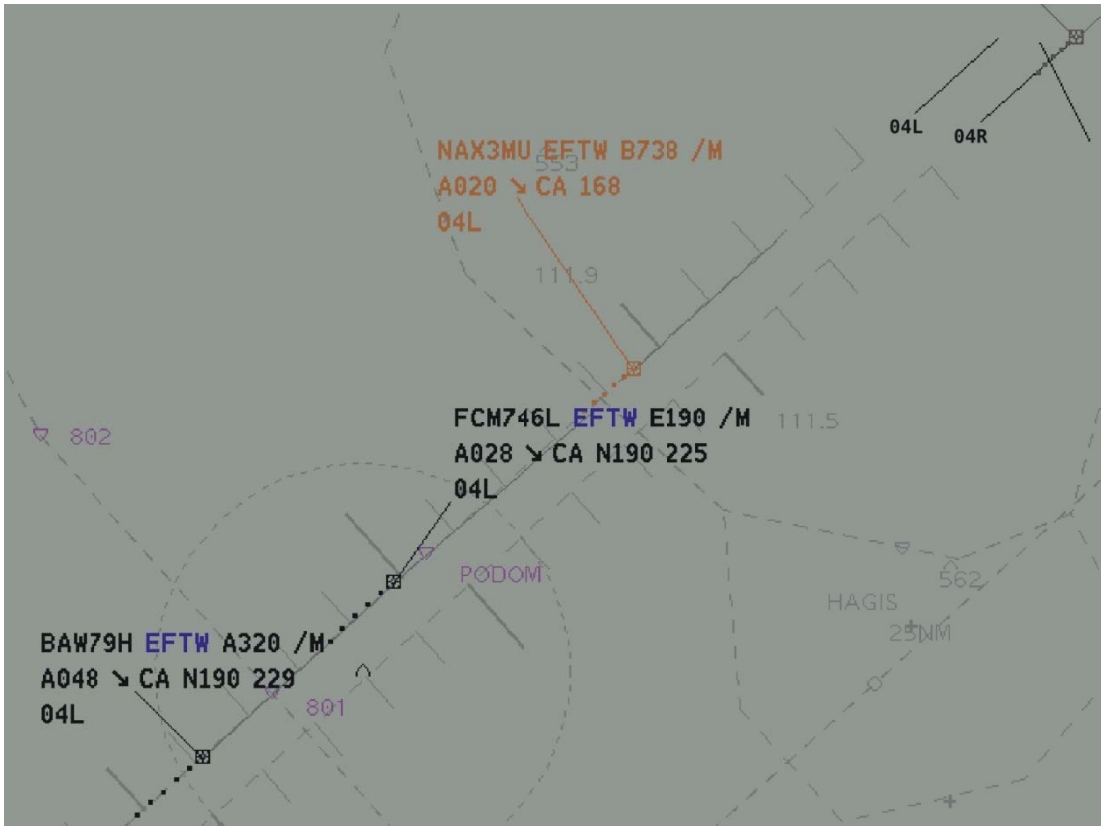

Figure 5. FCM746L intercepts the final approach course.
© Finavia, permission 4/590/2007.

AT 16:01:46 ARR-E told NAX3MU to contact TWR-W. Following the contact, TWR-W issued a landing clearance to it.

Initially, ARR-E reduced FCM746L's speed to 210 KT and then to 190 KT, 170 KT and 160 KT. At 16:04:02 ARR-E told it to contact TWR-W. At that time the distance from FCM746L to NAX3MU, flying ahead, was 3.2 NM (5.9 km) and to BAW79H, trailing behind, 3.1 NM (5.7 km). FCM746L contacted TWR-W which replied "… you are number two, number one is half mile from touchdown, so expect late landing clearance".

When BAW79H contacted ARR-E it was reducing its speed to 230 KT. ARR-E further reduced its speed to 210 KT, 190 KT, 180 KT, 170 KT, 160 KT and to minimum approach speed. At 16:04:50 BAW79H was 6 NM from the threshold of RWY 04L, and 2.9 NM from the preceding FCM746L (Figure 6).

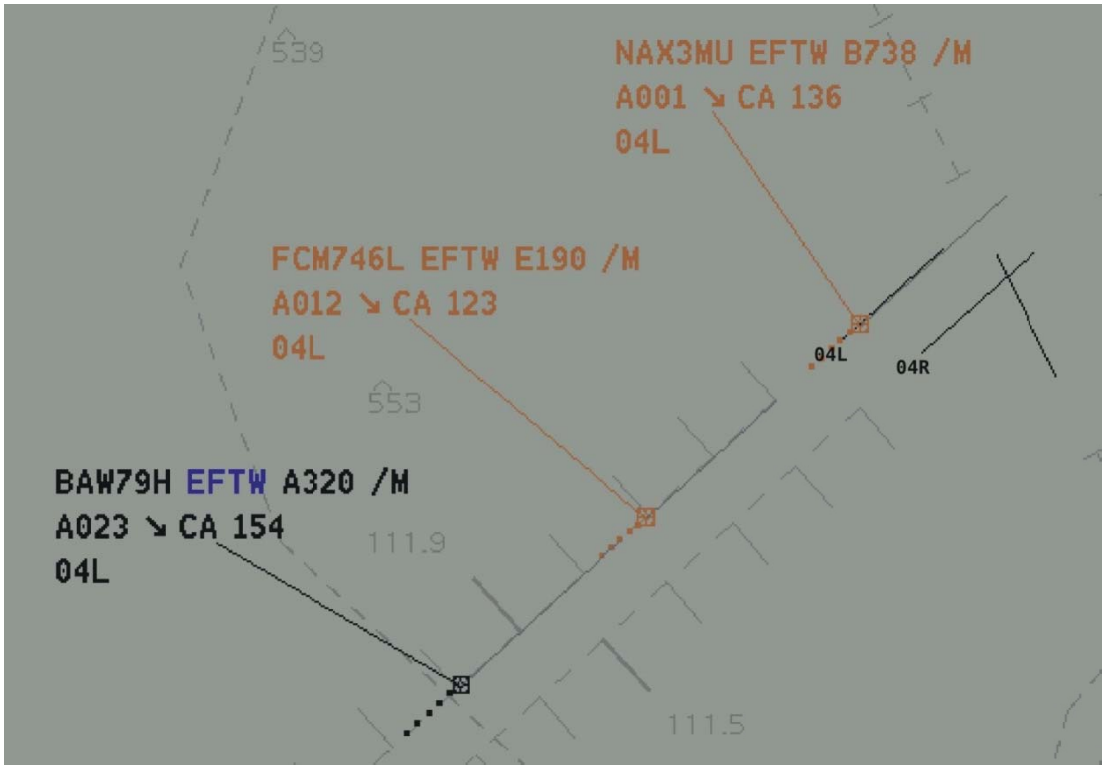

Figure 6. The distance between BAW79H and FCM746L is 2.9 NM. NAX3MU is landing on RWY 04L. The brown colour of the radar labels indicates that ARR-E has transferred the aircraft to TWR-W and that TWR-W has assumed them. © Finavia, permission 4/590/2007.

During NAX3MU's landing roll TWR-W instructed it to turn to the right "when convenient". NAX3MU rolled past both exit taxiways, continuing to taxi towards the end of RWY 04L. At this time TWR-W requested NAX3MU to expedite taxiing because of successive landing traffic.

At 16:05:16 ARR-E informed BAW79H that it was closing on the preceding aircraft and asked whether it could further reduce speed. The pilot replied negatively, stating that they were already flying at the minimum airspeed. At 16:05:57 ARR-E told BAW79H: "…sorry losing separation for the preceding, go around fly heading 040 climb 3000 FT". At that time the distance from BAW79H to FCM746L, flying ahead, was 2.7 NM (5 km) and there were 4 NM (7.4 km) to go to the threshold. When BAW79H aborted its approach it was flying at 1400 ft (420 m). At 16:05:58 ARR-E called TWR-W and reported having called off BAW79H's approach due to an infringement of the required minimum separation.

At 16:06:10 FCM746L was 0.5 NM from the threshold of RWY 04L. The pilot requested a landing clearance from TWR-W, which replied that the runway was still occupied. From 16:06:14 to 16.06:30 TWR-W discussed vacating the runway with the pilots of NAX3MU on its frequency. At 16:06:31 TWR-W issued a landing clearance to FCM746L, who replied that it had aborted the approach. At the time when TWR-W is-

sued the landing clearance it had not confirmed by radio whether NAX3MU had vacated the runway.

From the radar display TWR-W noticed that BAW79H and FCM746L were too close to each other. The controller attempted to increase their mutual distance by telling FCM746L to fly heading 050 so as to prevent it from turning to the left, as per the missed approach procedure. A moment later the controller corrected the heading to 040 degrees after the TWR SUP warned of a flight departing from the adjacent parallel runway.

At 16:06:45 the radar system annunciated a Short Term Conflict Alert (STCA) relating to BAW79H and FCM746L as the distance between them at the time was 2 NM (3.7 km). The succeeding BAW79H was flying 80 KT faster, and there was no vertical separation between them. At 16:06:55 ARR-E told BAW79H to fly to heading 335.

At 16:07:08 TWR-W called ARR-E and informed it that FCM746L was going around, heading 040 degrees. TWR-W urged ARR-E to immediately turn BAW79H to the left, at which time ARR-E told BAW79H to continue turning to the left, heading 310 (Figure 7), and a moment later, to heading 280. The minimum distance between BAW79H and FCM746L was 1.5 NM (2.8 km), and at this time they were flying at the same altitude.

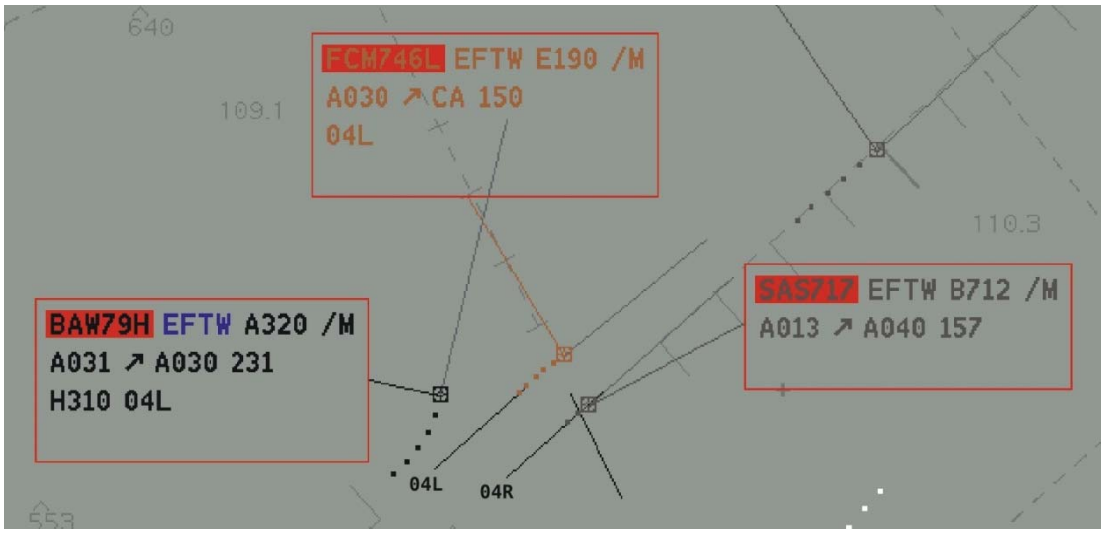

Figure 7. The distance between BAW79H and FCM746L is 1.5 NM. The red SCTA alerts are illuminated. © Finavia, permission 4/590/2007.

FCM746L, maintaining 040 degrees, reached 3000 ft soon after passing the threshold of RWY 04L. At 16:07:20 the radar system annunciated an STCA alert concerning FCM746L and SAS717 which had just departed from RWY 04R (Figure 7). The aircraft flew abreast of each other at the distance of 0.9 NM (1.7 km) for one minute and ten seconds. At 16:07:34 FCM746L requested TWR-W to confirm the heading 040 degrees, at which time TWR-W told it to contact ARR-E (Figure 8).

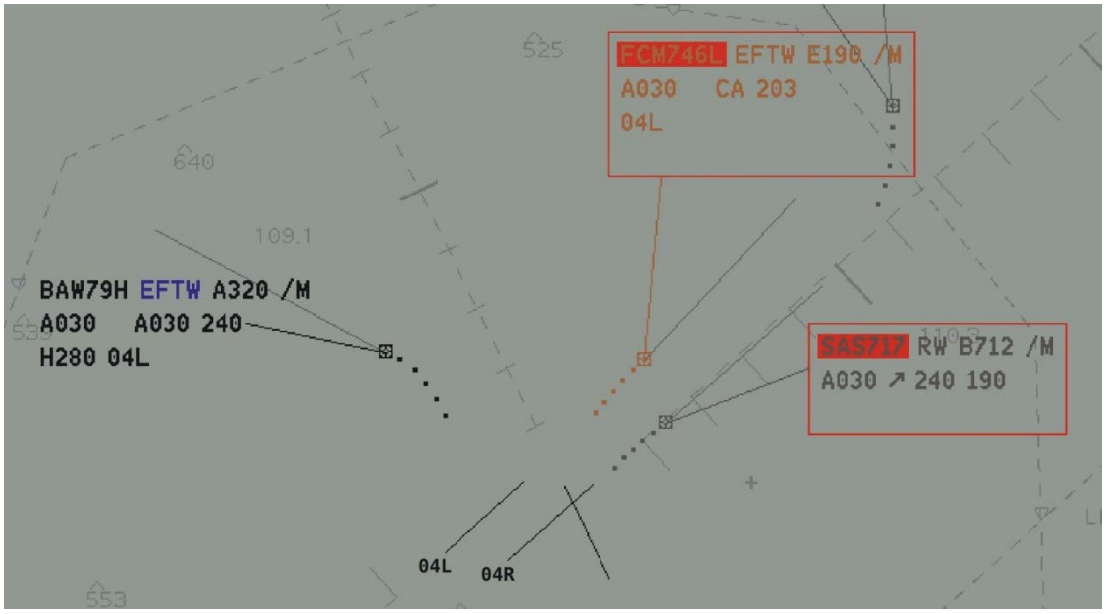

Figure 8. FCM746L and SAS717 flying abreast of each other at the same altitude. STCA alerts are illuminated. © Finavia, permission 4/590/2007.

At 16:07:50 FCM746L contacted ARR-E. After first issuing an approach clearance to another aircraft, at 16:08:01 ARR-E told FCM746L to immediately turn left heading 330. When FCM746L initiated the turn it was 3.5 NM (6.5 km) from the end of RWY 04L. The STCA alert remained on until SAS717 had climbed through 4000 ft.

1.1.6 Action of the tower supervisor (TWR SUP)

The TWR SUP was informed by TWR-W that the distances between the arriving traffic were too short in view of the desired sequencing, meteorological conditions and runway capacity. The TWR SUP notified the approach control supervisor of this.

At 16:06:50 the TWR SUP heard the controller at TWR-W clear FCM746L, flying a missed approach procedure, to turn right heading 050. Being aware of the fact that SAS717 was simultaneously taking off from RWY 04R, the TWR SUP cautioned TWR-W against turning FCM746L to the right. Following this, TWR-W corrected FCM746L's heading to 040 degrees.

1.1.7 Flight crew action

FCM746L (Flybe Finland)

FCM746L was on a scheduled flight from Warsaw (EPWA) to EFHK. At 0.5 NM from the threshold of RWY 04L it asked for a landing clearance: "May we land?". When the reply was negative, FCM746L decided to go around. As the radio frequency was busy the pilot of FCM746L could not immediately inform TWR-W of the go-around.

The pilot of FCM746L asked TWR-W to confirm the heading 040 degrees at which time the controller told FCM746L to contact ARR-E. Following the controller's instruction FCM746L turned to the left heading 330 degrees.

FCM746L made a new approach and landed on RWY 04L at 16:20.

BAW79H (British Airways)

BAW79H was on a scheduled flight from London (EGLL) to EFHK. It contacted RAD-E and reported that it was descending to FL 100 and maintaining "high speed". Following the instruction of RAD-E, BAW79H continued the flight without any speed restrictions. A little later BAW79H was told to reduce speed to 230 KT and contact ARR-E.

Despite the repetitive speed reductions assigned by ARR-E, BAW79H's speed was not reduced enough. Instead, it was closing on the preceding aircraft. When BAW79H was at 4 NM from the threshold of RWY 04L it aborted its approach in accordance with the air traffic controller's clearance.

BAW79H made a new approach and landed on RWY 04L at 16:18.

SAS717 (Scandinavian Airlines)

SAS717 was departing EFHK for a scheduled flight to Stockholm (ESSA). It was cleared for take-off from RWY 04R. Following the take-off SAS717 followed Standard Instrument Departure VETUD 1C, according to which the initial climb is to be flown by tracking the runway heading. Climbing through approximately 3000 ft (900 m) the pilots noticed from their TCAS system that there was another aircraft to their left, flying at the same altitude and the same heading. As per their report, they deduced that it was the aircraft flying a missed approach procedure from RWY 04L. The pilots did not report this observation to the ATC.

NAX3MU (Norwegian)

NAX3MU was on a scheduled flight from Alicante (LEAL) to EFHK. It landed on RWY 04L at 16:04. In the beginning of its landing roll it was told: "NAX3MU, turn right when convenient".

A moment later it was told to expedite taxiing because of another landing aircraft. NAX3MU did not significantly increase its taxiing speed; it vacated the runway through taxiway WG. The controller asked NAX3MU why it had passed one taxiway without using it to vacate the runway. The pilot replied that the runway was extremely slippery.

While NAX3MU was taxiing the pilot and TWR-W discussed vacating the runway, thus occupying the TWR-W radio frequency. The pilot wanted to justify their action over the telephone and so once they parked at the stand the pilot called the TWR and discussed the matter with the TWR SUP.

1.1.8 Missed approach procedure

A missed approach procedure can be initiated by a flight crew or on the command of the ATC. In both instances the flight crew will comply with the procedure published in the instrument approach chart so long as the ATC does not issue an alternate clearance.

According to the ILS chart (EFHK AD 2.13-1) for RWY 04L the missed approach point (MAPt) is over the threshold. The procedure goes as follows: "climb on track 040° until 0.2 NM (370 m) DME HTV or turning altitude 580 ft (175 m), whichever is later. Then left turn onto track 355°".

In accordance with the HK-TKK OPS (6.5.2.11), ARR is to coordinate the situation with TWR if the go-around clearance deviates from that which is published. This applies to situations in which the published missed approach procedure cannot be used, for instance, because of airspace reservations.

TWR is to immediately notify ARR when it observes that an aircraft aborts its approach (HK-TKK OPS 4.5.3.4). TWR can deviate from the published missed approach procedure, should safety so require. TWR must report the issued clearance to ARR.

1.1.9 Separation minima and related responsibility

In accordance with the Helsinki ATC Ops Manual, the minimum horizontal separation used in the radar display in normal circumstances is 3 NM (5.6 km). At the time of the occurrence the system was operating normally. The minimum vertical separation is 1000 ft (300 m).

The minimum horizontal distance between BAW79H and FCM746L was 1.5 NM (2.8 km) and the aircraft were flying at the same altitude.

The horizontal distance from FCM746L to SAS717, while they were flying in the same heading for one minute and ten seconds, was 0.9 NM (1.7 km). During its climb SAS717 passed through the altitude FCM746L was maintaining.

Pursuant to the Manual, the arrival controller is responsible for maintaining the separation minima of arriving aircraft to touchdown (HK-TKK OPS 6.5.2.8). If the TWR controller has visual contact with the arriving aircraft and is able to maintain sufficient distance between them, separation can be terminated. TWR must inform the ARR controller when the meteorological conditions facilitate the termination of separation minima.

Air traffic control responsibility for departing traffic transfers from TWR to RAD when the aircraft climbs through 1300 ft (HK-TKK OPS 4.5.4.7).

1.1.10 Speed control

When it comes to horizontal separation, speed control is a commonplace ATC practice. The approach control normally assigns speed restrictions in Indicated Air Speed (IAS).

In addition to numerical values verbal expressions are also used, such as ”free speed”, “no speed restriction”, “high speed”, “keep up speed”, “minimum clean speed” and “minimum approach speed”. Almost all of these were heard in the radiocommunication recordings during the investigation.

1.1.11 ATC technical systems

Short Term Conflict Alert (STCA) system

The STCA system is a radar-based alerting system that warns of conflicts between aircraft. The purpose of an STCA warning is to guarantee sufficient reaction time for an air traffic controller to prevent a mid-air collision between two aircraft (Eurocat2000 manual 6.1.1).

The STCA alert is indicated to the controller on the radar display by the addition of a red border on the radar label, and by changing the call sign data block’s fill colour to red (Eurocat2000 manual 6.1.1.1). The STCA alerts are visible on all displays, irrespective of the working position which is controlling the flights in question.

The Helsinki ATC Ops Manual does not include any instructions for STCA alerts.

The Maestro traffic flow management system

The Maestro system is a program integrated in the EUROCAT E2000 ATC system. Its sequencing function continually calculates a proposed landing sequence for traffic arriving at EFHK, making certain that the volume of traffic in the TMA does not exceed the runway capacity. The arrival sequence calculated by Maestro is the foundation for traffic flow planning. The final arrival sequence is determined by the traffic situation at hand. RAD plans the preliminary arrival sequence to the landing runway on the basis of Maestro’s proposals. ARR is responsible for the final arrival sequence (HK-TKK OPS 6.5.2.1).

The investigation group requested Maestro’s recordings from Finavia Corp. According to the response received this information is not recorded. Later the response was supplemented with the explanation that while Maestro’s technical log database is available, there is no operational data used by the air traffic controllers. The manufacturer of the system said that the Maestro system does indeed record operational information as well. According to Finavia’s later notification, they normally record operational data as well but, due to a technical malfunction at the time of the occurrence, this information was not available.

1.2 Injuries to persons

There were no injuries to persons.

1.3 Damage to aircraft

There was no damage to aircraft.

1.4 Other damage

There was no other damage.

1.5 Personnel information

1.5.1 Air Traffic Control personnel

Air traffic controller (TWR-W)	Age 45
Licence	Air Traffic Controller's Licence, valid until 16 Mar 2014
Ratings	All required ratings were valid
Language Proficiency, English	LP (Language Proficiency) English level 4
Medical certificate	Air Traffic Controller's medical certificate, valid until 13 Mar 2013.

Air traffic controller (ARR-E)	Age 36
Licence	Air Traffic Controller's Licence, valid until 20 Feb 2013
Ratings	All required ratings were valid
Language Proficiency, English	LP (Language Proficiency) English level 4
Medical certificate	Air Traffic Controller's medical certificate, valid until 23 Aug 2013.

Air traffic controller (TWR SUP)	Age 40
Licence	Air Traffic Controller's Licence, valid until 14 Oct 2015
Ratings	All required ratings were valid
Language Proficiency, English	LP (Language Proficiency) English level 4
Medical certificate	Air Traffic Controller's medical certificate, valid until 30 Sep 2013.

1.6 Aircraft information

FCM746L (Flybe Finland)

Type:	ERJ 190-100 LR
Nationality and registration:	OH-LKO
Manufacturer:	Embraer SA.
Owner:	Finnair Aircraft Finance Ltd
Operator:	Flybe Finland

BAW79H (British Airways)

Type:	A320-232
Nationality and registration:	G-EUUK
Manufacturer:	Airbus S.A.S
Owner/operator:	British Airways PLC

SAS717 (Scandinavian Airlines)

Type:	B717-200
Nationality and registration:	OH-BLQ
Manufacturer:	Boeing Commercial Airplane Group
Owner:	Pembroke Alpha Limited
Operator:	Blue1 Oy

NAX3MU (Norwegian)

Type:	B737-8JP
Nationality and registration:	LN-DYK
Manufacturer:	Boeing Commercial Airplane Group
Owner:	JSA International Aircraft 39046 Ltd
Operator:	Norwegian Air Shuttle ASA

1.7 Meteorological information

During the afternoon snow showers passed over Helsinki-Vantaa airport area, which caused varying visibility and runway conditions.

Aviation Routine Weather Report (METAR) at 15:50

Wind 070 deg 9 KT. Runway Visual Range (RVR) for RWY 04R over 1500 m, increasing. RVR for RWY 22L over 1500 m, no significant change. RVR for RWY 04L 1400 m, no change. Light snow. Mist. Broken clouds at 500 ft (150 m). Temperature -1 °C, dew point -2 °C. QNH 997 hPa. Temporarily: visibility 900 m, snow.

Aviation Routine Weather Report (METAR) at 16:20

Wind 070 deg 9 KT, visibility 800 m, Runway Visual Range (RVR) for RWY 04R over 900 m, variable, RVR over 1500 m during the 10-minute evaluation period, increasing. RVR for RWY 15 over 1000 m, variable, RVR over 1500 m during the 10-minute evaluation period, decreasing. RVR for RWY 22L over 1500 m, decreasing. RVR for RWY 04L 800 m, RVR over 1300 m during the 10-minute evaluation period, variable, no significant change. Snow. Few clouds at 400 ft (120 m), broken clouds at 500 ft (150 m). Temperature -2 °C, dew point -2 °C. QNH 998 hPa. Becoming: visibility 4000 m, light snow.

SNOWTAM at 15:30

A) Aerodrome: EFHK B) Time of observation: 6 Feb 2013 at 15:30 C) RWY 04L F) Type of deposit: dry snow on first third of the runway; dry snow, frozen ruts or ridges on the second and third thirds of the runway G) Mean depth of deposit 1 mm, extent of runway

contamination 100% H) Estimated surface friction is medium on the first and second thirds of the runway; medium to poor on the third third of the runway T) Drifting snow, 100 % of RWY covered F) Edges 5 m, 20 mm deep compacted or rolled snow, 100 % of RWY covered H) Estimated surface friction is poor on edges. Remark: estimated surface friction is medium to poor on taxiways and poor on apron (dry snow and ice).

1.8 Aids to navigation

The investigation group had access to EFHK ATC radar recordings. All aids to navigation functioned normally at the time of the occurrence.

1.9 Communications

The investigation group had access to EFHK ATC radiocommunication and telephone recordings. All communication aids functioned normally at the time of the occurrence.

1.10 Aerodrome information

The Helsinki-Vantaa aerodrome reference point is located at 60°19'02''N, 024°57'48''E, 179 ft MSL (55m). More detailed information is available in the Finnish Aeronautical Information Publication (AIP Finland).

Helsinki-Vantaa aerodrome has the three following runways in use: 04L/22R, 04R/22L and 15/33. In the serious incident pertaining to this investigation the arriving aircraft used RWY 04L, and the departing aircraft used RWY 04R.

1.11 Flight recorders

The investigation did not use any information from the flight recorders.

1.12 Familiarisation with ATC processes and practices

The investigation group visited EFHK air traffic control, studying the processes and practices of the aerodrome control and approach control.

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.

1.16 Tests and research

No tests or research were conducted.

1.17 Organisations and management

Finavia Corporation is a public limited company wholly owned by the Finnish State. Finavia maintains a network of 25 airports and air navigation services covering the entire country. Helsinki-Vantaa is the largest airport in Finland, and the leading transit airport in northern Europe as regards travel between Europe and Asia. Finavia has three subsidiaries: Lentoasemakiinteistöt Oyj, Airpro Oy and RTG Ground Handling Oy. For the purpose of training Finavia Corp runs the Avia College.

No investigation was done on organisations and management.

1.18 Additional information

There is no additional information.

2 ANALYSIS

The investigation applied the Accimap analysis method (Appendix 2).

2.1 Controlling the arriving traffic

2.1.1 Desired sequencing

The approach control supervisor and the TWR SUP had decided that the desired sequencing for arriving traffic was 5 NM (9.3 km). The corresponding value in seconds was put into the Maestro system, which in this case translated to 120 seconds. This was the customary procedure and is in compliance with the instructions. Should the approach control significantly deviate from the agreed sequencing, it may result in go-arounds caused by the runway capacity being exceeded.

Achieving the desired sequence relies on proper coordination between the RAD and ARR working positions. For the most part RADs hand over arriving traffic to the ARR working position in the sequence calculated by Maestro. The RAD working position can deviate from the calculated sequence in order to expedite the flow of traffic. It was for this reason that the plan was to merge FCM746L between NAX3MU and BAW79H. ARR-E continued to implement the plan of RAD-E but, due to their relative speed differences, the desired sequencing was being infringed even at this stage.

2.1.2 Speed control

Controlling the speeds of aircraft is a customary ATC practice in maintaining horizontal separation. Whereas speed control is particularly useful in maintaining already existing separation, it may be too slow a method to achieve separation.

Right before RAD-E told BAW79H to contact ARR-E it told the aircraft to reduce speed to 230 KT. At that time BAW79H was flying 50 KT faster than the preceding NAX3MU. With such a difference in airspeed their mutual distance was decreasing by nearly one NM per minute. RAD-E should have reduced the speeds of BAW79H and FCM746L much earlier, lest their distance to NAX3MU, flying ahead, decrease too much.

RAD-E transferred a traffic situation to ARR-E in which the ARR-E was unable to maintain the 5 NM desired sequencing through speed control. Nonetheless, RAD-E's actions did not cause the infringement of separation minima.

Most of the time, ARR-E reduces aircraft speeds by 10 KT increments. The airspeed reductions should have been carried out more aggressively so as to maintain the needed 3 NM horizontal separation. Airspeeds are displayed on radar track labels from which the air traffic controller can monitor the realisation of assigned speed restrictions.

When BAW79H was at 5 NM from the threshold ARR-E asked whether it could reduce speed even further. The pilot replied negatively. At this stage the distance between

BAW79H and FCM746L was 2.9 NM (5.4 km), and speed control was no longer a viable option in achieving separation.

2.1.3 Efficiency requirements and safety

Characteristic to traffic at Helsinki-Vantaa is first the large number of arrivals, shortly thereafter followed by a greater number of departures. The aim is to control arriving traffic at minimum sequencing so as to maximise the runway capacity.

Air traffic controllers' recurrent training includes controlling arriving traffic at the 3 NM minimum sequences. This is important in order for controllers to be able to control arriving traffic to touchdown without delay. Nevertheless, inexperienced controllers may feel subconscious pressure to aim for the minimum sequencing in all traffic situations and conditions. There must be no conflict between efficiency and safety in air traffic controllers' work. The primacy of safety must be accentuated in instructions and refresher training alike.

2.2 Air Traffic Control action

2.2.1 Action of the ARR-E controller

ARR-E continued the radar vectoring, started by RAD-E, with the intention of merging FCM746L, approaching from the south, between NAX3MU and BAW7H, already on the approach course. It is customary for the approach control to handle corresponding situations through vectoring. Even in this instance the vectoring was successfully completed; the problems were caused by great differences in relative speeds. ARR-E should have early on made the proper situational assessment that speed control alone would not maintain the desired sequencing. The controller should have applied alternative measures in order to preserve adequate separation between the aircraft.

ARR-E's decision-making process was slow as regards solving the situation. Still, the controller had enough time to instigate such measures which would have prevented the infringement of the 3 NM minimum separation. When the controller finally decided to call off the approach of BAW79H the minimum separation to the preceding aircraft had already been infringed. Counter to normal practice, ARR-E vectored BAW79H on the heading 040 to the threshold of RWY 04L, at which time the controller instructed the aircraft to turn to heading 335. Issuing a new heading may have come as a result of an STCA alert which the system had annunciated a moment earlier.

Normally, the aim is to vector aircraft that have aborted their approaches to a new approach as soon as possible, so as to minimise delay. The controller said that the purpose of issuing the 040 heading was to provide the flight crew more time to concentrate on the go-around, which had increased their workload. Moreover, the controller thought that ground obstacles could have posed risks, had they turned to the left any earlier. Also, the workload caused by having to monitor other traffic deflected the controller's attention and delayed the turning of BAW79H.

According to the instructions radar controllers must at all times be aware of the published minimum altitudes in their area of responsibility, and the minimum altitudes which can be used for radar vectoring (LJKK 4.8). BAW79H was flying at a safe altitude and ARR-E should have turned it to the left before the minimum separation to the preceding aircraft was infringed.

ARR-E should have informed TWR-W of the decision to vector BAW79H almost directly over the runway. ARR-E did not consider the possibility that the aircraft on TWR-W's frequency could also abort its approach. The controller should have realised that the clearance issued to BAW79H simultaneously prevented the preceding aircraft from safely executing a missed approach procedure. As a result, the preconditions required for segregated parallel operations were not met (HK-TKK OPS 4.5.13.1). ARR-E should have asked TWR-W to relay an alternate clearance to FCM746L in case of a go-around. Pursuant to instructions the ARR working position must coordinate with the TWR if the go-around clearance deviates from the published instructions, for instance, because of airspace reservations. It is the view of the investigation group that the instructions in the Helsinki ATC Ops Manual that concern missed approaches and non-standard go-arounds are somewhat difficult to understand, and that the associated sections should be clarified (HK-TKK OPS 4.5.3.4 Missed approach, 4.5.3.9 Amended missed approach clearance for an instrument approach, 6.5.2.11 Non-standard go-around clearances).

Even though ARR-E acknowledged having noticed the radar label of FCM746L, initially the controller had thought that it was a false echo. The colour of the label was different than the colour of the controller's own, active radar track labels. Colour changes are to be considered normal system operation. The colour of the label changes when it is transferred to the next working position and that position assumes it. The increasing altitude information in the label of FCM746L should have made the controller deduce that FCM746L had not landed, but rather, it was going around.

It came as a surprise to ARR-E when TWR-W reported that FCM746L, too, was going around. Having received this information ARR-E could have immediately cleared BAW79H to climb to 4000 ft. This would have enabled FCM746L to safely fly the missed approach procedure and climb to 3000 ft. At no stage did the controllers begin to use vertical separations. The radar label of FCM746L was visible at all times, and the STCA alert indicated that there was a conflict with BAW79H.

The ARR-E controller had received a radar rating approximately five months earlier, and the controller's action was somewhat epitomised by inexperience. At times it was difficult for the controller to change a decision. It is typical that humans only reluctantly change decisions in which they have invested a lot of resources. The closer the goal, the higher the resistance.

The traffic situation became complex and the ARR-E controller no longer necessarily grasped the big picture. Thorough situational awareness requires abundant information processing capacity – a scarce resource in stressful situations. Stress may affect action in such a manner that it becomes reactive, i.e. one reacts to events as they keep hap-

pening. It is no longer possible to observe the situation in a comprehensive manner, nor can one anticipate or plan future events. The stress experienced in the situation also easily leads to abandoning any active exploration of alternative solutions.

2.2.2 Action of the TWR-W controller

TWR-W noticed that NAX3MU, FCM746L and BAW79H were approaching, closer to each other than at the agreed desired sequencing. The controller reported this to the TWR SUP who then called the supervisor at the approach control and requested more extended sequencing. However, as the flights were already in the final approach phase, the request had negligible effect. In order to expedite the flow of information TWR-W should have directly called the ARR-E controller and reported that TWR-W could not assume arriving flights at such short sequences.

Despite the short distance to the succeeding aircraft, TWR-W permitted the first-to-land NAX3MU to turn right off the runway "when convenient". This contained the risk that, in snowy weather, the pilots would use the entire length of the runway, just as happened this time. A moment later the controller corrected the taxi clearance by asking the pilots to expedite vacating the runway because of another aircraft on short final. By allowing NAX3MU to vacate the runway when convenient, the controller was not sufficiently taking the traffic situation into account. In this traffic situation TWR-W should have already included the instruction to vacate the runway as soon as possible in NAX3MU's landing clearance. Misunderstandings in vacating the runway could be avoided by using the taxiway designator and correct phraseology.

The aircraft that had landed a little earlier had either vacated the runway through the exit taxiways or from the end of the runway on the controller's permission. Therefore, the controller may have assumed that this situation, too, would clear itself out without any problems.

As the radio frequency of TWR-W was occupied by the conversation between the controller and NAX3MU, FCM746L could not report having aborted its approach any earlier. This is possibly why the pilots had not yet initiated the turn to track 355, as per the missed approach procedure. TWR-W should have concentrated on controlling the traffic and left the conversation with NAX3MU to a later time. TWR-W should have immediately reported to ARR-E that FCM746L was going around; this would have given the controllers more time to agree on the clearance to be issued to FCM746L. TWR-W could also have independently cleared FCM746L to climb to 2000 ft and follow the missed approach procedure's track 355 degrees, because from the radar display the controller could have spotted that BAW79H had already reached 3000 ft.

The air traffic controller focused too much attention on the conversation with NAX3MU about vacating the runway. Approximately 60 seconds after FCM746L aborted its approach TWR-W reported to ARR-E that this had happened. At this stage FCM746L was above the end of RWY 04L, reaching 3000 ft. It would have been of utmost importance to immediately report the missed approach. According to the instructions TWR must

immediately notify ARR when it observes that an aircraft has aborted its approach and initiated a go-around. When a go-around occurs, TWR and ARR agree on the frequency to which the aircraft will be transferred (HK-TKK OPS 4.5.3.4).

The aerodrome controller cleared FCM746L to land without first making certain that NAX3MU had vacated the runway. As TWR-W did not have visual contact with NAX3MU, nor had the controller ascertained over the radio that NAX3MU had indeed vacated the runway, the controller was in no position to clear FCM746L to land. Pursuant to the Finnish Air Traffic Control Manual, the Surface Movement Radar is used as an aid in guaranteeing the safe control of traffic. Using the system does not alter the air traffic control's separation responsibilities, nor can it be used to ascertain that the runway is free when clearing an aircraft onto the runway after another one which has landed/departed (HK-TKK OPS 5.2.7).

TWR-W issued the headings 050 and 040 to FCM746L, which was going around; the headings deviated from the published procedure. This can be considered as justified when BAW79H was 1.5 NM from FCM746L at its closest, and compliance with the published procedure could have put FCM746L in front of BAW79H, coming from behind. Nonetheless, the headings that TWR-W issued to FCM746L led to the situation that the preconditions for segregated parallel operations were no longer met. For this reason, FCM746L's distance to the aircraft that departed from the adjacent parallel runway clearly infringed the required minimum separation. According to the instructions TWR can deviate from the published missed approach procedure, should safety so require (HK-TKK OPS 4.5.3.4).

2.2.3 Coordination between ATC working positions

The ARR-E controller was primarily responsible for coordinating the traffic situation. The controller managed the flow of arriving traffic and remained responsible for the separation of arriving aircraft all the way to touchdown. Even though ARR-E called TWR-W over the phone and reported having called off the approach of BAW79H, ARR-E did not tell TWR-E the details of the clearance, which prevented FCM746L from safely executing the missed approach procedure. At this juncture ARR-E should have provided TWR-W with an alternate clearance in view of a potential go-around.

ARR-E's tasks included vectoring aircraft that had executed a missed approach procedure to a new approach. TWR-W called ARR-E and reported that FCM746L had initiated a go-around and that its assigned heading was 040 degrees. During that phone call ARR-E should also have given TWR-E instructions on how to establish proper separation between FCM746L and SAS717. Then again, TWR-W could also have asked for such an instruction.

When it comes to this case, the air traffic controllers at ARR-E and TWR-W played leading roles. They held two short telephone conversations during which they could have agreed on the measures to achieve proper separation. However, the content of these phone calls was unsatisfactory in this regard.

Segregated parallel operations rely on instructions and practised work processes. Any deviation from the normal procedure may preclude the use of segregated parallel operations. In such a case the controller must provide separation between his aircraft and that being controlled by another air traffic controller. In such a traffic situation it may become useful to abandon the so-called "silent coordination" process and coordinate the situation between working positions over the telephone.

In summarising the air traffic controllers' action it can be stated that it is impossible to prepare instructions for every conceivable traffic situation. Air traffic controllers must also be able to apply their expertise in providing separation between aircraft in traffic situations that are outside the normal routine.

2.3 Use of ATC systems and equipment

2.3.1 Action during the STCA alert

The ATC system annunciated an STCA alert concerning BAW79H and FCM746L at 16:06:45. A moment later ARR-E told BAW79H to turn to the left. This may have happened because of the STCA alert, even though TWR-W had not yet reported that FCM746L, i.e. the other party to the conflict, had initiated a go-around. A little later the system also annunciated an alert concerning FCM746L and SAS717.

The RAD-W controller was responsible for traffic departing from RWY 04R. Upon noticing that the STCA raised an alert for SAS717, controlled by RAD-W, and FCM746L which was going around, the controller asked whether ARR-E's intention was to turn FCM746L to the left. ARR-E said yes, although FCM746L was not even on the radio frequency of ARR-E at that stage.

The distance from FCM746L to SAS717 was only 0.9 NM (1.5 km) and the STCA alert had activated. Since extending the distance between the two aircraft was the most important task, RAD-W considered vectoring SAS717 to the right. And yet, no immediate action was taken to establish separation. When ARR-E finally turned FCM746L to the left, SAS717 was already climbing through 4000 ft and the STCA alert had expired.

Nuisance STCA alerts had previously appeared in the ATC system at EFHK. However, following reparameterisation the system has been operating appropriately. In this occurrence all working positions spotted the STCA alerts, but were slow to react to them. The investigation revealed that controllers are somewhat unfamiliar with the fundamental features of STCA alerts. For example, they assumed that STCA alerts indicate an impending infringement of separation minima.

The ATC instructions on STCA alerts should be augmented at EFHK. At present, the instructions mainly illustrate the technical features of the system. In addition, the instructions should include the immediate action that the air traffic controllers must take when they observe an STCA alert. The European air navigation service organisation *Eurocontrol* has published the document "Guidance Material for Short Term Conflict Alert" addressing the STCA system. The guide details, among other things, what the STCA train-

ing curriculum for air traffic controllers should include. According to Eurocontrol the training must cover the controller's actions during STCA alerts. Likewise, all parameter changes must also be trained. It is the opinion of the investigation group that the STCA instructions at EFHK must include the operational instructions, and that the controllers must be trained on them as soon as possible.

2.3.2 Using the features of the radar display

Helsinki ATC uses electronic flight strips and electronic data transfer. The system requires that the radar track labels are continually updated. Labels are reactivated so that controllers can enter their clearances, such as heading or altitude, into the label. The ARR-E controller tried to reactivate the label of FCM746L, which was going around, back to the ARR-E position, to no avail. The other controllers working at the approach control also tried to assist ARR-E in reactivating the label. They, too, failed to do so. Nonetheless, ARR-E could have issued instructions and clearances to FCM746L regardless of whether the label was activated or not. Achieving separation was the most important task for the controller, and in this case the system update could have been done later.

The use of infrequently encountered technical features may take too much time and deflect the controller's attention in a stressful situation. In such cases essential instructions to aircraft may be delayed. In situations outside the normal routine controllers should still be able to prioritise their actions by first guaranteeing the safety of aviation, followed by system updating.

2.4 Flight crew action

The investigation group had access to the pilots' occurrence reports. The investigation did not set up any flight crew interviews. In addition to the occurrence reports the evaluation of flight crew action is based on radar and communications recordings.

Several speed restrictions were assigned to the aircraft during their approach. Initially, BAW79H flew with unrestricted speed; the first speed reduction was issued when the aircraft was transferred to the frequency of ARR-E. In order to stay within the approach profile in relation to altitude, BAW79H was not able to reduce speed fast enough to the value assigned by the controller. Because of the further speed restrictions that followed in rapid succession the aircraft never reached its assigned airspeed.

The taxi instructions to NAX3MU were confusing. First, they were allowed to vacate the runway "when convenient", but a moment later they were requested to expedite taxiing. NAX3MU reported that the runway was slippery and that they were unable to expedite taxiing any further. Because of the controller's instructions and the slippery runway NAX3MU occupied the runway longer than normally. Later, in a conversation with TWR-W, the pilot said that they could have vacated the runway earlier, if only the controller had issued such an instruction at an earlier stage.

Judging by the recorded information the flight crews followed the controllers' clearances and instructions.

2.5 The effect of weather

It was snowing at EFHK, which impacted both visibility and runway conditions. The snow intensity varied significantly. While at times aerodrome control TWR had visual contact with RWY 04L, at the time of the occurrence this was not the case. The estimated friction coefficients on RWY 04L were still fairly good and the aircraft that landed vacated the runway through exit taxiways unless otherwise instructed by aerodrome control TWR.

It came up in the interviews that the approach controllers had estimated that winds were stronger and more straight-ahead at low altitudes than what the reported wind data stated. If headwind increases at the final stage of an approach it impacts the reduction of speed and may cause shorter sequencing between aircraft than planned. None of the examined meteorological information or actual wind data measured by aircraft during their approach supported the approach controllers' assumption.

The weather had no bearing on the onset of the incidents.

3 CONCLUSIONS

3.1 Findings

1. The air traffic controllers had the required licences and ratings.

2. The required working positions at EFHK approach control and aerodrome control TWR were manned.

3. Runway 04L was used for arrivals and RWY 04R for departures.

4. It was snowing and visibility varied significantly.

5. The approach control supervisor and the TWR SUP had decided that the desired sequencing for arriving traffic was 5 NM (9.3 km).

6. The ARR-E controller vectored the arriving aircraft to the final approach course.

7. The airliners NAX3MU, FCM746L and BAW79H were approaching RWY 04L, following each other.

8. Even though the 5 NM desired sequencing was clearly about to be infringed, the arrival controller transferred NAX3MU and FCM746L to the TWR frequency.

9. The TWR controller cleared NAX3MU to land on RWY 04L.

10. Following the landing the TWR controller told NAX3MU that it could vacate RWY 04L when convenient.

11. A moment later the TWR controller urged NAX3MU to expedite taxiing because of another aircraft on short final.

12. Because the runway was slippery NAX3MU taxied all the way to the end of RWY 04L and vacated the runway through taxiway WG.

13. The arrival controller told BAW79H to gradually reduce speed to its minimum approach speed.

14. Because the minimum separation had been infringed the arrival controller told BAW79H to go around and issued a clearance to fly heading 040 degrees and climb to 3000 ft (900 m).

15. While over the threshold of RWY 04L the flight crew of FCM746L decided to go around because the aerodrome TWR controller had not issued them a landing clearance.

16. The ATC system warned the air traffic controllers of a potential collision between BAW79H and FCM746L by annunciating an STCA alert.

17. BAW79H was at the threshold of RWY 04L when the arrival controller told it to turn left heading 335 so as to achieve separation.

18. At first the TWR controller cleared FCM746L to heading 050, but corrected the heading to 040 degrees a moment later.

19. SAS717 took off from RWY 04R and followed Standard Instrument Departure VE-TUD 1C.

20. The ATC system warned the air traffic controllers of a potential collision between SAS717 and FCM746L by annunciating an STCA alert.

21. The required separation minima were infringed between BAW79H and FCM746L, and between FCM746L and SAS717.

22. The aircraft involved in the incident were on different radio frequencies.

23. The arrival controller told BAW79H to turn further left heading 280, which achieved separation between BAW79H and FCM746L. The arrival controller vectored BAW79H to a new approach.

24. SAS717 climbed through the altitude FCM746L was maintaining and reached 4000 ft, at which time separation between these two aircraft was achieved. Following this the arrival controller vectored FCM746L to a new approach.

25. The shift supervisors relieved the air traffic controllers involved in the incident from their working positions.

26. During the same day the air traffic controllers involved in the incident participated in a Critical Incident Stress Management (CISM) defusing session, led by a CISM peer support person.

27. Pursuant to the ESARR2 severity classification (Eurocontrol Safety Regulatory Requirement, ESARR) the severity of this occurrence is “Serious incident” (A).

3.2 Probable cause and contributing factors

The serious incident between British Airways (BAW79H) and Flybe Finland (FCM746L) flights developed when, after having told the British Airways flight to go around, the arrival controller cleared it to maintain heading 040. As a result, the aircraft passed almost directly above RWY 04L. For this reason the Flybe Finland flight no longer had sufficient airspace for flying a missed approach procedure in accordance with the published procedure.

The serious incident between Flybe Finland and Scandinavian Airlines (SAS717) flights developed when, after the Flybe Finland flight had aborted its approach, the TWR controller first cleared it to fly heading 050, and a little later heading 040. As a result of this the Flybe Finland flight, flying on the extended centreline of RWY04L, flew too close to the Scandinavian Airlines flight that had departed from the adjacent parallel runway.

Contributing factors included the arrival controller's delayed decision-making in an untypical traffic situation, the TWR and APP controllers failing to prioritise their tasks, and shortcomings in coordination between the ATC's working positions.

4 SAFETY RECOMMENDATIONS

4.1 Safety recommendations

1. Helsinki-Vantaa ATC instructions describe the technical features of the Short Term Conflict Alert (STCA) system, and how the alert is annunciated on the air traffic controller's radar display. The investigation revealed that controllers are somewhat unfamiliar with the features of STCA alerts. Among other things, Eurocontrol's document "Guidance Material for STCA" requires that STCA training include operational instructions during STCA alerts.

   Safety Investigation Authority, Finland recommends that Finavia Corporation augment the Helsinki-Vantaa ATC Ops Manual with an operational instruction in case of an STCA alert.

2. The Surface Movement Radar (SMR) is used at Helsinki-Vantaa as an aid in guaranteeing the safe control of traffic. The investigation revealed that the system may also have been used in establishing that the runway is free without confirming the matter over the radio. Using the SMR does not alter the air traffic control's separation responsibilities, nor can it be used to ascertain that the runway is free when clearing an aircraft onto the runway after another one which has landed/departed (HK-TKK OPS 53)[2].

   Safety Investigation Authority, Finland recommends that Finavia Corporation take measures which make it possible to use the SMR at Helsinki-Vantaa ATC to ascertain that the runway is free when clearing an aircraft onto the runway after another one which has landed/departed.

3. The instructions that concern missed approaches and non-standard go-around clearances in the Helsinki ATC Ops Manual are difficult to understand and presented in a somewhat unsatisfactory manner (HK-TKK OPS 4.5.3.4 Missed approach, 4.5.3.9 Amended missed approach clearance for an instrument approach, 6.5.2.11 Non-standard go-around clearances).

   Safety Investigation Authority, Finland recommends that Finavia Corporation specify and augment the instructions in the Helsinki ATC Ops Manual as regards missed approaches and non-standard go-around clearances.

[2] Helsinki-Vantaa ATC Ops Manual

4. Segregated parallel operations (one runway reserved for arrivals and the other runway for departures) are used on a daily basis at Helsinki-Vantaa. However, segregated parallel operations are not regulated at the same degree of specificity as independent parallel approaches. In the Helsinki ATC Ops Manual the latter provide, among other things, instructions on achieving separation between a "threatened" aircraft (closer than 3 NM) and an aircraft that has deviated from its approach course.

   Safety Investigation Authority, Finland recommends that Finavia Corporation specify the instructions on segregated parallel operations with regard to when the criteria of segregated parallel operations are no longer met.

4.2 Other observations and proposals

The ARR-E controller tried to reactivate the radar label of FCM746L, which the TWR-E had assumed, to no avail. The other controllers working at the approach control also tried to assist the ARR-E controller in the reactivation. They, too, failed to do so. Even though this feature is trained and practised in the simulator, they were not able to use it in a demanding situation. This feature must be readdressed in the controllers' refresher training.

The investigation revealed that the 5 NM desired sequencing was not followed. The purpose of desired sequencing is to make certain that runway capacity is not exceeded. Primarily, RAD plans the preliminary arrival sequence on the basis of the Maestro system's proposals and ARR vectors the aircraft for an approach at the desired sequencing (HK-TKK OPS 6.5.2.4). Compliance with desired sequencing must be emphasised and any deviations from it must be pre-approved by the working position that assumes the traffic.

When the ATC issues instructions for vacating the runway, it should use the taxiway designator and correct phraseology in order to avoid misunderstandings.

ARR-E and TWR-W held two telephone conversations during the situation. In these conversations they should have agreed on the clearances to be issued to the aircraft involved in the incident. This, however, was not done. Coordination between working positions should receive extra attention in a traffic situation which is outside normal routine, when electronic data transfers no longer suffice.

Helsinki 27.1.2014

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Appendix 1

SUMMARY OF THE COMMENTS ON THE DRAFT FINAL REPORT

FINAVIA CORPORATION

Whereas Safety Investigation Authority, Finland (SIAF) categorises the occurrence as a "serious incident" (A), Finavia rates it as a "major incident" (B). Instead of applying the ESARR2 assessment method used by SIAF, Finavia employs the Risk Analysis Tool (RAT) in assessing severity. Finavia believes that the RAT is a more advanced assessment method because it also takes into account the rate of closure in addition to horizontal separation.

ACCIDENT INVESTIGATION BOARD NORWAY (AIBN)

The AIBN recommend that the importance of correct phraseology be mentioned in the report. In addition, the AIBN recommend that SIAF mention the advantage of letting the aircrew fly the standard missed approach procedure so as to minimise the workload in the cockpit by taking advantage of the preloaded automation in modern aircraft flight management and autopilot systems. Furthermore, the AIBN emphasise that controlling traffic is the ATC controllers' primary responsibility, rather than updating electronic systems.

FINNISH TRANSPORT SAFETY AGENCY (TRAFI)

No comments.

EUROPEAN AVIATION SAFETY AGENCY (EASA)

No comments.

UK AIR ACCIDENTS INVESTIGATION BRANCH (UK AAIB)

No comments.

FLYBE FINLAND

No comments.

BLUE1

No comments.

NORWEGIAN AIR SHUTTLE

No comments.

BRITISH AIRWAYS

No comments.

Appendix 2

The Accimap analysis method