FINLAND

Aircraft Incident Report

B 8/1997 L

B 8a/1997 L

Translation of the Finnish original report

ATC incidents near Vihti VOR radio beacon on 25.10.1997 and 20.8.1997, Finland

October 25, 1997
OH-LMW, DC-9-82

OH-LYS, DC-9-51

August 20, 1997
OH-LYZ, DC-9-51

OH-LYO, DC-9-51

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ABBREVIATIONS

ACC	Area control centre or area control
AIP	Aeronautical information publication
APP	Approach control office or approach control or approach control services
ARR	Arrive or arrival
ATC	Air traffic control (in general)
ATS	Air traffic services
CTA	Control area
CTR	Control zone
CRM	Crew resource management
CVR	Cockpit voice recorder
DEP	Depart or departure
DME	Distance measuring equipment
EETT	Tallinn Airport
EFES	Air Navigation Services Center for Southern Finland
EFHF	Helsinki-Malmi Airport
EFHK	Helsinki-Vantaa Airport
FDR	Flight data recorder
FIR	Flight information region
FL	Flight level
FT, ft	Feet (dimensional unit)
GND	Ground
hPa	Hectopascal

ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
LJKK	National manual of Air Traffic Control instructions
M, m	Meters
MHz	Megahertz
MSSR	Monopulse secondary surveillance radar
NM, nm	Nautical miles
QNH	Altimeter sub-scale setting to obtain elevation when on the ground
RCC	Rescue co-ordination centre
RTF	Radiotelephony
RWY	Runway
SID	Standard instrument departure (chart)
SSR	Secondary surveillance radar
STAR	Standard instrument arrival (chart)
STD, std	Standard
TAF	Aerodrome forecast
TAR	Terminal area surveillance radar
TMA	Terminal control area
TWR	Aerodrome control tower or aerodrome control
UIR	Upper flight information region
UTC	Co-ordinated Universal Time
VOR	VHF omnidirectional radio range
VTT	Technical Research Centre of Finland

DEFINITIONS

Aerodrome control tower

A unit established to provide air traffic control service for aerodrome traffic.

AIP, Aeronautical Information Publication

A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.

Air traffic

All aircraft in flight or operating on the manoeuvring area of an aerodrome.

Air traffic control clearance

Authorization for an aircraft to proceed under conditions specified by an air traffic control unit.

Note 1.- For convenience, the term "air traffic control clearance" is frequently abbreviated to "clearance" when used in appropriate contexts.

Note 2.- The abbreviated term "clearance " may be prefixed by the words "taxi", "take-off", "departure" "en route" "approach" or "landing" to indicate the particular portion of flight to which the air traffic control clearance relates.

Air traffic control service

A service provided for the purpose of:

a) preventing collisions :

1) between aircraft, and

2) on the manoeuvring area between aircraft and obstructions, and

b) expediting and maintaining an orderly flow of air traffic.

Air traffic control unit

A generic term meaning variously, area control centre, approach control office or aerodrome control.

ATS, Air traffic service

A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

Approach control office

A unit established to provide air traffic control service to controlled flights arriving at, or departing from, one or more aerodromes.
Additionally for Helsinki-Vantaa Approach Control the following terms are used when referring to a particular control position or radar controller:

ARR	Arrival controller or radar director
COR	Co-ordinator
DEP	Departure controller

Area control centre

A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

Clearance limit

The point to which an aircraft is granted an air traffic control clearance.

Control area

A controlled airspace extending upwards from a specified limit above the earth.

Controlled flight

Any flight which is subject to an air traffic control clearance.

Danger area

An airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

EFES-2+ device (Pommery)

A communication system between Tampere ACC and other ATC units, which makes possibie so-called quiet requests and acknowledgements of clearances.

Eurocontrol (European Organisation for the Safety of Air Navigation)

The unit which is responsible for planning and co-ordination of air navigation in Europe.

Flight level

A surface of constant atmospheric pressure which is related to a specific pressure datum, 1013.2 hectopascals (hPa) and is separated from other such surfaces by specific pressure intervals.

Heading

The direction in which the longitudinal axis of an aircraft is pointed, usually expressed in degrees from North (true, magnetic, compass or grid).

Prohibited area

An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited.

Radar control

Term is used to indicate that radar-derived information is employed directly in the provision of air traffic control service.

Radar monitoring

The use of radar for the purpose of providing aircraft with information and advice relative to significant deviations from nominal flight path, inciuding deviations from the terms of their air traffic control clearances.

Radar vectoring

Provision of navigational guidance to aircraft in the form of specific headings based on the use of radar.

Restricted area

An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions.

Separation

There is no official definition for this term. Separation means internationally agreed minimum safety limits, both horizontal and vertical, between aircraft flying controlled flights or between them and restrictive airspace areas. The vertical minimum safety limit is known as verticai separation and the horizontai minimum safety limit as horizontal separation.

Terminal control area

A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

SYNOPSIS

On Saturday 25 October 1997 at 12.23 local time east of Vihti VOR there was an air incident which endangered flight safety. The incident concerned two aircraft owned and used by Finnair. The aircraft were a DC-9-82 registered OH-LMW and a DC-9-51 registered OH-LYS. The first one was flying the scheduled flight AY836 from London to Helsinki and the second one the scheduled flight AY365 from Helsinki to Oulu. The incident took place at an altitude of about 10.000 ft when the aircraft passed each other on intersecting flight paths below separation minimums. According to the flight data recorders the vertical distance between the aircraft was about 300 ft at the moment of intersection. There were 152 people on board in all.

The Accident lnvestigation Board (AIB), Finland appointed on 28 October 1997 by letter No. B 8/1997 L an investigation commission to investigate the incident in accordance with the Finnish legisiation on investigation of accidents. Colonel (ret.) Mr Jouko Koskimies was appointed investigator-in-charge. Airline pilot (ret.) Mr Jussi Haila, air traffic controller Mr Ari Huhtala and psychologist, Ph.D. Ms Leena Norros were appointed members of the commission. The investigation commission began the investigations on 28 October 1997. All parties concerned with the incident were heard between 17 November 1997 and 10 December 1997 in Helsinki and Vantaa. The first briefing for media representatives was arranged on 13 November 1997 at the Accident Investigation Board.

On Wednesday 20 August 1997 at 19.20 local time south of Vihti VOR there was an air incident which endangered flight safety. The incident concerned two aircraft owned and used by Finnair. The aircraft were a DC-9-51 registered OH-LYO and a DC-9-51 registered OH-LYZ. The first one was flying a scheduled flight AY646 from Stockholm to Helsinki and the second one was on a training flight AY9803 from Helsinki to Turku. The aircraft would have passed each other below separation minimums, if the air traffic controller in charge had not ordered the corrective clearances, actually fairly late. However, the AY9803 took an avoiding manoeuvre. There were 8 people on board in all.

The Accident lnvestigation Board considered that the incident was similar to the incident on 25 October 1997 and appointed on 13 November 1997 by letter no. B 8a/1997 L the abovementioned commission to investigate the incident. The investigations had been started by the Flight Safety Authority (FSA) of the Finnish Civil Aviation Administration (FCAA) and were continued by the Accident lnvestigation Board. The investigation began on 13 November 1997. All parties concerned with the incident were heard between 17 November 1997 and 10 December 1997.

The investigation is done according the case-based method and the chain of events leading to the incident is explained separately for both cases. Factual information, analysis and causes of the incidents are contained in parts 1 and 2.

On the basis of the investigations the operation of Helsinki-Vantaa APP was studied and the results are shown in part 3. Research methods developed by VTT Automation were used in this study.
The safety recommendations of the commission are given in part 4.

The final draft of the investigation report was sent according the legisiation to the FCAA for comments on 9 June 1998. Comments were received on 9 July 1998 and they have been taken into account in the report.

1 ATC INCIDENT EAST OF VIHTI VOR RADIO BEACON ON 25 OCTOBER 1997

1.1 FACTUAL INFORMATION

1.1.1 History of the flight

The course of events was as follows (local time):

AY365 (DC-9-51) departed from Helsinki-Vantaa airport rwy 22 to Oulu at 12.16 local time and followed the standard departure route TENNI 1 E. The aircraft was cleared to climb to flight level (FL) 250 at 12.18 by the radar controller (COR). Then the controller issued clearances to two other aircraft.

At 12.19 the controller cleared AY836 (DC-9-82) coming from London to Helsinki-Vantaa to descend to FL 110 and to maintain heading 0750. The controller then, at about 12.20, recleared AY365 to FL 140.

During the next minute the controller issued clearances to three other aircraft.

At 12.22 AY836 reported reaching and maintaining FL 110. Simultaneously the controller vectored two aircraft for ILS-approach to Helsinki-Vantaa rwy 22.

At 12.23 AY365 was still climbing to FL 140 about 3 nm southeast of Vihti VOR and started a right turn according to the standard departure route. Simultaneously, AY836 passed Vihti VOR at FL 110. The flight paths of the aircraft were intersecting and AY365 was cleared through the flight level of AY 836. At 12.23 the controller issued a flight level clearance to AY213, which was flying westwards west of Vihti VOR. At this moment she noticed a threat of conflict between AY836 and AY365, and ordered twice AY365 to maintain FL 100. The aircraft acknowledged the clearance and reported descending to FL 100. At the moment of the order, AY365 had already climbed to FL 104 and continued up to FL 107 before the captain was able to stop the climb and start to descend. At the same time the crew saw from the left corner window AY836 passing above. The AY836 crew had understood the situation from radio traffic and noticed a turning DC-9 which was below them at the right-hand side approaching from the direction of Helsinki. The AY836 captain estimated that the aircraft would pass each other very closely but that there would not be any danger of collision. So the captain did not start any avoiding actions.

The aircraft passed each other, according to the crew and SSR recording, almost directly one above another. The Flight Data Recorders showed that AY365 was flying about 300 ft below AY836. Taking account of a typical error in the FDRS, the vertical distance could have been 150-400 ft (see figure).

After the incident AY365 continued its flight according to the air traffic control clearance, but AY365 had easied wings level and continued straight flight for about a minute at FL 100 before started the right turn to intercept and follow the standard departure route TENNI 1 E.

AY836 asked the air traffic controller immediately about the aircraft flying below them. The controller answered that opposite traffic had been passed and issued a clearance to descend to 5000 feet on QNH 1001. AY836 acknowledged the clearance and asked the controller to say QNH again , which also happened. AY836 acknowledged the barometric pressure and asked again the call sign of the other aircraft. The controller then gave the call sign of the other aircraft concerned.

At 12.24 AY365 reported maintaining FL 100 and heading to TENNI. The supervisor had taken over the COR control position and cleared AY365 climb to FL 250. At 12.25 he ordered AY365 to change radio frequency to 119,90 Mhz, where AY836 also transferred with its secondary radio. During the discussion the call signs of both aircraft were verified and it was agreed that each party concerned would make an incident report.

1.1.2 Injuries to persons

There were no injuries. There were five crew members and 100 passengers on board in AY365 and seven crew members and 40 passengers in AY365.

1.1.3 Damage to aircraft

There was no damage.

1.1.4 Other damage

There was no other damage.

1.1.5 Personnel information

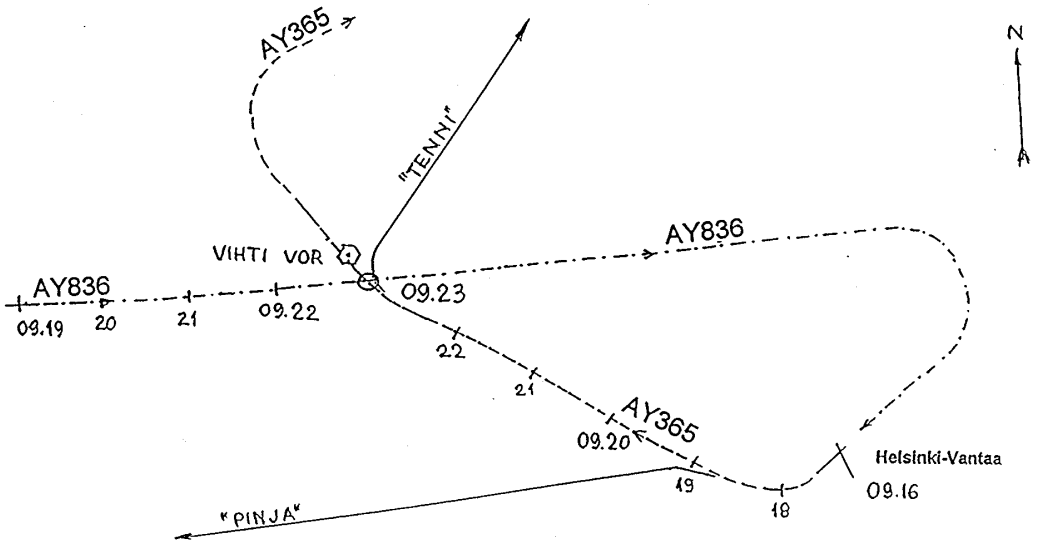
1.1.5.1 The personnel in the aircraft

AY365 crew
Captain: male, 33 years, airline transport pilot's licence, valid until 6 Feb 1998, type rating valid.

First offlcer: male, 46 years, commercial pilot's licence, valid until 30 Apr 1998, type rating valid.

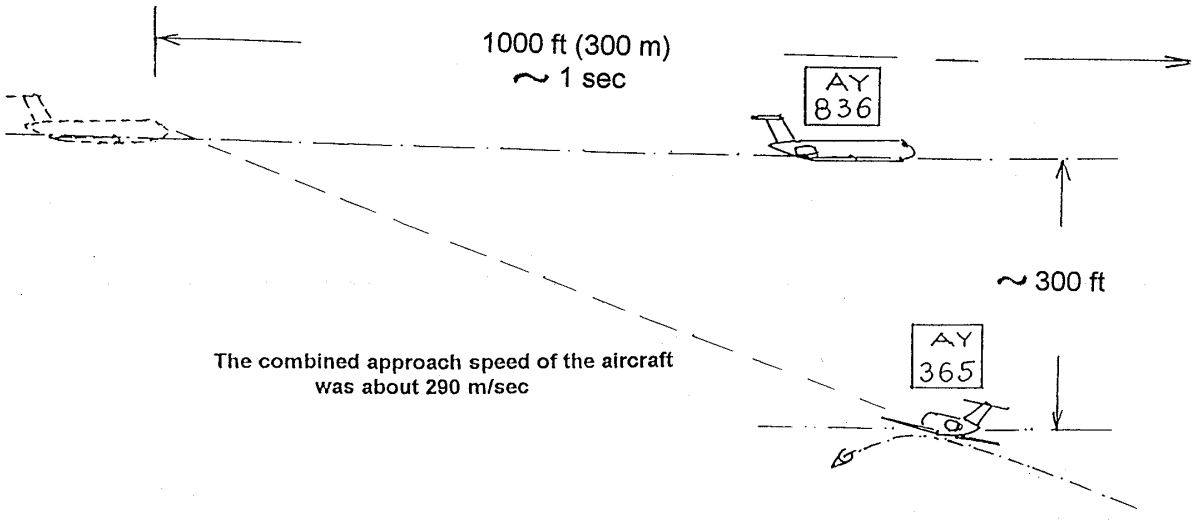
AY836 crew
male, 48 years, airline transport pilot's licence, valid until 29 Dec 1997, type rating valid.

THE INCIDENT BETWEEN AY365 AND AY836 ON OCT 25, 1997 AT 09.23 UTC



------ = AY-365 -·-·-·- = AY-836

Estimated mutual location of the aircraft at the moment of passing



The combined approach speed of the aircraft was about 290 m/sec

First officer: male, 29 years, commercial pilot's licence, valid until 23 Apr 1998, type rating valid.

1.1.5.2 Air traffic control personnel

At the time of the incident three working positions were occupied in Helsinki-Vantaa approach control room: a radar control position (COR), an assistant position where an air traffic controlled worked and a supervisor position. The shift lacked the second assistant.

The radar controller in charge had passed the practical examination for her ATC licence renewal about a week earlier and had thus proved to be qualified to take responsibility for radar controllers duties. The verification of the professional skill of the personnel and air traffic control operation in Helsinki-Vantaa ATC had not been performed by the Flight Safety Authority (FSA) or the Air Navigation Services Dept. by the time of the incident.

Radar control position (COR)
Air traffic controller, female, 52 years, air traffic controller's licence, valid until 24 Oct 1998. Quallfications valid for air traffic control: EFHK TWR/APP/TAR. EFHK TAR qualification was obtained on 26 June 1986.

The shift had started at 7.40 as scheduled and ended at 14.10 after working at the COR position. The shift was the first after a week's holiday. The controller had tried to change the shift because of family reasons with no resuits. She told she had been awake past midnight, but also stated that her alertness was good during the shift. The controller had received the COR duties in accordance with the normal procedure of change of control position. Traffic was light, but increasing.

The supervisor released the controller off her duties nearly immediately after the incident.

Assistant position
Air traffic controller, female, 30 years, air traffic controller's licence valid until 24 September 1998. Qualifications valid for air traffic control: EFHF TWR, EFHK TWR/APP/TAR. EFHK TAR qualification was obtained on 3 June 1997.

The shift had started at 7.40 as scheduled and ended at 14.10. The controller had worked in the APP from 12.40 to 19.10 on the previous day. She toid that her alertness was good during the shift.

The assistant position was exceptional for the controller because it is normally occupied by the ATC assistant. When the incident had happened the controller changed to the ARR position and the assistant came back to his own position.

Supervisor position
Air traffic controller, male, 46 years, air traffic controller's licence valid until 22 April 1998. Quallfications valid for air traffic control: EFHK TWR/APP/TAR. EFHK TAR qualification was obtained on 2 March 1978.

The shift had started at 7.40 as scheduled and ended at 14.10. The controller had been as a supervisor in the APP from 13.40 to 20.10 on the previous day. He toid that his alertness had been good during the shift.

After the incident he released the controller off the COR duties and started to work at the COR position himself.

1.1.6 Aircraft information

AY365

Registration:	OH-LYS
Owner and user:	Finnair
Aircraft type:	Douglas DC-9-51

AY836

Registration:	OH-LMW
Owner and user:	Finnair
Aircraft type:	Douglas DC-9-82

Technical details of the aircraft were not relevant to the incident.

1.1.7 Meteorological information

Weather in southern Finland was broken clouds, upper limit according to SWC at flight level 60-80. Wind at FL 100 was 300°/20 kt and temperature 20°C below freezing point. The incident took place above clouds and according to the pilots in VMC.

1.1.8 Aids to navigation

According to the entries in air traffic control log, there were no reported faults in navigation and approach equipment at Helsinki-Vantaa airport during the time of the incident. The equipment was not checked because of the incident. There is no reason to suspect any malfunctions.

The aircraft equipment was not checked but there were no reported faults and nothing indicates malfunctions.

1.1.9 Radio communications and radar recordings

Radio communications transcript related to the incident is shown in appendix 1.

The commission used the noise abatement control recording of Helsinki secondary surveillance radar (SSR) as well as Tampere ACC MSSR network collage recording.

1.1.10 Airport information

There are two intersecting runways at Helsinki-Vantaa airport, 04/22 and 15/33. At the time of the incident rwy 22 was in use, but rwy 33 was also used for take-offs. The airport is approved for Cat II instrument flights. The FSA of the FCAA accomplished the latest airport inspection on September 21, 1993.

1.1.11 Flight recorders

OH-LYS was equipped with a Lockheed Martin P/N 17M900-00A S/N 417 type Flight Data Recorder (FDR), which measures the altitude with its own pressure transmitter. lt is announced to have a vertical accuracy of +/-150 ft at the altitude of 10.000 ft. OH-LMW was equipped with a Lockheed Martin P/N 17M800-251 S/N 3224, which receives its digital altitude data from AirData (DADC) computer without any conversions of accuracy. lt is announced to have a vertical accuracy of +/-125 ft at the altitude of 10.000 ft.

The recorded FDR data of both aircraft was read out and analysed. According to the instructions in Finnair Flight Operations Manual (paragraph 7.1.1.) the CVR of AY365 had been stopped after the incident. Thus its data could be read out and analysed. The AY836 crew did not stop the CVR, and the data could not be used.

The AY365 pilots had, contrary to instructions, also stopped the FDR about 21 minutes after the incident. Therefore the FDR was not in use during the rest of the flight, neither for the following two legs.

1.1.12 The location of the incident and examination of the aircraft

The incident took place east of Vihti VOR/DME radio beacon at an altitude of 10.000 ft.

The aircraft were not checked.

1.1.13 Medical information

No tests were made.

1.1.14 Fire

There was no fire.

1.1.14 Survival aspects

Not applicable.

1.1.16 Tests and research

Materials

The investigation material consists of incident reports from the crews of both aircraft and the controller, the hearings of parties invoived, radar recordings, radio communications recordings, the aircraft FDRs data and the AY365 CVR recording. ln addition it contains documents, instructions and previous incident reports.

Background material consists of interviews, visits and previous incident reports.

Results

The material available on the incident was sufficient for the commission to build up a detailed picture of the course of events.

During the investigation, the commission gathered information on working conditions and operating procedures at air traffic control, both from its own observations and from hearings. On the basis of this material the operation of the Helsinki-Vantaa approach control is examined in part 3, including relevant conclusions and proposed corrections.

1.1.17 Organizational and management information

1.1.17.1 Definitions

Air Navigation Service consists of Air Traffic service, Aeronautical lnformation service, Aeronautical Telecommunication service, Aeronautical Meteorological service and Search and Rescue service.

Air Traffic Service consists of Air Traffic Control Service, Air Traffic Advisory service, Flight lnformation service and Alerting service. Air Traffic Control is responsibie for providing air traffic service to all aircraft known to it.

Air Traffic Control Service consists of Area Control service, Approach Control service and Aerodrome Control service.

1.1.17.2 Organization

According to the Act (1123/14.12.1990) and Decree (1124/14.12.1990) on the Finnish Civil Aviation Administration and FCAA Rules of Procedure dated 23.5.1991, Air Navigation services in Finland are directed by the Air Navigation Services Dept. (ANS), which operates in the head office of FCAA under its General Director. Responsibility for Air Traffic Control management rests with the Air Traffic Management unit. Planning and development inciuding the airspace structure and flight procedures are under the responsibility of the Systems Development unit. Air navigation services are also managed by externai units, which are Air Navigation Engineering and ANS Institute.

Aviation authority duties belong to the separate Flight Safety Authority (FSA) in the FCAA head office. The director of FSA has independent power of decision in flight safety

matters by virtue of the Act, paragraph 3. Within the FSA the AGA and ANS Regulations Division works as an authority in air navigation services.

In the organization the airports and air navigation service centers are profit responsible service units. Their directors and managers are direct subordinates of the General Director of FCAA or the managers of the central airports, according to the formal organizationai chart of the FCAA Rules of Procedure.

The ATC units at the airports are operatinal units under the airport manager. As an operational leader there is a chief of ATC. At Helsinki-Vantaa airport, the air traffic control organization belongs to the operations group under the general manager of operations.

ACC units belong to the ANS centers and operate under the manager of the center.

According to the principle followed by the FCAA as a state enterprise the profit units must themselves provide for their own resources. Their budgets are separately handied in the budget negotiations in the FCAA. Open vacancies can only be filled with the permission of the director general of FCAA. New vacancies are decided on the FCAA Board of Directors.

1.1.17.3 The airspace structure and responsibility for the controlled areas

Tampere Flight lnformation Region

Tampere Flight lnformation Region (FIR) and Upper Information Region (UIR) cover the whole of southern Finland from the 64° latitude southwards. The lower limit is the surface of water or ground, and there is no upper limit. Tampere ACC is responsible for the airspace and provides air traffic service in this region. The FIR was divided into five ACC sectors in summer 1997. However, no more than four sectors are working simultaneously due of four control suites installed. lf needed, the sectors can be combined.

Helsinki Terminal Control Area

Helsinki Terminal Control Area (TMA) is located in Tampere FIR. The TMA is a polygon (see figure). The boundaries are 30-50 nautical miles from Helsinki-Vantaa airport. The upper limit is FL 245 (7450 m std). Helsinki-Vantaa APP is responsible for air traffic services at Helsinki TMA. There are 18 entry points on the boundaries. The air traffic is controlled via those points by following mainly standard departure and arrival routes.

Helsinki-Vantaa ATC has a Letter of Co-operation with Tampere ACC and Tallinn ATC. Additionally in the co-operation agreement with Tampere ACC there are items concerning the transfer of control and radio communications between Helsinki and St. Petersburg ATCs.

Background and realization of the airspace design

The Systems Development unit, which belongs to the ANS Dept. of the FCAA, is responsible for the medium term planning of the airspace and its structure. The director of the ANS Dept. decides on new arrangements after consuiting air traffic control units, air carriers and other airspace users.

The airport or the ANS center may work out a written proposal on desired airspace arrangements and flight procedures to the ANS Dept. The department examines the proposal, gives feedback and takes measures to carry out the proposals, if necessary.

The sector division of Tampere ACC is based on commercial traffic flows and the needs of military aviation.

The existing structure of Helsinki TMA has been in use since November, 1995. According to the director of the Systems Development unit, the structure of the airspace was pianned for FATMI system (Finnish Air Traffic Management Integration), which should have been taken into use simultaneously with the new structure. FATMI was not implemented, but the airspace reform was still carried out.

The aim of the large Helsinki TMA was to give enough airspace for the APP, because the ACC sectors were not able to co-ordinate the traffic arriving at Helsinki with each other. The operational possibilities of the APP are restricted by both the military danger and restricted areas located in the southern TMA, and the airspace reservations for general aviation in the north and northwest. Also the general aviation and parachute jumping at Malmi airport on the extention of Helsinki-Vantaa rwy 15 complicate the operations of Helsinki ATC. Environmental demands and increasing traffic are more and more important limiting factors. They have to be taken into account in daily ATC work as well as in the airspace system planning.

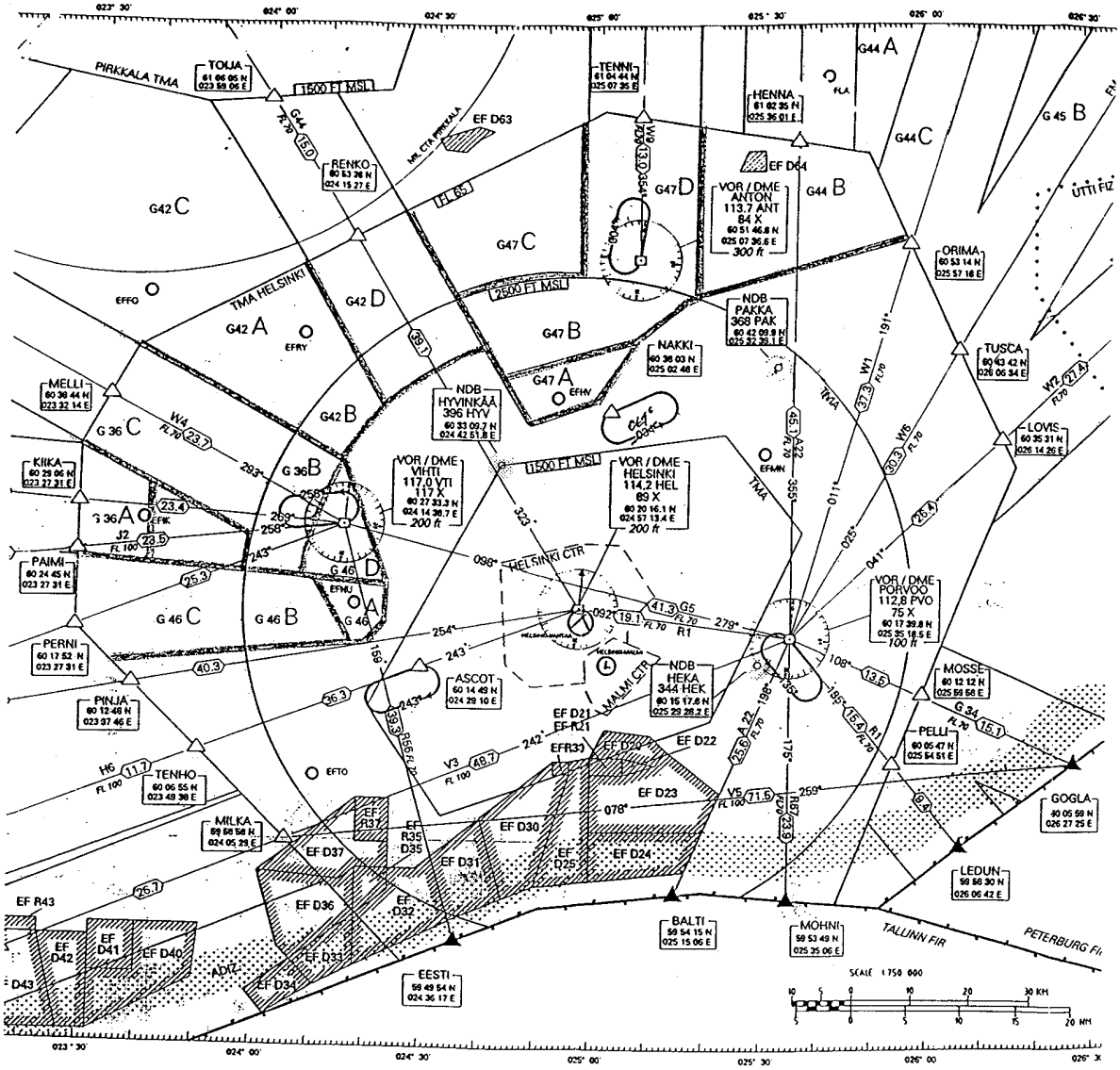
1.1.17.4 Helsinki-Vantaa Airport Approach Control

The accident investigation commission visited Helsinki-Vantaa aerodrome control and approach control on Oct 29, 1997 and Jan 12, 1998. The commission familiarized themselves with ATC control positions, operating conditions, airspace structure and flight procedures. The commission also received a description on the resources at the ATC, and the improvements and the plans made after the incidents under investigation were explained.

The APP working premises, technical premises and other facilities are located underground. The operations room is 8 x 15 meters in size and there are six working positions: two assistant positions, three radar control positions - co-ordinator (COR), arrival or radar director (ARR) and departure (DEP), - and the supervisor's desk. Only the COR control position is continuously occupied. Other radar control positions are occupied according to a shift list or when traffic so requires.

During the duty period the supervisor is in charge of both the APP and TWR. He/she is working in the APP during the shift. His/her work consists of both operative and administrative duties. ln addition to supervising duties, the supervisor often has to participate in operative air traffic control work, especially when there are staffing problems. To help him/her in shift arrangements Tampere ACC gives an arriving traffic forecast twice a day.

TMA HELSINKI



LEGEND

AERODROMES (LAND)

- Civil Aerodrome
- Aerodrome with no facilities

AIR TRAFFIC SERVICES

- Control Area (TMA, ATS Route)
- Control zone (CTR)
- Flight information zone (FIZ)
- A22 — ATS Route designator
- 357° (56) — VOR RDL or MAG Track , Distance NM
- FL 70 — Minimum IFR Enroute Altitude
- Flight Information Region (FIR)
- Compulsory Reporting Point
- On request Reporting Point

RADIO NAVIGATION FACILITIES

- VOR/DME
- NDB / LO

MISCELLANEOUS

- EF P10 Prohibited area
  EF R30 Restricted area
  EF D60 Danger area
- ADIZ
- G 47 B Glider Flying Area
- 1200 FT MSL — FIZ ,TMA lower limit
- Holding

ln addition to radio and telephone communications the APP has a Terminal Area Surveillance Radar (TAR) and a Secondary Surveillance Radar (SSR). Helsinki-Vantaa ATC cannot yet use the new Monopulse Secondary Surveillance Radar of Helsinki (MSSR). Targets of primary and secondary radars can be seen on radar displays but the radar image is not recorded. A short-time technical fault report recording and a continuous recording for noise abatement control are recorded from the SSR. The data of Helsinki MSSR is used by Tampere ACC and it is also recorded there.

The APP also uses various kinds of non-specified data transmission devices and computer systems to facilitate co-operation with the ACC and TWR.

Operational procedures

The ACC leads the traffic arriving at Helsinki mainly through the entry points. After receiving the aircraft to its responsibility area the APP vectors them for the final approach. TWR gives the clearances for landing and take-off. Departing traffic is usually led to the standard departure routes (see figures). lt is also possible to use direct routing if needed. Most of the traffic is controlled by the COR position. The DEP and ARR positions are in charge of departing and arriving air traffic. The COR position has the heaviest workload because it has to co-ordinate the whole traffic and arrange arriving traffic into the proper approach sequence. Each of the APP control positions is independent and the positions are occupied by only one controller at a time.

The capacity of Helsinki-Vantaa airport has been estimated as 38 aircraft in hour including no more than 22 arriving. When traffic density exceeds the capacity traffic has to be regulated. Short peak periods (less than one hour) are managed by keeping the aircraft waiting in holding patterns, and restricting departing traffic if needed. Regulation for a longer time will be announced to Tampere ACC. This may be caused by weather, equipment malfunctions, staffing problems etc. Then the ACC informs the CFMU (Central Flow Management Unit) of Eurocontrol about the situation so as to regulate traffic arriving at Helsinki-Vantaa airport. The regulation measures and reasons are daily recorded on a special form, which is filed in the ATC office.

All communication and radar devices used by Helsinki-Vantaa ATC are located at or in the vicinity of Helsinki-Vantaa airport.

Personnel resources

The number of controllers (58) is calculated to be sufficient for the needs of ATC operations. The average working time is 96 hours in a three-week period of uninterrupted three-shift work. According the shift system development report of FCAA on 18 May 1998, about 62 % of the working hours are used for the actual air traffic control work. Illness and other cases of absence, however, lead to a shortage of personnel and then all the positions cannot be occupied according to the shift list. There is no stand-by system, but the absences are replaced by the supervisors, management or voluntary. ln addition leaving of ATC officers abroad has hampered the operation.

The shortage of personnel has hampered the participation of the controllers in training and development work. There are refresher training plans but all parts of them cannot

have been carried out. Annual competence checking scheme is currently being introduced. Formal shift briefings are not in use at Helsinki-Vantaa ATC. Normally the handover of control position between controllers is taking place by working together in the same position for a moment. Thus the receiving controller gets the image of traffic situation. Methods are individual.

Co-operation exercises have not been arranged between Tampere ACC and Helsinki APP. It came out in the hearings that there is some discord between controllers at times.

1.1.17.5 Tampere Area Control Centre

The accident investigation commission familiarized themselves with the control positions, working conditions and the structure of the responsibility area of Tampere ACC in EFES. The ATC procedures in use were also studied.

EFES is an independent profit responsibie unit. Tampere ACC forms part of EFES. lts responsibility areas are Tampere Flight lnformation region (FIR) and the Upper lnformation region (UIR). The duty of the ACC is to provide air traffic control services to all controlled flights in controlled airspace excluding those terminal areas and control zones where air traffic control services, flight information services and alerting services are provided by APP or TWR. The ACC provides flight information services and alerting services in the flight information region and air traffic advisory service in certain parts of airspace.

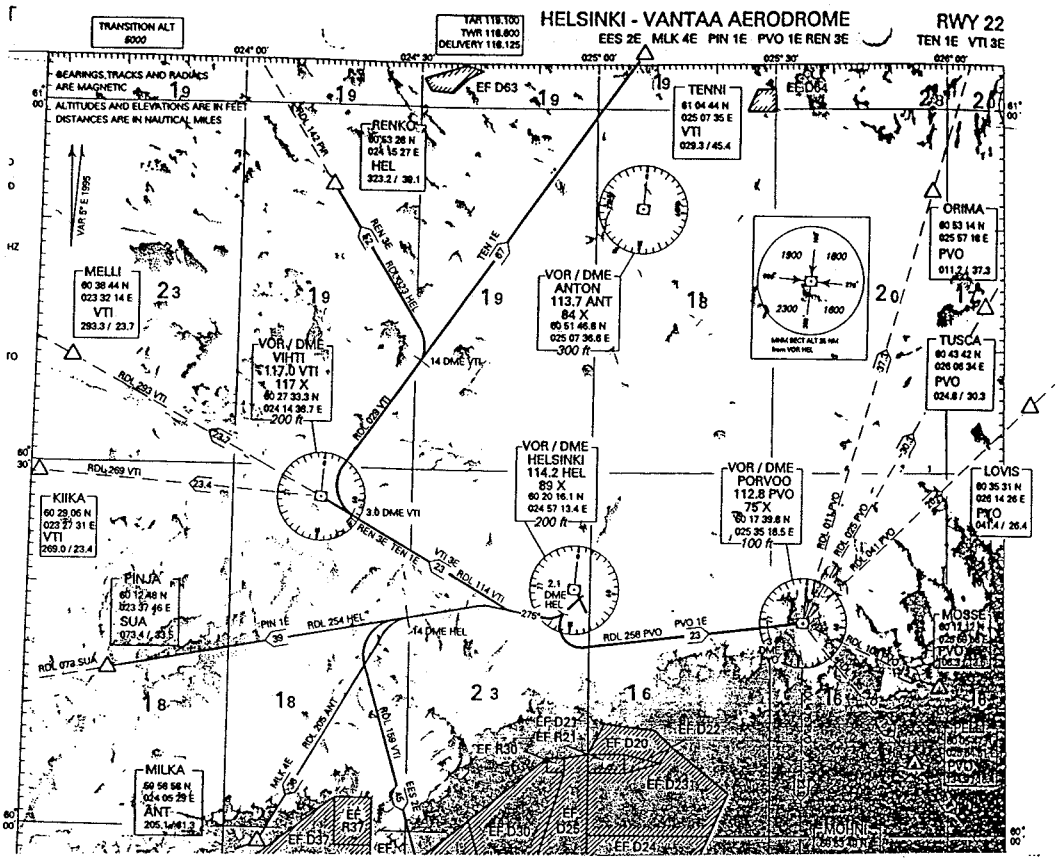
Operational procedures

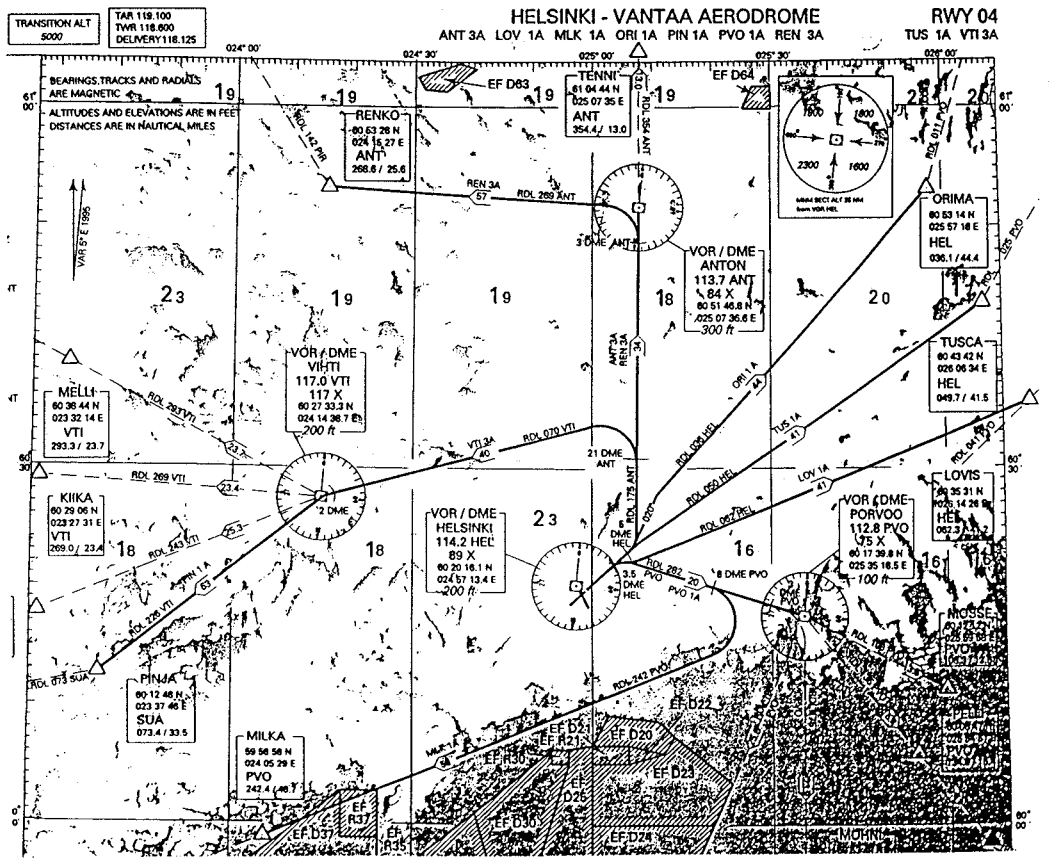
Tampere ATC has divided its area into five sectors. Each sector has its own radio frequency. In the operations room there are four control suites installed, so at most four control positions are working simultaneously and some separate sectors have to be combined depending on air traffic density. At night the operation of all sectors is concentrated on one position. There is always a three-person team working in each position: a radar controller, a procedural controller and an assistant. The busiest sector is the southwest sector because of the commerciai traffic. The operation of the other sectors is affected by the military traffic in addition to the commercial traffic. The morning shift supervisor draws up, for both the morning and the evening shifts, an internal watch list which is based on the prediction of expected air traffic received from the CFMU. The estimated capacity of the ACC is 25 aircraft in an hour and it has been announced to the CFMU. If the capacity is exceeded, the ACC will announce to the CFMU how much traffic per hour it can handle in that particular situation. The CFMU will assign slots to inbound traffic for the area of Tampere ACC, thus regulating the density of traffic.

For radio communications Tampere ACC uses remote controlled radio stations located in its flight information region. The lower limit of radio coverage is 4000 ft or less.

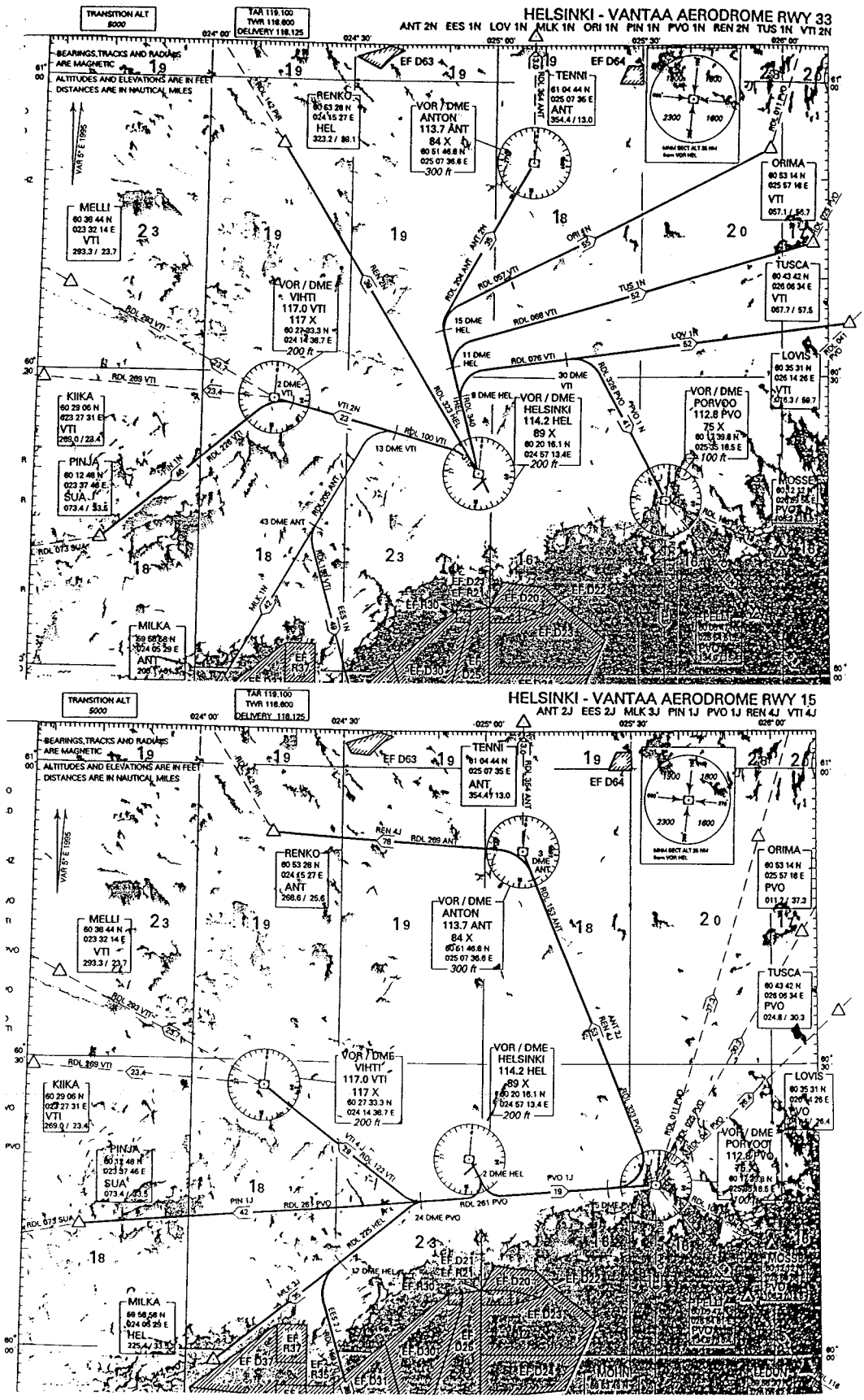
The ACC is currently preparing to transfer from a procedural based ATC system to an MSSR based one. The ACC uses radar data received from several separate MSSRS. The data is stressed according to the coverage of each separate radar unit. The lower limit of the present MSSR network coverage is 4000 ft or less.

HELSINKI-VANTAA STANDARD INSTRUMENT DEPARTURES (SID) RWYS 22 AND 04





HELSINKI-VANTAA STANDARD INSTRUMENT DEPARTURES (SID) RWYS 33 AND 15



The ACC sectors do not co-ordinate with each other the approach sequence of the traffic arriving at Helsinki.

Personnel resources
There are 55 licensed controllers in Tampere ACC. The average working hours are 102 hours in a three-week period of uniterrupted three-shift work. According to the chief of ACC about 66 % of the working hours are used for the actual air traffic control work. The personnel resources make it possibie to carry out all educational and development work. There is not stand-by system in use in Tampere ACC. The absences are replaced in similar way as in Helsinki.

The supervisor is mainly working in management duties. His duty is also to alert the rescue co-operation centre (RCC) when necessary. The supervisor also conducts the formal shift briefing in the ACC.

1.1.18 Other information

1.1.18.1 Air traffic controller training

The air traffic controllers are trained in the ANS Institute. The training has been divided into a basic course, an approach control course, an area control course and radar courses. ln addition, other education related to air navigation services is given.

The applicants for around 20 months basic training must pass an entrance examination and an aptitude test. The training can be interrupted because of poor studies or unsuitability. Students for advanced training are chosen on basis of proposals of airports and air navigation centres. Their training cannot usually be discontinued for the above mentioned reasons.

There are fairly good training facilities and a modern simulator in the institute. The facilities may also be used for tests and development of procedures.

The training is mainly individual, so a lot of instructor resources are needed. There is a regular staff of one director and one full-time instructor in the institute. The other instructors are usually air traffic controllers working in air traffic control units. The institute reported it rather difficult to attract controllers to become instructors.

Tampere ACC and Helsinki ATC are each taking care of refresher training for their own staff. Any co-operation training has not been arranged between them.

1.1.18.2 Reporting of incidents

The provisions on reporting risks of aircraft collision or ATS incidents are contained in the Aeronautical lnformation Publication (AIP) of Finland, section ENR 1.14. The FSA of the FCAA has given instructions for reporting aircraft accidents, damages and incidents. The instructions are contained in the Aviation Regulation GEN M1-4 (previously OPS

M1-4). GEN M1-4 also includes directions on the duty to notify which concerns the pilot-in-command, controller and other persons in duties affecting flight safety.

As part of a new quality assurance control system the ANS Dept. has introduced a new reporting system, which is called the ANS occurrence and observation report. lt can be used when reporting any kind of malfunctions and shortcomings in the flight safety system regardless of whether any danger existed. The report will be handled confidentially and the aim is to find out any latent faults and defects in the system.

ln this case the pilots-in-command of both aircraft and the radar controller on duty submitted an incident report. Additionally the radar controller made an occurrence and observation report.

1.1.19 Investigation methods

Normal methods of data collection were used during the investigation. Each case was analysed using data processing methods described in Annex 13. Additionally a method of analysis developed in VTT Automation was used, because it made possible, on the basis of the case-specific material, to draw conclusions on the working methods of air traffic controllers and determine how the methods are affected by the limitations and conditions set by their operating environment.

1.2 ANALYSIS

The operational situation in the ATC

According to the instructions (LPOM 30/97, Orders of the chief of Helsinki ATC), the air traffic in Helsinki terminal control area was controlled by one, two or three radar control positions, depending on the prevailing situation. When traffic is light only the COR position is used. When traffic is getting heavier the ARR position will be opened. During the heaviest traffic also the DEP position will be occupied. If traffic is controlled by more than one station, it is called dealing of traffic.

At the time of the incident air traffic was controlled by the COR position only. Another radar controller worked in the assistant position, because the assistant was making traffic statistics for invoicing and the second assistant was missing from the shift. The supervisor was working at his desk, from where he could not see the air traffic situation from the radar displays.

The air traffic controller at the assistant position was working for the first time with the new Win ATM -program system which had been installed to the EFES-2+ device a few days before the incident. She told that she was not quite familiar with the device, which increased her workload. She told to have got training with the device two times during spring 1997, but had not used it after that.

The controller who worked at the COR position was on duty for the first time after a week's holiday. She had known that she would have to stay awake past midnight on the previous day and had tried to change her shift with no resuit. However, she told that her alertness was good during the shift. The shift had started at 7.40 in the morning and the controller was at the COR position for the last time during the shift. Therefore her alertness might have been lowered. Before the holidays the controller had passed the written examination required for her licence renewal, and she had given a practical demonstration of skill to the deputy chief of ATC.

The controller had changed to the COR position only a few minutes before AY365 contacted her after take-off. The COR controller had agreed with the assistant controller that she was allowed to accept independentiy the standard departure routes for aircraft departing from runway 22. For the aircraft taking off from other runways, separate clearances and departure routes had to be issued by the COR controller. Traffic was fairly light but increasing because of arriving traffic.

Forming of a traffic image by the controller

AY365 departing for Oulu contacted the radar controller and was cleared to climb to flight level (FL) 250. The COR controller handled now AY365 at first time, because the departure route had been accepted by the assistant position. About one minute after the AY365 departure the controller cleared AY213, which was heading west, to FL 100. Then AY836 arriving from the west contacted the controller and was cleared to descend to FL 110 and to fly on heading 075°. Next the controller restricted the AY365 climb to FL

140 trying to obtain a vertical separation with regard to arriving AY854 from southwest. AY854 had according to an established practice been cleared to descend to FL 150.

The image of traffic formed by the controller did not fully correspond to the reallty. She told in the hearings that she had the incorrect impression that AY365 was flying to the southwest to PINJA and so she did dot vector the aircraft to fly straight towards TENNI, although traffic would have permitted it. The controller told that her attention was drawn to the southwest traffic, which was descending to FL 150. She cleared AY365 to FL 140 to separate it from arriving traffic without utilizing the information on the ATC strip concerning AY365 departure route and destination, although she had circled them. The difference between the departure routes is not easy to notice on the radar display, because a large scale is typically used at the COR radar control position (60-80 nm). The controller anticipated traffic growth and had repeatedly announced that traffic should soon be dealed. Her change to the COR position only a few minutes earlier may have had the effect that she did not have time to form a correct image of the traffic situation. As she told in the hearings, she had not sorted out the strips of the departing traffic either. This points to the conclusion that the preparation in receiving of control position was not done thoroughly enough.

The incorrect air traffic image was not noticed

ln the next stage, the controller had to focus her attention on arriving traffic. She vectored the approaching AY653 to runway 22 contacting the aircraft two times and simultaneously issued the clearance to AY854 which was arriving from southwest. ln addition she accepted the departure routes for three aircraft which were not using runway 22.

AY836 reported reaching FL 110 but the controller did not yet notice the situation developing in the direction of Vihti. Her attention was fixed on SU645 which was contacting at LEDUN in the southeast. Simultaneously AY653 reported to be ready to turn to the base leg for runway 22. At this phase the COR controller still had a partly incorrect image about the air traffic situation, although she had the correct information available.

The commission got the impression that the COR controller prepared the traffic deallng in her mind, which required a part of her capacity. She also announced for the second time, just before the incident was noticed, that she wanted to deal the traffic, but she did not call for it. lt is possibie that she was aware of the workload of the other controller, who worked with the modernized EFES-2+ device, and that the assistant was busy with invoicing duties. Also the supervisor could have had right to call for dealing of traffic.

Noticing the risk of collision

After having vectored AY653 to turn to base leg, the controller cleared AY213, which was west of Vihti, to climb to FL 120. Then the controller noticed the northern location of AY365 compared with the route that she had assumed, and realized the danger of collision over Vihti. She was able to interfere in the flight of AY365 at the last second and ordered it twice to maintain FL 100 as follows:

12.23.00	*APP:*	*"Finnair ..... sorry!"*
12.23.05	*APP:*	*"Finnair 365 maintain 100."*
	APP:	*"365.. (almost shouting) .. maintain 100."*

The controller did not use the intensifying word "immediateiy", which would have been the right word according to the radio communication guide.

There was an imminent risk of collision between AY365 and AY836 because the aircraft were on converging flight paths.

Passing of the aircraft

AY365 was about two nautical miles southeast of Vihti VOR in right turn and passing FL 104 in climb. The captain piloted the aircraft manually and was therefore able to react immediately to the exceptional clearance. The aircraft reached FL 107 anyway before the captain managed to change the climb into descent and to pilot the aircraft down to FL 100. lf the aircraft had been piloted by an autopilot, as usual at that altitude, it would have taken some more time to carry out the evasive manoeuvre, although the AY365 captain had started airspeed acceleration a moment earlier and so decreased the aircraft's vertical speed. During the early phases of manoeuvre the AY365 pilots caught a glimpse of an MD-80 aircraft (DC-9-82) flying above them. The turn of the aircraft was interrupted due to the evasive manoeuvre and it flew wings level to the north-northwest for about one minute until it started a right turn to intercept and follow its departure route. According to the crew hearings this was because they were frightened by the danger of collision.

The AY836 pilots heard the exceptional clearance and when increasing lookout they got in sight a DC-9 approaching from their front right side and below. They told having seen the aircraft for a few seconds and, according to the captain, he estimated that the other aircraft would pass near but that there was no need to start any avoiding action. The commission supposes, however, that the possibilities to perform any late evasive manoeuvres were limited because the aircraft were approaching each other at a speed of about 290 m/s (approx. 560 kt). There was no traffic alert and collision avoidance system (TCAS) in either of the aircraft. According to the FDRs of both aircraft, and taking into account a typical margin of error, the aircraft passed each other with a vertical distance of 150-400 ft. AY365 was flying below AY836. The radar recordings of the incident are consistent with the data of the FDRS. The recordings show that the aircraft were one above another when passing. The AY836 captain told that he saw the other aircraft all the time until it vanished from sight to the rear left.

lt is not possibie to estimate on grounds of the usable facts, whether the aircraft had collided, if the controller had been late with her warning, or if the AY365 had been on autopilot.

When AY836, after passing, asked the call sign of the other aircraft, the controller did not answer but issued a normal reciearance. The commission estimated that this was because of a fright caused by the incident.

The incident was immediately treated by the aircraft and ATC according to the Aviation Regulation OPS M1-4. The commission has called its attention to the point that discussing about incident causes extra radio traffic and draws participant's attention to it resul-

ting possibiy in a new conflict. The commission states that the immediate checking of relevant incident data is reasonable, as done in this case.

The AY365 crew stopped the CVR according to the instructions in Finnair's Flight Operations Manual, but for some reason they also stopped the FDR. The aircraft flew the rest of the flight and next two legs with the stopped FDR, which is not the purpose of the system. According to the instructions (Annex 6, paragraph 6.3.10.1.) flight recorders shall not be switched off during flight time.

The instructions concerning the operation of flight recorders have been revised in Finnair's new Operations Manual (1 April 1998) as required by the FSA.

Re-occupying the control positions in the approach room
After the incident the supervisor released the radar controller off the COR position and started to work there himself. Another radar controller started to take care of arriving traffic at the ARR position. The assistant moved to his own position. After these changes the APP control positions were staffed according to the instructions given by the chief of Helsinki ATC.

Reporting of the incident
The ATC ordered AY365 to change to frequency 119,90 Mhz, where also AY836 changed with its secondary radio. The pilots announced to the ATC, at this frequency, that they would make an incident report.

The radar controller submitted an incident report to the aviation authorities and also an occurrence and observation report to the ANS Dept. The controller announced in her reports and later to the commission that the incident had happened because of her mistake. She stated that she had the impression that AY365 was following the departure route PINJA 1 E although it in reallty followed the departure route TENNI 1 E.

The controller separated AY365 vertically in relation to traffic which was arriving from southwest, direction of PINJA reporting point, by giving to the aircraft a restricting altitude clearance to FL 140.

Summary
On the basis of the analysis it can be said that the controller had not formed an entirely correct image of the traffic situation after she had received her control position. Furthermore, she did not realize the disagreement between the image in her mind and the real situation, which she had on the radar and the strips available. The controller had thought that the predicted increase of arriving and departing traffic required opening of another radar control position, to which she was already preparing in her mind, but she did not give an order for it.

ln this situation, the controller worked, in spite of her professional skills, rather schematically and mechanically considering the demanding nature of the task. This is indicated by an insufficient usage of the relevant information available and a difficulty in accepting information in contradiction with her own impression.

Furthermore the case reveais that if the staffing of the control positions is not done as instructed, it is important to restore it as instructed in good time before the traffic becomes heavier. The dealing of traffic was not carried out despite the COR controller had already twice expressed her wish to open the ARR position. The reason for the delay in traffic deallng was obviously the lack of a clear order. The supervisor did not carry out the dealing until the incident had occurred.

In the ATC unit the change of a control position is always a critical situation. The receiving controller has to create for him/herself a complete image of the prevailing traffic situation. The transfer of the traffic image from the previous controller to the next demands, besides technical information, also mutual communication to ensure that the image of the traffic situation is correct.

1.3 CONCLUSIONS

1.3.1 Findings

1. The controllers had valid licenses and qualifications.

2. The pilots of the aircraft had valid licences and qualifications.

3. The certificates of registration and the certificates of airworthiness of the aircraft were valid.

4. Both aircraft followed the clearances excluding the transient deviation of AY365 from the standard departure route after the incident.

5. The approach control work shift lacked the second ATC assistant.

6. The control positions in the approach room were not staffed according to the valid instructions.

7. The controller who worked at the assistant position had little experience with the new WinATM-system of the EFES-2+ device.

8. The COR controller's general image of traffic situation did not fully correspond to the reality after she had received the COR position.

9. The COR controller expressed twice her wish to open the ARR position but she did not call for it.

10. The COR controller had the correct information about the situation on her radar dispiay and in the strips.

11. The AY-836 crew saw the opposite traffic.

12. The incident happened above clouds and according to the pilots in VMC.

13. The aircraft passed each other on almost opposite flight tracks and nearly one above another with a vertical distance of 150-400 ft.

14. The pilot-in-command who saw the other aircraft, did not take any avoiding action because he considered it not necessary.

15. The COR controller managed to give a warning order to AY365 in time to maintain altitude.

16. The AY365 crew saw the oncoming aircraft only just when it passed.

17. The AY365 crew stopped the CVR but also the FDR, and the aircraft flew the rest of the flight and next two legs with the FDR inoperative.

18. The staffing of the control positions in the approach room was restored in accordance with the instructions right after the incident, and the supervisor took over the COR position.

19. The details of the incident were discussed immediately by the parties on the frequency 119,90 Mhz.

20. All parties made an incident report.

21. The controller understood immediately the direct cause of the incident and wrote it down to her report.

22. The aircraft crews discussed later with the controller about the incident and its causes.

1.3.2 Probable cause

The probable cause of the incident was the partially wrong traffic image of the radar controller, when she thought that AY365 was flying southwest. In reallty the aircraft flew northwest following the standard departure route TENNI 1 E via Vihti to Oulu. The controller had the correct traffic information on her radar display and on the strips, but she did not realize the disagreement between the image in her mind and the real information. Neither did she give a clear order to open the ARR control position as she wanted, although it should have been done because of the traffic situation and according to valid instructions.

2 ATC INCIDENT SOUTH OF VIHTI VOR RADIO BEACON ON 20 AUGUST 1997

2.1 FACTUAL INFORMATION

2.1.1 History of the flight

The course of events was as follows (local time):

AY646 arriving from Stockholm contacted Helsinki-Vantaa radar controller (COR) at 19.17 and reported passing flight level (FL) 237 when descending to FL 110. The controller cleared AY-646 to fly on heading 080° and to descend to FL 80, and reported that the aircraft would be vectored for rwy 22.

AY9803, a training flight bound for Turku, contacted the same controller also at 19.17 and reported passing 3500 ft in climb. The controller cleared the aircraft to fly on heading 270° and to climb to FL 120 with clearance limit Rusko VOR.

At 19.18 AY646 requested permission to turn about 10° to the right obviously because of cumulonimbus in front of them. The controller approved the turn and asked the aircraft to report when it would be ready to turn back to the left. AY646 reported that they would call back when ready to turn.

At 19.20 the controller asked if AY646 would be ready for the left turn. The aircraft replied "about in two minutes". At this stage the controller ordered AY9803 to maintain FL 110. AY9803 acknowledged the altitude clearance although it was aiready passing FL 110 and started an evasive-like descent to the cleared altitude. According to the recordings the aircraft reached FL 114 before the descent started. Then the controller ordered AY646 to maintain FL 120 and to read the clearance immediately back. AY646 did as ordered and reported reaching FL 120 (see figure).

As the controller noticed on her radar display that AY9803 was almost at FL 114, she ordered AY9803 to descend immediately to FL 110. The aircraft reported shortly reaching that level.

lmmediately after the discussion described above, at 19.21, AY646 reported being ready for left turn. The controller issued heading 060° and ordered the aircraft to maintain FL 120. AY646 acknowledged the clearance. At the same time AY9803 reported to have the opposite traffic in sight. After a while the controller cleared AY9803 to fly direct to Rusko and to climb to FL 120. ln a little while AY-9803 reported reaching FL 120.

Another controller who started his shift at 19.22 cleared AY646 to descend to 3000 ft.

2.1.2 Injuries to persons

There were no injuries. There were five crew members on board in AY646 and three crew members in AY9803. There were no passengers in the aircraft.

2.1.3 Damage to aircraft

There was no damage.

2.1.4 Other damage

There was no other damage.

2.1.5 Personnel information

2.1.5.1 The personnel in the aircraft

AY646 crew
Captain: male, 32 years, airline transport pilot's licence, valid until 22 Sept 1997, type rating valid.

First officer: male, 27 years, commercial pilot's licence, valid until 25 Nov 1997, type rating valid.

AY9803 crew
Captain: male, 43 years, airline transport pilot's licence, valid until 26 Aug 1997, flight instructor and type ratings valid.

First officer: male, 34 years, commercial pilot's licence, valid until 22 Oct 1997.

Check pilot: male, 44 years, airline transport pilot's licence, valid until 24 Dec 1997, check pilot and type ratings valid.

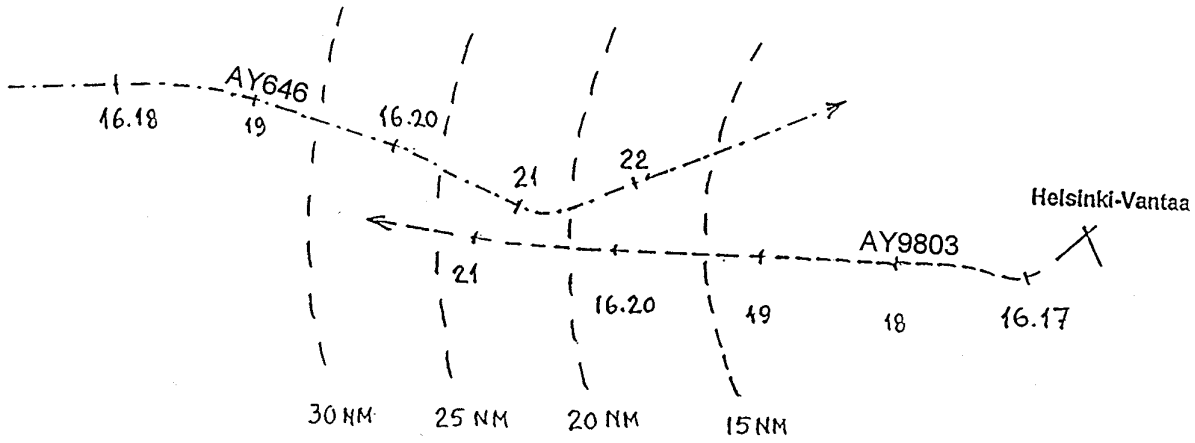
2.1.5.2 Air traffic control personnel

At the time of the incident three working positions were occupied in Helsinki-Vantaa approach control room: a radar control position (COR), an assistant position and a supervisor position.

Radar control position (COR)
Air traffic controller, female, 30 years, air traffic controller's licence valid until 2 Sept 1998. Quallfications valid for air traffic control: EFHK TWR/APP/TAR. EFHK TAR qualification obtained on 22 March 1993.

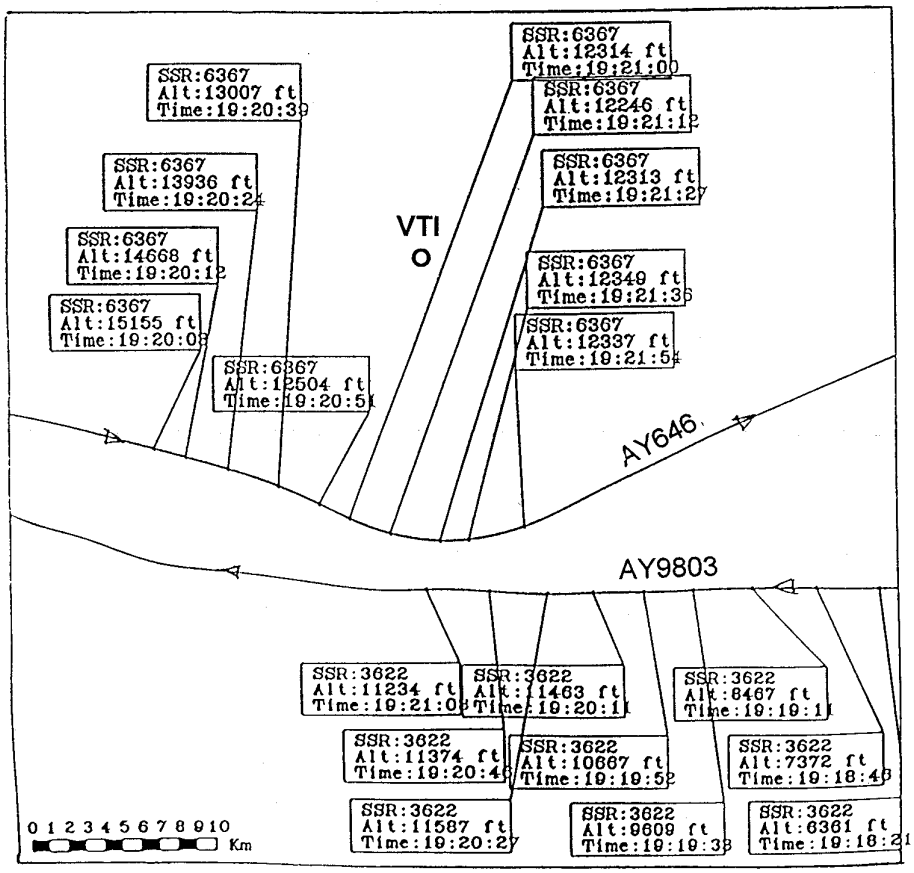
The controller had started her shift at 13.40 and finished it at 20.10 after having worked at the COR position. According to the shift list the duty period should have been between

THE INCIDENT BETWEEN AY646 AND AY9803 ON AUG 20, 1997 AT 16.20-16.21 UTC



—·—·—·— = AY-646 — — — = AY-9803

Part of the Helsinki SSR noise abatement control recording (local time)



7.40-14.10. On the previous day, she had worked in the APP from 13.40 to 20.10. She told that her alertness had been good during the shift.

Assistant position
There was an ATC assistant working at the position.

Supervisor position
Air traffic controller, male, 49 years, air traffic controller's licence valid until 25 June 1998. Qualifications valid for air traffic control: EFHK TWR/APP/TAR. EFHK TAR qualification was obtained on 21 March 1978.

His duty period was in accordance with the shift list. He had started at 13.40 as scheduled and finished at 20.10. The controller had worked in TWR from 12.40 to 19.40 on the previous day. He stated that his alertness had been good during the shift.

2.1.6 Aircraft information

AY646

Registration:	OH-LYO
Owner and user	Finnair
Aircraft type:	Douglas DC-9-51

AY9803

Registration:	OH-LYZ
Owner and user	Finnair
Aircraft type:	Douglas DC-9-51

Technical details of the aircraft were not relevant to the incident.

2.1.7 Meteorological information

During the whole day there had been a rather stationary cumulonimbus(CB) front in northwest part of Helsinki TMA. According to the AY9803 captain the sky was partly clouded. He had seen on the weather radar that there were CBs northeast of Vihti at a distance of 4-5 nm. He estimated that the CBs would be left at a distance of 1-2 nm from their flight path.

2.1.8 Aids to navigation

According to the entries in air traffic control log, there were no reported fauits in navigation and approach equipment at Helsinki-Vantaa airport during the time of the incident. The equipment was not checked because of the incident. There is no reason to suspect any malfunctions.

The aircraft equipment was not checked but there were no reported faults and nothing indicates malfunctions.

2.1.9 Radio communications and radar recordings

Radio communications transcript related to the incident is shown in appendix 2.

The commission used the noise abatement control recording of Helsinki secondary surveillance radar (SSR).

2.1.10 Airport information

See incident report B 8/1997 L, paragraph 1.1.10.

2.1.11 Flight recorders

DC-9-51 aircraft are equipped with Lockheed Martin P/N 17M900 type Flight Data Recorder (FDR), which measures the altitude with its own pressure transmitter. lt is announced to have a vertical accuracy of +/- 150 ft at the altitude of 10.000 ft.

The AY9803 FDR data was read out and analysed. The AY646 FDR data was not available. The Cockpit Voice Recorders (CVRS) of neither aircraft had been stopped and so their data could not be used.

2.1.12 The location of the incident and examination of the aircraft

The incident took place south of Vihti VOR/DME radio beacon at an altitude of 11.000 ft.

The aircraft were not checked.

2.1.13 Medical information

No tests were made.

2.1.14 Fire

There was no fire.

2.1.13 Survival aspects

Not applicable.

2.1.16 Tests and research

The time interval between the incident and the investigations complicated carrying out the examination. The incident was first investigated by the Flight Safety Authority (FSA) of FCAA and then the investigation was transferred to the Accident lnvestigation Board.

Materials
The investigation material consists of the incident report from the AY9803 captain, the hearings of parties invoived, radar recordings, radio communications recordings and the AY9803 FDR data. In addition it contains documents, instructions and previous incident reports.

Background material consists of interviews, visits and previous incident reports.

Results
The materiaa available on the incident was sufficient for the commission to build up a detailed picture of the course of events.

During the investigation, the commission gathered information on working conditions and operating procedures at air traffic control, both from its own observations and from hearings. On the basis of this material the operation of the Helsinki-Vantaa approach control is examined in part 3, including relevant conciusions and proposed corrections.

2.1.17 Organizational and management information

See incident report B 8/1997 L, paragraph 1.1.17.

2.1.18 Other information

2.1.18.1 Air traffic controller training

See incident report B 8/1997 L, paragraph 1.18.1.

2.1.18.2 Reporting of incidents

Only the AY9803 captain made an incident report. The AY646 crew did not realize that flight safety had been compromised and did not make a report.

According to the controller's statement the separation minimums were not broken, and she was not obliged to make an incident report. Neither did she make an occurrence and observation report. However, she was informed after her shift that AY9803 had made an evasive manoeuvre.

2.1.18.3 Characteristics and use of the radars

Helsinki-Vantaa approach control has both primary and secondary surveillance radars in their use. According to the FSA letter of instructions (no. 9/30/96) the separation minimums are measured between the centers of the signal blips in primary radar video. The minimum radar separation is 5 nm, but at a distance of less than 20 nm from the radar antenna, it is 3 nm. When only the SSR is used, the minimum is 8 nm. The intensity of the video of both radars can be adjusted on the dispiay units. To achieve a clear picture, the afterglow in the displays is short. Rain clutter has been removed by puise handling

technique, but cloud echoes can be restored by an overriding switch, if needed. The intensity can be adjusted by the brightness control of the primary video, but the strength of cloud echoes is not comparable to the image on weather radar.

In accordance with the recommendation of ICAO Annex 6, commercial transport aircraft are usually equipped with weather radar. The operation of an airborne weather radar with colour display is based on the grains and raindrops in the air, which give signals on the radar display. The amount of moisture in the clouds can be seen on the radar display by different colours and shades. By interpreting the radar picture it is possible to determine accurately the location of the CB clouds and avoid them, if needed.

2.1.19 Investigation methods

The investigation methods are same as described in the incident report B 8/1997 L, paragraph 1.1.19. In this case an additional analysis was made of the location of the aircraft in relation to each other during five minutes before and after the passing. It was made by engineer Olavi Hettula on the basis of the SSR recording of Helsinki-Vantaa noise abatement control system. There was not any radar display recording available which would have been exactly the same as the radar image seen by the controller.

The analysis made it possible to determine the location of the aircraft in relation to each other at intervals of one second, which corresponds to about 1000 ft (300 m) in distance. The analysis proved to the commission that separation minimums were certainly not broken during the incident.

2.2 ANALYSIS

The operational situation in the ATC

Since aircraft had to avoid the CBs in northwest part of Helsinki TMA for safety reasons, ATC had been under a greater workload than usual during the whole day. The approach room was staffed according to the instructions with two radar control positions (COR and ARR), an assistant position and a supervisor position. The COR controller was working at the position for the last time before the end of her duty period. She told in the hearing that she had closed the ARR position and taken the whole traffic herself, because in her opinion the other controller was not able to meet the demands caused by the CB front to air traffic control. The COR controller stated that the traffic had been rather heavy. The supervisor did not interfere in the closing of the ARR position.

Forming of a traffic image by the controller

AY646 arriving from Stockholm reported to the controller that it has been cleared to FL 110 and was passing FL 237. The controller cleared AY646 to fly on heading 080° and to descend to FL 80. She also reported radar vectoring for runway 22 but did not state the approach procedure.

AY9803, which was on a training flight to Turku, was piloted by the first officer. The flight was his check flight. The captain worked as a pilot-in-command and monitoring pilot. The check pilot sat behind them. He did not have his own microphone and had only a limited possibility to listen radio telephone traffic from the loudspeakers above the pilots. The check pilot could not interfere in piloting of the aircraft. AY9803 was cleared by the controller to fly on heading 270° and to climb to FL 120.

The heading given by the controller would have maintained the minimum horizontal radar separation of 5 nm related to the opposing AY646. Therefore the controller was able to give to the departing AY9803 clearance to climb to FL 120 and arriving AY646 clearance to descend to FL 80. The clearances were in accordance with the instructions.

Planning and reallzation of the CB avoidance.

The commission assumes that the AY646 crew observed the CB front by the aircraft weather radar. This could not be verified because the crew did not remember anything special about the flight when they were interviewed. Having made the observation they requested the controller, without stating any reason, for a permission to turn 10° to the right. The controller approved the turn assuming that AY646 was avoiding CBs. She did not order a new heading, and did not mark the heading change on the ATC strip either. The radio communication was as follows:

AY646:	*"Finnair 646, may we take about 10 degrees to the right."*
APP:	*"Turn is approved, report when able to turn left again."*
AY646:	*"Approved, call you back, Finnair 646."*

According to the national manual of Air Traffic Control instructions (LJKK) the radar vectoring shall be achieved by issuing to the pilot specific headings which will enable the aircraft to maintain the desired track. When the controller approved for AY646 an unaccurate 10° turn, the aircraft was no longer under radar vectoring but radar monitoring.

After the approved 10° turn AY646 would have had a heading of 090° and 5 nm horizontal radar separation would have been maintained. The analysis of radar recording proved, that in reality AY646 changed gradually heading until it was 122°. Consequentiy the heading change was 32° instead of 10°. The commission's view of the matter is that pilots do not consider the approved heading change as being accurate when avoiding CBs. They rather suppose it to be an approximate change monitored by the controller, and suppose that the controller will also interfere in the situation if needed. lt also seems that the pilots are not generally aware of the fact that the controllers do not have the cloud echoes on their radar dispiays because of disturbance.

ln the commission's opinion, the crew of AY646 should have reported to the ATC about the greater heading change than requested. The commission also wants to point out that there is no established standard for requesting an avoiding action due to adverse weather. ln practice the aircraft request permission to change heading for a certain number of degrees. However, it might be difficult to predict the heading change required and any requested change in degrees can be misleading, as it obviously was in the incident under investigation. If the request is only to circumnavigate the adverse weather, the controller immediately has to consider the necessity of vertical separation.

Regaining control of the situation

When the controller noticed that AY646 had made a greater change of heading than assumed, she realized the the required 5 nm horizontal separation would be broken. She asked if AY646 could return to its original heading immediately, but AY646 was not able to turn back yet. At this stage the controller initiated to apply vertical separation between the aircraft flying in opposite directions. She ordered AY9803 to maintain FL 110. The clearance was late because the aircraft was aiready passing FL 110. The captain switched the autopilot off and made a fairly strong evasive manoeuvre to get the aircraft to FL 110. However, the aircraft did climb to FL 114. At the same time the controller restricted the descent of AY646 ordering it to maintain FL 120, and the aircraft reported reaching it at the moment. When the controller noticed on her radar display that AY9803 was still approxmately at FL 114, she issued it a reclearance to descend immediately to FL 110. The radio communication was as follows:

APP:	*"Finnair 646, are you able to turn left now?"*
AY646:	*"In two minutes."*
APP:	*"Okay, Finnair.. aa... 9803, level at 110.*
AY9803:	*"Okay, levelling at 110."*
APP:	*"Finnair 646, level at 120, read back now."*
AY646:	*"Level at 120, Finnair 646, and reaching now.'*
APP:	*"Okay, Finnair 9803, descend to 110 immediately!"*
AY9803:	*"We have .. aa .. shortly 110."*
APP:	*"Okay"*

The controller repeatedly used the phrase "level at...", which is not contained in the radio communication guide published by the FCAA. The national ATC manual (LJKK) does not mention the phrase either. Both RTF guides are analoguous to Doc 4444-RAC/501.

The AY9803 captain acknowledged the clearance to maintain FL 110, although he could not follow it. However, the commission believes that the captain took action instinctively in safest way as he understood that there was a risk of collision.

The first officer piloting AY9803 had anticipated reaching FL 120 and reduced the aircraft's rate of climb to about 2000 feet per minute, which easied returning to FL 110. After reaching FL 110 the AY9803 crew noticed the oncoming DC-9, which was in a left turn. The AY9803 captain estimated the horizontal distance between the aircraft as 1,5-2 nm. According to the radar recording the distance was 1,5 nm. At the same time AY646 reported being ready for left turn and the controller isued it heading 060°, in other words a 60 degrees change of heading.

When AY9803 reported to have the oncoming aircraft in sight, the controller abandoned vertical separation between the aircraft on grounds of that report only. According to the SSR recording, vertical separation was abandoned before the aircraft had passed each other. The commission did not have at its disposal the data recorded from the controller's display, which would have shown the reasons for the controllers action. Radar separation is based on the video of the primary radar. The blip positions of secondary and primary radars may differ from each other.

According to the analysis of the SSR recording, the vertical separation minimum between the aircraft had not been broken. However, the situation developed to such a phase that to maintain the vertical separation, the controller had to issue quick and late altitude restrictions.

Reporting of the incident

The AY9803 crew discussed the incident and the pilot-in-command decided to make an incident report. The AY646 crew did not make a report, nor did they remember the occurrence when later inquired.

The controllers opinion was that she had the situation under control all the time, separations were not broken and there was no need to make an incident report although the aircraft was not able to follow the issued clearance. She did not make an occurrence and observation report either. The controller was, after her shift, informed about the evasive manoeuvre of AY9803 and according to the aviation regulation OPS M1-4 (later changed to GEN M1-4), she should have made the report. ln addition, it is stated in the regulation that in cases of uncertainty the report always has to be made.

Summary

The controller first intended to maintain the adequate distance between the aircraft by radar vectoring. Consequently she was able to issue such altitude clearances to the aircraft on opposite directions that enabled them to climb and descend smoothly and continuously. The radar-monitored AY646's unexpectediy large change of heading

caused the controller to issue the unusually hurried and late altitude restrictions, which were taken by AY9803 as an imminent danger situation.

AY646 underestimated the heading change needed when avoiding CBs, but they were not obliged to keep to their first estimation, because the controller did not issue a new heading. The procedure is not exceptional, but to avoid misunderstandings the aircraft should have reported to the controller that it turns more than requested. The procedure for avoiding adverse weather conditions should be studied and confirmed to avoid comparable situations.

It seems that the controller tried, without paying enough attention to the situation as a whole, to manage the traffic in accordance with the requests from the aircraft. She did not use vertical separation either to anticipate and secure the traffic at once in this unstable situation.

Although the traffic was rather heavy and the circumstances somewhat exceptional, the COR controller relieved the ARR controller of her duties and decided to control all traffic by herself. The action was not in accordance with current instructions. The supervisor did not interfere in the situation.

There were also deviations from standard radio phraseology. The COR controller's radio communications were occasionally inaccurate and she used phrases which are not contained in the FCAA's radio communication guide, nor in the national ATC manual (LJKK). The radio traffic did not directly contribute to the incident, but the non-standard phraseology and arbitrary shortening of radio communication do not meet the flight safety requirements. The primary purpose of the standard phraseology in radio communications is to avoid misunderstandings, either due to deficient language skills or the technical limitations of VHF systems.

2.3 CONCLUSIONS

2.3.1 Findings

1. The controllers had valid licences and qualifications.

2. The pilots of the aircraft had valid licences and qualifications.

3. The certificates of registration and certificates of airworthiness of the aircraft were valid.

4. Both aircraft followed the clearances, exept at the end of passing where AY9803 was not able to follow the altitude clearance given at the last moment.

5. The CB front increased ATC workload during the whole day since the aircraft had to avoid it for safety reasons.

6. The working positions in the approach room were staffed according to current instructions as appropriate in that traffic situation, until the COR controller closed the ARR position. The supervisor did not interfere in the situation.

7. AY646 had requested a 10° change of heading, but in reality the change was about 30°.

8 The controller did not mark the accepted change of heading on her strip, nor did she give a new heading.

9. When avoiding the CBs, AY646 was not under radar vectoring but under radar monitoring.

10. The actual heading change of AY646 was about to lead to separation minimums being broken

11. The late orders requiring immediate action given by the controller gave to the crew of AY9803 an impression that there was a danger of collision, and therefore the captain made a fairly strong avoiding manoeuvre.

12. The AY9803 CVR was not stopped.

13. The separation minimums were not broken.

14. The COR controller abandoned vertical separation between the aircraft obviously on grounds of the visuaL lookout report of the other aircraft only.

15. The radio communications of the controller were not in accordance with the FCAA radio communication guide, nor the national ATC manual (LJKK).

16. The AY9803 captain made an incident report. The AY646 crew did not realize that flight safety had been compromised and did not make a report. The controller did not make an incident report although she was informed after her shift about the avoiding manoeuvre of AY-9803.

2.3.2. Probable cause

Separation minimums were not broken during the incident.

The probable cause of the incident was the working practice of the controller in a traffic situation that was difficult to anticipate. A contributing factor was the heading change of AY646, which was greater than requested and approved. In addition, the controller closed the ARR position contrary to current instructions, and then she had to manage alone all air traffic, which was rather heavy and further complicated by the CB front.

The controller tried to work in a flexible way, accepting the requests of the aircraft. However, she did not make sufficient allowance for the possibility of unexpected changes in traffic situation as a whole, and therefore had to use exceptional procedures in order to maintain safety margins.

3 ANALYSIS OF THE OPERATION OF HELSINKI-VANTAA APPROACH CONTROL ON THE BASIS OF THE INCIDENT REPORTS

Introduction

During the investigation the commission evaluated the operational principles of Heisinki-Vantaa air traffic control. As a conclusion it may be stated that ATC has three central goals that form the general guidelines for the operations of the unit. These are safety, functionality and economy. To achieve efficient operations, these goals must be balanced in such a way that a flexible flow of air traffic can be maintained at all times without any risk of collision between aircraft, or between them and other objects.

The central cognitive demands set for air traffic controllers emerge from the necessity to create a realistic three-dimensional image of the continuously changing air traffic situation based on visual, spoken, or alpha-numerical information. A further necessity is, based on this image, to plan the flow of traffic and advise each aircraft of an appropriate flight path. The complexity of the tightly coupled air traffic system is controlled by distributing it to mutually co-ordinated units, which requires shared awareness of the state of the system achieved through communication between the units. The co-operative structure of the ATC system can be adjusted to situational needs by opening or closing control positions within the control units. Thus, also a conception of the situational capacity of the units must be created.

Air traffic control can be conceived as continuous interaction between the controller and the on-going air traffic. The progress and appropriateness of this interaction can be examined from the point of view of the utilisation of the actual ATC resources available in each situation. Using analysis of the course of action and the controllers' own accounts of it, it is possibie to evaluate the prevailing habits of action' and the underlying values related to ATC work.

Based on the analyses of the two incidents we will, in the following, consider the identified working practices and draw conclusions on them, present an analysis of the most important pressures for changing the operating conditions at Helsinki-Vantaa approach control, and, finally, study the availability of ATC operational facilities in relation to these pressures. Earlier investigation reports as well as information and observations gathered by the commission during the investigation were also used as background material.

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[1] Habit of action is a theoretical concept that was used in the analysis of ATC operations. It refers to the different ways adaptive interactions are constructed with the environment. A practical way to identify habits of action is to analyse the actor's ways of taking into account the possibilities and constraints of the situation and making use of available resources. ln this report the everyday term "working practices" is used for "habit of action".

3.1 EVALUATION OF THE AIR TRAFFIC CONTROLLERS' WORKING PRACTICES IN THE LIGHT OF THE CASE-RELATED ANALYSES OF INCIDENTS

ln the case-related analyses the air traffic control operations were examined from the point of view of utilisation of resources. Based on this, conclusions were drawn on the characteristics of air traffic controllers' working practices. ln the following a summary of these characteristics will be presented, in which the characteristics are classified according to three evaluation criteria that emerged on the basis of the analysis. The criteria describe the extent to which the air traffic controllers sought to utilize situational information in order to create an image of the traffic situation, to properly time decision-making, and the extent to which their actions indicated commitment to norms and common practices. These criteria are considered to reflect the attitude of the air traffic controllers towards the core tasks of air traffic control.

3.1.1 Utilisation of situational information to create a traffic image

The following observations seem to indicate deficient utilisation of situational information. The indented passages are direct citations from the case-related analyses, presenting the observations on the basis of which the conclusions on the working practices were drawn.

> ”In ATC unit the change of a control position is always a critical situation. The receiving controller has to create for him/herself a complete image of the prevailing traffic situation. The transfer of the traffic image from the previous controller to the next demands, besides technical information, also mutual communication to ensure that the image of the traffic situation is correct." (page 27)

> "On the basis of the analysis it can be said that the controller had not formed an entirely correct image of the traffic situation after she had received her control position. Furthermore, she did not realize the disagreement between the image in her mind and the real situation, which she had on the radar and the strips available." (page 26)

> "In this situation, the controller worked, in spite of her professional skills, rather schematically and mechanically considering the demanding nature of the task. This is indicated by an insufficient usage of the relevant information available and a difficulty in accepting information in contradiction with her own impression." (page 26)

These observations are interpreted to manifest insufficient awareness of the dynamic nature of the system and of its inherent uncertainties, which necessitate continuous updating of the controller's own image of the traffic situation. Unawareness of these system-inherent features may cause feelings of uncertainty and unnecessary mental strain.

3.1.2 Proper timing of decision-making

The following observations concerning working practices indicate problems in decision-making:

> "Furthermore the case reveals that if the staffing of the control positions is not done as instructed, it is important to restore it as instructed in good time before the traffic becomes heavier. The dealing of traffic was not carried out despite the COR controller having already twice expressed her wish to open the ARR position. The reason for the delay in traffic deallng was obviously the lack of a clear order. The supervisor did not carry out the dealing until the incident had occurred." (page 27)

> "The controller first intended to maintain the adequate distance between the aircraft by radar vectoring. Consequently she was able to issue such altitude clearances to the aircraft on opposite directions that enabied them to climb and descend smoothly and continuously. The radar-monitored AY646's unexpectedly large change of heading caused the controller to issue the unusually hurried and late altitude restrictions, which were taken by AY9803 as an imminent danger situation." (page 39-40)

ln neither of the cases did the shift supervisor intervene in the staffing of the control positions during the course of events.

The observations make it evident that improper timing of decision-making may manifest itself in schematic behaviour or as a tendency to achieve flexibility through accepting the pilot's requests without taking into account the traffic situation as a whole. This may lead to reactive and delayed activity. The achievement of the operational goals of air traffic control necessitates proactive control and taking overall responsibility. Delays in decision-making, which according to our observations also may be disguised in overconfidence, easily lead to a loss of control over the situation.

3.1.3 Commitment to norms and common practices

The following observations on the air traffic controllers' working practices indicate inadequate commitment to the norms of the working community:

> "There were also deviations from standard radio phraseology. The COR controller's radio communications were occasionally inaccurate and she used phrases which are not contained in the FCAA's radio communication guide, nor in the national ATC manuai (LJKK). The radio traffic did not directly contribute to the incident, but the non-standard phraseology and arbitrary shortening of radio communication do not meet the flight safety requirements. The primary purpose of the standard phraseology in radio communications is to avoid misunderstandings, either due to deficient language skills or the technical limitations of VHF systems." (page 40)

> "Although the traffic was rather heavy and the circumstances somewhat exceptional, the COR controller relieved the ARR controller of her duties and decided to control all traffic by herself. The action was not in accordance with current instructions." (page 40)

Deviations from norms are indicative of an individual-centred and self-determinative working atmosphere within which communication for creation of common awareness of the situation may be neglected. A selective attitude towards the norms may also develop in such an atmosphere. There seems to be evidence of deficient comprehension of the holistic nature of the air traffic control system, the reliable functioning of which requires commitment to norms and common practices.

3.1.4 Summary

Our incident-related analysis of the working practices indicates that there are deficiencies in the comprehension of the critical demands of the ATC system. This becomes manifest in the operations of Helsinki-Vantaa approach control, showing insufficient orientation towards fulfilling the core tasks of air traffic control and resulting in risk-prone working practices.

The analysis of the working practices was based on investigation material relating to two ATC incidents. In this analysis a method and concepts were used that make it possible to evaluate the appropriateness and risk-proneness of the working practices in use from the point of view of the air traffic control system. The working practices may turn out to be risk-prone if the critical demands of the system are not fulfilled in all circumstances.

The observations on the air traffic controllers' working practices made in this investigation are consistent with those made in a major accident investigation (Investigation report 2/1993), in which an earlier version of the same methodology was used. When reviewing the conclusions of these two investigations it may be noted that there are deficiencies in the working practices particularly with regard to commitment to norms and common practices.

The commission deems it necessary to draw intensive attention to the development of appropriate working practices and acquisition of a personal insight into their underlying reasons during the initial training provided by the ANS Institute and in on-the-job training.

3.2 OPERATING CONDITIONS AT THE ATC AND PRESSURES FOR CHANGE

The requirements set for ATC operations and factors creating possibilities or restrictions to it are hereafter called operating conditions of ATC. The central operating conditions considered here are the quantity and nature of air traffic and the structure of airspace, including the procedures for air navigation services. The aim is to assess the eventual pressures for change related to these factors.

3.2.1 The quantity and nature of air traffic

The quantity and nature of air traffic make important demands on ATC operations. Even in the busiest hours traffic density at Helsinki-Vantaa airport remains lower than at the largest European airports. The amount of traffic may still occasionally cause capacity problems at the ATC. The flight schedules of the airlines indicate that the departure and arrival times accumulate in the same hours, causing traffic peaks. Another factor is the overall increase of air traffic, which is reflected in the growth of the number of ATC operations. Adverse weather conditions especially in winter may also cause problems for the ATC from time to time.

The estimated total capacity of Helsinki-Vantaa airport is 38 aircraft per hour with a maximum of 22 arrivals. If the density of traffic exceeds the capacity, traffic must be regulated. Short traffic peaks of less than one hour are managed through directing the aircraft to holding patterns and restricting departures where necessary. Should the capacity be decreased for a longer period, e.g. due to weather, technical failures, staffing problems etc., the Area Control Centre for Southern Finland (EFES) wili be informed. It will transmit this information further to the CFMU of Eurocontrol that takes measures to regulate the traffic arriving at Helsinki-Vantaa airport.

In the opinion of both the flight crews and the air traffic controllers, the operators tend to pian the schedules too tightly. Change of the runway in use or severe weather conditions may easily cause delays which the air traffic controllers experience as stressful. Measures needed to regulate air traffic also have the same subjective effect.

Helsinki-Malmi airport is located on the extension of Helsinki-Vantaa runway 15. The type of its air traffic, general aviation and parachute jumping further increase the ATC workload. Business and military aviation have some loading effect, too. Gliding areas, danger and restricted areas as well as noise abatement procedures also create restrictions and cause extra work.

It can be estimated that the intense traffic and the expected increase in its volume and to some extent also differences in speed due to the large diversity of aircraft types, as well as general aviation may put pressure on the other operating conditions and also on the resources of Helsinki-Vantaa air traffic control.

3.2.2 Structure of airspace and operational procedures

The structure of airspace provides the framework for the control of air traffic. In the following we will first consider the general structure of Helsinki TMA. This defines the task sharing between Helsinki-Vantaa APP and Tampere ACC. Secondly, we will examine the sector division of Helsinki TMA, which has an effect on the internal task sharing within Helsinki-Vantaa air traffic control.

The general structure of Helsinki terminal control area

Due to the anticipated impiementation of the FATMI system (Finnish Air Traffic Management Integration) Helsinki TMA was restructured and the procedures redesigned in 1995. These changes were based on the new possibilities of the system for automatic calculation and regulation of the arriving and departing traffic, which would allow a flexible flow of traffic and a simultaneous use of several runways. As a consequence the TMA currently has 18 entry points. The large number of entry points was justified by the multidirectionallty of traffic flows and operational flexibility. The structure was complicated and would have required effective calculation of arrival times and anticipatory regulation of arrivals. The FATMI system and the computer could, however, not be delivered. As a resuit the Helsinki-Vantaa approach control is not functioning as intended because it is not possibie to co-ordinate the arriving traffic into a proper approach sequence before their entry into Helsinki TMA. Therefore the COR controller is forced to unexpectedly issue inside Helsinki TMA speed restrictions and changes in heading to arriving traffic. From time to time the present situation tends to cause discord between controllers of Helsinki-Vantaa APP and Tampere ACC.

Sector division of Helsinki TMA

The internal division of TMA and the co-operative structure is based on a concentric circular area divided in sectors. This solution is appropriate with regard to the radial distribution of traffic flows over the 360° sector and the flexible change of staffing at the control positions within the unit. ln the approach room there are three control positions, co-ordinator (COR), arrival or radar director (ARR) and departure (DEP). These control positions are occupied according to planned shift lists or depending on situational needs. The controllers themselves oppose a rigid staffing practice, which cannot be adjusted to the traffic situation. lnstructions that guide the staffing of the control positions have been established but the controllers are either unwilling or unable to follow them at all times. The co-ordinator and the shift supervisor have the authority to open or close the other radar control positions; only the COR position is never closed. As a resuit, COR is by far the most loaded position at APP and its responsibility area is wide, which sets high requirements for professional qualifications.

As a conclusion it can be stated that the complexity of the general structure of Helsinki TMA and the procedures used make it difficult for the controllers to meet the central goals of air traffic control, which produces major pressures for change.

The commission had an opportunity to observe the simulation examining the new structure planned for Helsinki TMA at the ANS Institute and finds the on-going work very promising. The commission sees that in order to achieve an appropriate solution for the future structure and operating procedures at Helsinki TMA, a co-operative development and testing project should be carried out by Helsinki-Vantaa ATC and Tampere ACC under the management of the ANS Dept.

3.3 OPERATIONAL RESOURCES

In the following the operational resources of air traffic control and their sufficiency in regard to the operating conditions are discussed.

3.3.1 The number and qualifications of personnel

The number of personnel

When considering the capacity of an air traffic control system it is usual to refer to the amount of available personnel. Different methods have been used to estimate the number of personnel needed at Helsinki-Vantaa ATC. The same evaluation has been carried out both by the empioyer and the employees but no agreement has been reached in the matter. During the investigation it was found out that due to the alleged shortage of staff the shift supervisor was repeatediy obliged to participate in the operative work. This lowered his capacity to act as a supervisor. Moreover, it was difficult to allow controllers to act as instructors in ANS Institute or send them to training courses, and there was not enough staff for the development work due to the scarcity of personnel. Furthermore, there were repeatedly staffing problems in a shift, as there was no stand-by system. During the investigation, however, FCAA has started measures to recruit more personnel.

Tampere ACC has developed its own procedure for calculating the need for personnel. The calculations are based on the number of controllers needed in each working position per shift, the number of shifts in twenty-four hours, the effects of the three months long holiday period and the following extra duties of the controllers: participation in refresher training and co-operation courses, yearly competence checks, instructor and development duties, military refresher courses, taking account of the loss of personnel for natural reasons (e.g. retirements) and estimated effect of unanticipated losses. These bases for calculation have proved to be appropriate and the method has also been approved by the head office of the FCAA.

lt is generally agreed that there is a need for a particular stand-by system that can rapidly provide substituting qualified staff in case of illness or other unexpected shortage of personnel.

The number of personnel and the amount of personnel costs are directly connected. ln a unit based on profit responsibility, cost/benefit analysis must also be applied. Thus, besides calculating the required increase in capacity it is necessary to take into account factors that are not easily measurable by economic indicators. Such factors are e.g. flight safety, job satisfaction, the working atmosphere and the working culture. Shortage of personnel usually causes overloading and selection of tasks, which may have a negative effect on the working practices and attitudes of the personnel.

Working hours

During the investigation both Helsinki-Vantaa ATC and the Tampere ACC raised concerns relating to working hour issues. Both units work according to an uninterrupted three-shift system. In Tampere the average working time in a three-week period

is 102 hours, out of which 66% is actual ATC work. In Helsinki-Vantaa the average working time of the controllers is 96 hours, out of which 62% is actual ATC work. In the comparison it is necessary to take account of the functional differences between these two units.

According to the observations of the commission the working hour issues have developed into a dispute between the air traffic controllers and the employer, which hinders co-operation. Working hour issues are related to another, currently still unsolved problem of organising a paid stand-by system to provide qualified staff in case of illness or other unexpected shortage of personnel. Up to now those absent are replaced by the superiors or by off-duty controllers, but controllers have become more and more reluctant to cope with this. Working hour disputes have caused an inflamed atmosphere that hampers the efforts to achieve overall air safety improvements. Therefore an acceptable solution should immediately be reached in this question.

The major accident investigation commission has also dealt with this matter in its report (2/1993, page 92) published on 7 August 1997.

Training and professional competence

The basic training of air traffic controllers takes place at the ANS Institute. According to the Director of the institute the quantity and quality of applicants are satisfactory and the selection system functions well. The training is carried out so that those not performing well enough cannot complete the course. The level of trainees at the end of the course is such that 95% of them have met the required criteria.

On the radar courses included in the continuation training this kind of evaluation is not usual. Continuation training should, however, be organised so that the candidates would themselves have to assess their own chances of passing the course, because the radar course gives the controller, after the required on-the-job practice, the opportunity to apply for a rating at any radar control unit.

The training courses lay the basis for the air traffic controller’s competence. Because professional skill is formed as a result of experience from actual work, on-the-job training has a significant role. The commission has received the impression that the instructions and training material concerning on-the-job training have recently been improved at least at Helsinki-Vantaa ATC. In addition to on-the-job training, regular refresher training at the ANS Institute is needed to keep up the controllers' competence and appropriate working methods. Co-operation exercises should also be organised between the ATC units. In the opinion of the commission, the ANS Institute plays a significant role in the refresher training in eliminating improper working practices and promoting standardised good practices. If refresher training is organised at each unit separately, this goal may not be reached. The goals, requirements and supervision methods of on-the-job training and refresher training established in the quality control system of the FCAA should be revised with regard to the above issues.

The aim of the regular competence checks is to evaluate and control the quality of the air traffic controller's individual competence. With their help it is furthermore possible to gain feed-back on the quality of the working practices in the units and the adequacy of the training system. Aviation regulation PEL M3-10 states that when renewing an air traffic controller's license an examination organised by the FCAA has to be passed. The FCAA has specified the instructions for competence checks in letters dated 26 April 1995 and 10 May 1995. The FCAA sees that the airports and ANS centres have the responsibility for the tests and for the ways of carrying them out, inciuding the evaluation criteria. ln the opinion of the commission these procedures should be standardised and applied uniformly in the whole country. The check controllers should be authorised in the same way as check pilots. ln these respects the norms concerning the competence checks should be developed.

The instructor resources of the ANS Institute are insufficient, which adversely affects the realisation of the training. There is a shortage of both permanent training staff and part-time instructors. This is due to problems in the compensation. The number of permanent staff should be increased, or the ATC units should, in their personnel plans, be obliged to take account of the instructor needs of the Institute and also to make instructor duties economically attractive enough.

lssues concerning air traffic controllers' competence requirements, selection, training, working practices and working culture, as well as the impact of the current conceptions of the nature of the controller's professional skill on flight safety have been dealt with in investigation report 2/1993 on pages 70-75.

3.3.2 Physical working conditions and facilities

With the physicai working conditions we refer to the work environment and its ergonomic features. The work environment thus consists of the actual working premises, technical premises, other facilities and areas for the visitors.

The present working premises of Helsinki-Vantaa APP are situated Underground. Even though the premises fulfil the applicable requirements, the location is regarded as a deficiency. The new facilities under construction are above ground level and will thus better meet the requirements set for physicai working conditions.

The ergonomic features of the control positions have continuously been developed. The commission has, however, heard some complaints concerning the ergonomics. For example the controllers have mentioned the inconvenience caused by the need to move the strip racks and communication equipment when opening or closing radar control positions. The facilities can, however, be considered ergonomically sufficient. It is likely that the new premises and the modernisation of equipment will eliminate the existing deficiencies.

The facilities needed in air traffic control inciude e.g. communication equipment, radars, strips, computers, circulars, charts and documents. The information obtained by these means must be relevant for the air traffic control and easily available. There

does not seem to be major deficiencies in Helsinki-Vantaa ATC with regard to information facilities. The radar system is old but it has been planned to be renewed as part of the FATMI project. The FCAA representatives have pointed out that an essential part of the FATMI system is a computer which is able to provide the parameters necessary for traffic regulation well in advance. It seems that the FATMI system will be implemented in a reduced form at the turn of the millennium.

Different systems have been developed to safeguard succesful delivery of various types of information between the air traffic controllers and to ensure that the information is properly utilised. It should not be possible to switch off safety systems.

The usefulness of any facilities depends on the users competencies and attitudes. In the implementation of new facilities it is necessary to consider the impact of these facilities on working practices. It would also be necessary through information, equipment and refresher training to assure that a necessary level of competence is achieved and maintained and that the controllers have a positive attitude towards continuous utilisation of available information.

3.3.3 Norms

Norms governing air traffic control consist of acts and decrees, regulations of the authorities, manuals, standard procedures and other instructions. The development of air traffic and societal demands cause pressure for change in the norms. This issue has been dealt with extensively in investigation report 2/1993, chapter 3 "Organisational control of ATC" on pages 76-92.

In aviation regulation PEL M3-10 "Air traffic controller's license and ratings" the required competence and skills are listed, and TRG M3-2 "Training of Air Navigation Service personnel" contains the regulations for training. The need for revision in these regulations and in the instructions for their application, especially, in respect of supervision and follow-up of their implementation, has already been discussed above. The commission also sees that the contents of the co-operation agreements between ATC units and their requirements for training and co-operation exercises should be normatively defined.

The commission reviewed the sufficiency of normative control of daily operations at Helsinki-Vantaa ATC. The commission found that more detailed specifications would be needed in the following issues:

- internal organisation of the air traffic control activity, managerial responsibilities and authorities of the controllers
- instructions concerning both the staffing of control positions and intentional changes in it
- definitions of the tasks and responsibilities at each working position, especially for the shift supervisor.

It can be stated that there are some weaknesses and deficiencies in the norms, due to which they do not provide sufficient support for operations. The commission, however, wants to emphasise that norms are nothing but a mean, and only the acceptance of them and the internalisation of the principles behind them as part of professional competence, will lead to changes in working practices.

3.3.4 Administration and management

Administration

The top management of the FCAA and its head office are in charge of aviation policy and the operation of the airports and air traffic control centres, providing them with the necessary facilities. The Flight Safety Authority (FSA) supervises flight safety as an independent authority, without direct connection with the commercial section of FCAA. From the point of view of the administration both of these bodies are responsibie for providing sufficient facilities for air traffic control with the help of proper organisation, professional competence of the personnel, physical working conditions, norms and instructions, inciuding the supervision of these issues.

The practical managerial responsibility rests with the Air Navigation Services Dept. (ANS). The tasks have been divided among different units of the department. ln facilitating the operations of air traffic control, these units have significant responsibilities with regard to planning and development of operations, training, normative control of daily operational work and quality control system. The foregoing assessment of the changes in the operating conditions and evaluation of the adequacy of other ATC facilities revealed capacity deficiencies in the organisation in all of these areas. The ANS Dept. and the supporting service units should be provided with sufficient resources to carry out their tasks efficiently. lt is likewise necessary to assure that the regulations having an effect on flight safety are clear and efficiently supervised, so that compliance with them will not be questioned anywhere.

The services are provided by profit responsibie airports and air navigation services centres. Air traffic controllers are part of these organisations and work under unit managers. With reference to international practices the air traffic controllers have, however, suggested that they should be organised into a separate unit subordinated directly to the ANS Dept. The arguments are that not all airport managers have sufficient expertise to be able to develop working conditions at the ATC. Another argument is that for economical reasons the airport managers may increase the controller's workload too much and compromise their ability to maintain flight safety. The commission sees that this kind of differences in views should be analysed and cleared up in open discussions. Internal management should create a co-operative and positive atmosphere that could facilitate carrying out the core tasks of ATC.

Unit management and working athmosphere

At Helsinki-Vantaa airport the general manager of operations is responsibie for air traffic control. The chief and the deputy chief of ATC, who also participate in operationai air traffic control work, are subordinated to him. ln each shift there is also a su-

pervisor. His tasks are basically managerial but he often participates in the operational air traffic control work, for example in case there are staffing problems in the shift.

In a study carried out by the Institute of Occupational Health in 1997, published on 18 May 1998 as part of an FCAA report concerning the development of the ATC shift system, air traffic controllers estimated their work satisfaction, possibilities of having an influence on their own work and support from superiors to be lower than personnel in similar studies in average. About 30% of air traffic controllers felt that their ability to work had been reduced during the last two years. Based on the results of the study it was not possible to distinguish work-related causes of ill-being from other possibie causes.

The chiefs of air traffic control feel their responsibility to be great but at the same time they consider that they have little power. There have been attempts to solve these problems through issuing a great deal of instructions at short intervals, but compliance with these instructions has not been controlled. Moreover, many employees seem not to take these instructions very seriously.

lnstructions exist on the tasks of the supervisors, but the instructions are not uniformly applied. The supervisors do not share a common conception of their tasks and among the air traffic controllers there are contradicting views of the responsibilities and position of the supervisors. The task and responsibility profile of the ATC superiors should be clarified and it should be made sure that the instructions are followed.

These issues have also been dealt with in investigation report 2/1993, pages 81-83 and in recommendation no. 3 on page 94.

The commission sees that there are many problems in the administration and especially in unit management and in the working atmosphere. These should be thoroughly examined, because otherwise these issues may lower the effectiveness of other measures aimed at improving flight safety. The commission has studied the plan for the development of ATC operations prepared by the operations group of HelsinkiVantaa airport. The commission is of the view that realisation of this pian would improve the operating facilities at the ATC.

Reporting and recording

The supervision of ATC operations, reporting and recording have been dealt with in investigation report 2/1993 on pages 88-91, and in recommendation no. 5 on pages 95-96. The commission notes that clearly positive development has taken place in the motivation for and frankness of reporting, and in the quallty of radio communications and radar data recordings. During 1997 the FCAA created an ANS occurrence and observation report (PHI), which provided confidentiai reporting of all disturbances and deficiencies in the air traffic control system. The commission highly appreciates the PHI system. ln order to make use of the potential benefits of this system reports are to be handled quickly and feed-back must be provided. The ANS Dept. has aiready made efforts to achieve this.

ln order to assure the legal protection of on air traffic controllers and to facilitate investigations, the recordings of radar data, radio communications and telephone conversations should be further improved. To facilitate the analysis of decision-making situations and air traffic controllers' working practices the recordings should be obtained from the same information that is available for the controller in the actual situation. Special attention should be devoted to improving the time signals of the recordings. The signals should come from one source, and with sufficient frequency. It would also be useful to record the radar data actually displayed on the radar screen, and the direct verbal communications between air traffic controllers should be recorded.

3.4 SUMMARY

Based on the investigation of two ATC incidents we have studied the air traffic controllers' ways of utilising their situational resources. As a consequence we were able to draw conciusions on the controllers' ability to take account of the demands set by the air traffic control system, and the constraints and possibilities provided by it in each situation. Three evaluation criteria could be established to describe the controller's orientation to the functional core tasks of ATC. The results of this and earlier investigations support the conclusion that the functional core tasks are not understood clearly enough among the air traffic controllers, and that the controllers do not direct sufficient attention and effort to their fulfilment. It was found that there were deficiencies in particular in the commitment to norms and common practices. The central operating conditions and facilities of air traffic control were also defined. The resuits of the analysis indicate that there are both external and internal pressures for change in the operating conditions, which set additional requirements for the ATC work. The facilities provided by the organisation to meet these requirements are not sufficient in every respect. As a result too much pressure is put on the individual air traffic controllers to find adequate solutions in particular ATC situations. Working practices that are formed in such circumstances may have restricted applicability, while at the same time all available resources are probably not utilised.

4 SAFETY RECOMMENDATIONS

1 The structure of Helsinki Terminal Control Area

The present structure of Helsinki TMA is complicated and makes it difficult for the controllers to meet the central goals of ATC. The sector division of TMA is causing far too much load to one control position, and it does not facilitate effective co-operation between ACC and APP.

The investigation commission proposes that under the control of ANS Dept of FCAA a modernization of Helsinki TMA structure and procedures should be carried out, the limitation of liability between Helsinki-Vantaa approach control and Tampere area control centres should be reconsidered, and the working methods, sectoral structure and working positions of both ATC units should be adapted to the reform. The implementation of the reform should be tested and the training demanded should be carried out in co-operation with HelsinkiVantaa ATC and Tampere ACC.

2. The personnel of Helsinki-Vantaa ATC

An estimation of the number of controllers needed has been carried out at Helsinki-Vantaa airport in autumn 1997. As a result an additional need of eleven (11) air traffic controllers was detected. The shift system development group of FCAA delivered its report in May 1998. During investigations it became evident that the air traffic controllers are not satisfied with the results of studies in every respect. The commission sees these as reasons for the prevailing poor working atmosphere in Helsinki-Vantaa ATC. lt reflects frustration among personnel and it is related to other factors, which basically are among other things in working hour issues.

The investigation commission proposes that the personnel problems in Helsinki-Vantaa ATC should be solved on the basis of the settlements done so that all parties can commit themselves to the result. The commission deems it important that the decision is made in accordance with the reform of Helsinki TMA, the necessary re-organizing of the ATC and the stand-by-system for providing substituting personnel in case of occasional absences.

3 The development of air traffic controller training and professional competence

The instructor resources of the ANS Institute are totally insufficient. The general evaluation criterias for supervised on-the-job training needed for licence rating are not documented. The goals, requirements and control of on-the-job training and regular refresher training are not accurately specified. The realization and control of the competence checks varies in the ATC units. The realization of co-operative exercises are not satisfactory. FCAA has announced measures to improve the situation.

The deeper examination of the topics mentioned above and the development of the air traffic controller's working practices would require a study of the operating conditions and working procedures in the air traffic control system.

The investigation commission proposes that FCAA carries out the measures needed so that
- the ANS Institute is provided with sufficient instructor resources in accordance with its duties
- the realization of training goals and competence criterias is supervised and the follow-up of the results is carried out
- the goals and realization of the on-the-job training and refresher training is specified and the evaluation criteria of results is determined
- the instructions conceming the competence checks shall be revised so that the competence checks are standardized and the check controllers are, if possible, nominated and instructed by FCAA in the manner of check pilots.

4 Documents regulating daily operation

The quality of the safety of air navigation is determined by the quality of the daily air traffic control work. In ATC operation it is important to call more attention to quality control. Especially the normative control of daily operations is insufficient both in general and in profit-responsibie units. lt is important that the administrative means are measured so that the principles behind them are accepted as part of professional competence, the compliance of norms is engaged and all this will be supervised.

The investigation commission proposes that FCAA defines more precisely in its normative documents when it is mandatory to make an agreement of co-operation, the contents of agreement and the goals and realization of the co-operation exercises.
Further the commission proposes that Helsinki-Vantaa airport specifies the following documents:
- internal organisation of the air traffic control activity, managerial responsibilities and authorities of the controllers
- instructions conceming both the staffing of control positions and intentional changes in it
- definitions of the tasks and responsibilities at each working position. especially for the shift supervisor.

Helsinki on 18 August 1998

Jouko Koskimies

Jussi Haila Ari Huhtala Leena Norros

RADIO COMMUNICATIONS ON EFHK APP FREQUENCY 119.10 MHZ 25.10.1997

UTC time. Words in parentheses are translations from finnish.

09.18.07	AY365:	Radar, good morning, Finnair 365, passing 2000.
	APP:	Good morning, Finnair 365, radar contact, climb to flight level 250.
	AY365:	Cleared to level 250, Finnair 365.
09.18.30	APP:	Finnair 653, descend to 2000 feet, QNH 1001.
	AY653:	Okay, cleared down to 2000 feet, QNH 1001, we are leaving level 80, Finnair 653
	APP:	Finnair 213, climb to level 100.
	AY213:	Climbing to level 100, Finnair 213.
09.19.22	AY836:	Tervehdys (*greetings)* approach, Finnair 836, passing 153 down to 130, MD 11, with Papa.
	APP:	Finnair 836, terve *(hello)*, radar contact fly heading 075, descend to flight level 110, vectoring for ILS-approach runway 22, right circuit, you have 65 track miles.
09.19.45	AY836:	Heading 075, down to 110, vectors 22 right circuit, Finnair 836.
09.20.20	APP:	Finnair 365, stop your climb to flight level 140.
	AY365:	Recleared level 140, Finnair 365.
09.21.00	AY854:	???? radar, Finnair 854, 170 down to 150, DC 9, with Papa.
	APP:	Finnair 653, turn left heading 050.
	AY653:	Left heading 050, Finnair 653.
	APP:	Finnair 854, radar contact, fly heading 055, maintain 150 when reaching, as cleared (non readable??) for ILS-approach 22, right circuit, number 4.
09.21.30	AY485:	Heading 055, and maintaining 150 soon, Finnair 854.
09.21.40	APP:	Finnair 485, to Tampere Control 125,4.
	AY485:	125,4 Finnair 485, terve!

Appendix 1/2

	AY836:	836 reaching 110.
09.22.10	APP:	836, maintain 110.
	SU645:	?? radar, Aeroflot 645, position LEDUN at 160, with information Papa.
	APP:	Aeroflot 645, radar contact, fly heading 310, descend to flight level 80, vectoring for ILS-approach 22, left circuit, speed 250.
	SU645:	Okay, speed 250, on heading 310, descending to level 80, vectoring 22, 645
09.22.40	AY653:	Finnair 653 is ready to turn inbound.
	APP:	Finnair 653 right heading 130.
	AY653:	Right heading 130, Finnair 653.
	APP:	Finnair 213 climb to flight level 120.
09.23.00	AY213:	Level 120, Finnair 213.
09.23.05	APP:	Finnair 836..... *(at the background noise of stripholder)* ..... sorry!
09.23.10	APP:	Finnair 365 maintain 100 !
	APP:	365 ..*(almost shouting)*.. maintain 100 !!
09.23.20	AY365:	We are going down 100, Finnair 365.
09.23.30	AY653:	Finnair 653, we have the field in sight.
09.23.35	APP:	Finnair 653, right heading 200, cleared for ILS-approach 22.
09.23.40	AY653:	Right heading 200, cleared for ILS-approach 22, Finnair 653
	AY836:	Finnair 836, what was the aircraft below us?
	APP:	You have passed opposite traffic, descend to 5000 feet QNH 1001.
	AY836	Descend to 5000 feet...say again, the QNH 1001!
09.24.00	APP:	Correct, QNH 1001.
	AY836:	1001, what is the call sign of the aircraft passing us, it was very close?
09.24.10	APP:	It was Finnair 365.
	AY836:	Okay.

09.24.20 AY653: Finnair 653 on localizer 22.

APP: Finnair 653 contact tower, 118,6.

AY653 18,6 - 653.

09.24.35 AY365 Finnair 365 säilytellään satasta ja mennään nyt kohti TENNIä *(Finnair 365 we maintain one hundred and are going now towards TENNI).*

---------- **A male voice is beginning in the ATC** ----------

APP: 365 kohti TENNIä ja nouse 250:aan *(365 towards TENNI and climb to 250).*

(two transmissions) -- descending 150.

APP: Lufthansa 3018, fly direct PORVOO descent to 150 runway 22.

LH3018: On course PORVOO descending 150, Lufthansa 3018.

09.25.00 AY653: Tower good afternoon, Finnair 653 on ILS 22.

APP: Finnair 653, contact tower 118,6.

AY653: Sorry!

AY655: Radar, good afternoon Finnair 655.

APP: Finnair 655, identified, climb to maintain 70.

AY655: 70, Finnair 655.

AY365: Ja tutka 365 vielä *(And radar three six five yet).*

APP: Ja 365 vaihda 119,9:lle *(And 365 change to 119,9).*

AY365: Yhdeksäntoistyhdeksän *(nineteen nine)*

APP: Finnair 854 descnd to flight level 150.

AY856: To level 150, Finnair 853.

--------- **EFHK APP radio communications on 119,90 MHz** ----------

09.25.30 AY365: Ja tutka, Finnair 365 19,9:llä *(And radar, 365 on 19,9).*

APP: *(a female voice on the frequency)* 365, tutka *(365, radar).*

	AY365:	Joo, siinä tota kyllä mentiin aika lähekkäin tossa äsken, meillä oli silloin tota suurinpiirtein kymmenen ja neljäkö meillä olis ollu, kymmenen ja puol suurinpiirtein nousussa, ja mikä tää oli tää toinen kone, joka siin 09.26.00 tuli? *(Aaa...well, just there, we were really rather near just recently, we had...well then...I think...approximately ten and four it could have been...I suppose ten and half approximately in climb, and what was that other plane, which came around at 09.26.00?).*
	APP:	836 ja se oli 110:ssä *(836 and it was at 110).*
	AY365:	Joo, tästä joutuu nyt tekeen paperia sitte *(Well yes, we´ll gonna make paper then).*
	APP:	Näin on *(So it is).*
	AY836:	836 on kans jaksolla, niin näytti kans aika lähellä, että me tehdään kans raportti *(836 is on the frequency too, well, seemed pretty near too, so that we´ll make report too).*
09.26.40	AY854:	Helsinki, Finnair 854.
	APP:	*(another female voice on the frequency)* Finnair 854 radar contact.
09.26.50	AY854:	854.
09.28.25	APP:	Finnair 854, descend to 2000 feet on QNH 1001.
	AY854:	Down to two thousand, 1001, Finnair 854.
09.29.05	SU645:	Iltapäivää *(good afternoon)* radar, Aeroflot 645, heading 330, maintaining 80.
	APP:	Iltapäivää *(good afternoon)* Aeroflot 645, turn left heading 300, descend to 2000 feet on QNH 1001.
	SU645:	Left heading 300, descending 2000, 1001, Aeroflot 645.
	APP:	Aeroflot 645, is 19 track miles enough for you?
	SU645:	Okay
	APP:	Is it enough?
	SU645	Yes, ma'am.
	APP:	Thank you, sir.
	APP:	Finnair 854, turn right heading 065.

	AY854:	Right heading 065, Finnair 854.
	APP:	Aeroflot 645, turn left heading 250, cleared for ILS-approach 22, 10 miles from touchdown.
	SU645:	Left heading 250, cleared for ILS-approach, Aeroflot 645.
	APP:	Radar.
09.32.00	APP:	Finnair 854, turn right heading 130.
	AY854:	Right heading 130, Finnair 854.
	APP:	Aeroflot 645, 5 miles from touchdown, contact tower 118,6 good bye.
	SU645:	118,6 näkemiin *(good bye)*..
	AY854:	Finnair 854, we have traffic on two o´clock in sight.
09.33.00	APP:	Finnair 854, thank you, cleared for visual approach 22 number 1, correction, number 2, number 1 Tupolev 134.
	AY-854:	Cleared for visual approach 22, we will follow Tupolev, Finnair 854.
	APP:	Radar.
	APP:	Finnair 854, number 1 is now 2,5 miles from touchdown, ground speed 155 knots, contact tower 118,6, terve.
	AY854:	Thank you, Finnair 854, 18,6.
09.34.00	APP:	Finnair 365, contact Tampere 132,32, terve *(good day)*.
	APP:	Finnair 365, are you still on this frequency?
	AY365:	Yes we are 19,9.
	APP:	Very fine sir, contact Tampere 132,32, terve *(good day)*.
	AY854:	32,32, - hei vaan *(bye-bye)*.
	APP:	Hei *(bye)*.

RADIO COMMUNICATIONS ON EFHK APP FREQUENCY 119.10 MHZ 20.8.1997

UTC time. Words in parentheses are translations from finnish.

16.17.05	AY646:	Iltapäivää *(good afternoon)* radar, Finnair 646, 237 down to 110, DC-9, Quebec.
	APP:	Iltaa *(evening)* 646, radar contact, fly on heading 080, descend 80 for vectors 22.
	AY646:	Heading 080, down to 80, Finnair 646 vectors for 22.
	APP:	Finnair 535, proceed to TUSCA.
	AY535:	Direct to TUSCA, Finnair 535.
	AY9803:	Radar, Finnair 9803, good evening, out of 3500.
	APP:	Good evening Finnair 9803, radar contact, on heading 270, climb to flight level 120, vectors for ....eeah mikäs se oli se majakka siel Turussa, Rusko *(eeah what that was that beacon down there in Turku, RUSKO).*
16.17.55	AY9803:	Okay, 270 heading, ... and climbing 120, vectors for .. RUSKO, Finnair 9803.
16.18.02	APP:	Finnair 387, contact control 132,32, moi *(hello).*
	AY387:	32,32, Finnair 387, morjes *(hello).*
	APP:	Finnair 589, report when ready to turn on course.
	AY589:	We'll do, 589.
	APP:	Oscar November Echo, contact Tampere control 132,67, goodbye.
	OY-ONE:	Tampere 132,67, OYONE, kiitos *(thank you).*
	APP:	Kiitos *(thank you).*
16.18.43	AY646:	Finnair 646, may we take about ten degrees to the right.
	APP:	Turn is approved, report when able to turn left again.
16.18.52	AY646:	Approved, call you back, Finnair 646.
16.19.49	KF308:	Radar, Botnia 308, final 15.

Appendix 2/2

16.20.06	KF308:	Radar, Botnia 308, final 15.
	APP:	... No ... ... 535 say again please.
	KF308:	Radar, Botnia 308, final 15.
	APP:	Sorry, 18,6, moi moi *(bye - bye)*.
16.20.20	KF308:	18,6.
	APP:	Finnair 646, are you able to turn left now?
16.20.28	AY646:	In two minutes.
16.20.32	APP:	Okay, Finnair aaa... 9803, level at 110.
	AY9803:	Okay, levelling at 110.
	APP:	And Finnair 646, level at 120.
(obviously	AY9803):	110
16.20.40	APP:	Finnair 646, level at 120, read back now.
	AY646:	Level at 120, Finnair 646, and reaching now.
	APP:	Okay, Finnair 9803, descend to 110 immediately!
16.20.52	AY9803	We have .. aaa .. shortly 110.
	APP:	Okay.
16.21.06	AY646:	And Finnair 646 .. aaa .. we are ready for left turn.
	APP:	646, roger, turn left heading 060, maintain 120.
	AY646:	Heading 060, maintain 120, Finnair 646.
	AY9803:	Traffic in sight, 9803.
16.21.20	APP:	Thank you.
	AY589:	Aaa, Finnair 589, turning on course now.
	APP:	Finnair 589, roger, contact Tampere 125,4, hei *(bye)*.
	AY589:	Hei *(bye)*.
16.21.31	APP:	Finnair 9803, proceed direct to RUSKO, climb to flight level 120.

	AY9803:	Now leaving 110, climbing 120, proceeding direct RUSKO, 9803.
16.22.00	AY9803:	Maintaining 120, Finnair 9803.
	----------a male controller begins to work ----------	
16.22.20	APP:	Finnair 9803.
	APP:	Finnair 646, descend 3000, 1023.
	AY646:	Descend 3000, 1023, Finnair 646, leaving 120.
	APP:	646.
	AY647:	Illat *(evenings)* radar, Finnair 647, passing 2000 feet.
	APP:	Finnair 647, radar contact, climb to flight level 250.
16.23.00	AY647	Up to 250, Finnair 647.