AIRCRAFT INCIDENT REPORT 5/98

Air Accidents Investigation Branch

Department of the Environment, Transport and the Regions

AIRPROX (C) : Boeing 737-200 and Boeing 757

Report on an incident near London Heathrow Airport on 27 August 1997

This investigation was carried out in accordance with
The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996

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LIST OF AIRCRAFT ACCIDENT & INCIDENT REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

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1/97	Douglas Aircraft Company MD-83, G-DEVR at Manchester Airport on 27 April 1995	February 1997
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Department of the Environment, Transport and the Regions
Air Accidents Investigation Branch
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10 September 1998

The Right Honourable John Prescott MP
Secretary of State
for the Environment, Transport and the Regions

Sir,

I have the honour to submit the report by Mr M M Charles, an Inspector of Air Accidents, on the circumstances of an AIRPROX incident near London Heathrow Aiport on 27 August 1997.

I have the honour to be
Sir
Your obedient servant

K P R Smart
Chief Inspector of Air Accidents

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GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AAIB	-	Air Accidents Investigation Branch
ACAS	-	Airborne Collision-Avoidance System
AFS	-	Aerodrome Fire Service
agl	-	Above ground level
AIRPROX	-	Aircraft proximity
AIP	-	Aeronautical Information Package
AMA	-	Approach Monitoring Aid
ANO	-	Air Navigation Order
AOC	-	Air Operator's Certificate
ATC	-	Air Traffic Control
ATSSD	-	Air Traffic Services Standards Department
ATM	-	Air Traffic Monitor
CAA	-	Civil Aviation Authority
DERA	-	Defence Evaluation and Research Agency
ECT	-	Emergency Continuation Training
FL	-	Flight Level
FPS	-	Flight Progress Strip
GMC	-	Ground Movement Controller
ICAO	-	International Civil Aviation Organisation
IFR	-	Instrument Flight Rules
JAAP	-	Joint AIRPROX Assessment Panel
LATCC	-	London Area and Terminal Control Centre
LHR	-	London Heathrow
MATS	-	Manual of Air Traffic Services
MTCA	-	Medium Term Conflict Alert
MOD	-	Ministry of Defence
MHz	-	Megahertz
NATS	-	National Air Traffic Services Limited
NDB	-	Non-Directional Beacon
nm	-	nautical miles
QNH	-	Corrected mean sea level pressure
R/T	-	Radio Telephone
SID	-	Standard Instrument Departure
SMF	-	Separation Monitoring Function
SVFR	-	Special Visual Flight Rules
TC	-	Terminal Control
TCAS	-	Traffic Alert and Collision-Avoidance System
UTC	-	Coordinated Universal Time
VCR	-	Visual Control Room

Air Accidents Investigation Branch

Aircraft Incident Report No: 5/98 (EW/C97/8/11)

Registered Owner:	1. Virgin Express
	2. British Airways
Operator:	1. Air Foyle Charter Airlines
	2. British Airways
Aircraft Type:	1. Boeing 737-200
	2. Boeing 757
Nationality:	British
Registration:	1. G-BECG (callsign SAB 603)
	2. G-BMRD (callsign BAW 818)
Place of incident:	Near London Heathrow Airport Latitude: 51° 28'N Longitude: 000°30'W
Date and Time:	27 August 1997 at 1350 hrs
	All times in this report are UTC

Synopsis

The incident was notified to the Air Accidents Investigation Branch (AAIB) on 28 August 1997 at 0900 hrs and the investigation was initiated that day. The AAIB team comprised Mr M M Charles (Investigator-in-Charge), Mr R W Shimmons (Operations), Mr I J Weston (Air Traffic Control) and Dr S M Baker (Human Factors).

The incident occurred when a Boeing 737, callsign SAB 603, initiated a missed approach from Runway 27 Left (27L) at London Heathrow (LHR). The air traffic controller of SAB 603, who was operating as the Air Arrivals controller, asked his colleague, the Air Departures controller sitting adjacent, for information on departing aircraft. The Air Departures controller who was working under the supervision of a Mentor, informed Air Arrivals that an Air France aircraft, callsign AFR 813, was airborne on a 'Midhurst' Standard Instrument Departure (SID). The Mentor also indicated to the Air Arrivals controller both verbally and by signs that AFR 813 would be turned to the right onto a north-westerly track. The Air Arrivals controller then turned SAB 603 right onto a heading of 310°. Shortly afterwards, the Mentor heard the Air Arrivals controller announcing that he had turned SAB 603 onto 310° and immediately

informed him that a British Airways aircraft, callsign BAW 818, was also airborne on a 'Brookmans Park' SID. The two controllers then instructed their respective aircraft to alter heading and noted from their Air Traffic Monitor (ATM) screens that the two aircraft symbols were very close.

Subsequent calculations revealed that the minimum separation was 200 feet vertically and 0.16 nm horizontally when the highest aircraft was at 2,400 feet agl. All the flight crews involved in the incident complied fully and correctly with ATC instructions. At the time of the incident, both SAB 603 and BAW 818 were in cloud and none of the crew members in either aircraft saw the other.

The investigation revealed the following causal factors:

(i) Co-ordination between Air Arrivals and Air Departures during the missed approach of SAB 603 was incomplete, primarily because neither Air Departures nor the Mentor advised Air Arrivals that BAW 818 was airborne, but also because Air Arrivals did not obtain agreement from Air Departures before turning SAB 603 to the right.

(ii) The ATC procedures current at the time of the incident for the integration of the missed approach aircraft into the departure flow placed too great a reliance on potentially fallible human communication at a time of increased workload.

(iii) The LHR ATC instructions relating to missed approaches were not sufficiently clear or comprehensive regarding the co-ordination required and the definition of a conflicting aircraft.

Two safety recommendations were made during the course of this investigation.

1 Factual Information

1.1 History of the incident

Heathrow ATC was using Runway 27 Right (27R) for take off and Runway 27 Left (27L) for landing. The weather had been good but was temporarily deteriorating with heavy rain showers. A Boeing 737 of Air Foyle Charter Airlines, operating as SAB 603, was making an Instrument Landing System (ILS) approach to Runway 27L; at approximately two to three miles range from touchdown, the Air Arrivals controller advised the crew that the weather had deteriorated and that they might not see the runway until they were at their minimum approach height. The crew acknowledged this message and advised the controller that they would be "Going Around" if they were not visual at their minimum approach height. This information was passed by the Air Arrivals controller to the Air Departures controller.

The Air Departures controller, who was undergoing training, was sitting to the right of the Air Arrivals controller; between these two controllers was another controller, the On the Job Training Instructor (OJTI, referred to as the Mentor throughout this report), who was supervising the training of the Air Departures controller. At around the time that SAB 603 was between two and three miles from touchdown, the Air Departures controller had given an Air France aircraft (AFR 813) clearance to take off on a 'Midhurst 3 Foxtrot' departure; this departure involves a left turn onto the London 244° radial and a subsequent crossing of the extended centre-line of Runway 27L (see Appendix A). Then, after the required interval, the Air Departures controller cleared a British Airways Boeing 757 (BAW 818) to take off on a 'Brookmans Park 6 Foxtrot' departure; this departure involves a northerly turn at approximately 3 miles from the airport (see Appendix B).

When SAB 603 reached its decision height, the crew could not see the runway and initiated a missed approach; they complied with the laid down procedure which was to 'Climb straight ahead to 3,000 feet, then as directed by ATC'. Air Arrivals had seen the aircraft going-around and had acknowledged the manoeuvre by radio to the crew. He activated the missed approach alarm, turned to Air Departures to inform her of the missed approach and to obtain information on departing aircraft. Air Departures informed him of the 'Midhurst' departure and the Mentor indicated that this aircraft would be turned to the right; Air Arrivals saw this aircraft on his Air Traffic Monitor (ATM) screen. As he then considered that the 'Midhurst' aircraft was close to the extended centreline of Runway 27L and apparently going left, the controller decided to turn SAB 603 right onto a heading of 310°; he transmitted this message to SAB 603 and listened to the acknowledgement. After announcing his actions to his colleague he then used a

direct landline to advise Terminal Control (TC) of the aircraft's direction. The Mentor heard this message and immediately advised Air Arrivals that there was also a 'Brookmans Park' departure aircraft airborne. Air Arrivals instructed SAB 603 to turn left and Air Departures instructed BAW 818 to turn right. Almost immediately, all three controllers saw the aircraft symbols for BAW 818 and SAB 603 appear very close together on the ATM with the two aircraft tracks beginning to diverge.

At the time of the incident, both SAB 603 and BAW 818 were in cloud and none of the crew members in either aircraft saw the other. They were not aware of the incident until their respective companies were informed by the AAIB.

1.2 Injuries to persons

None.

1.3 Damage to aircraft

None.

1.4 Other damage

None.

1.5 Personnel information

1.5.1

Mentor:	Male aged 43 years
Licence:	Initial issue 23 June 1980
Ratings:	Aerodrome control issued 23 June 1980
	Approach control issued 11 November 1980
	Approach radar control issued 8 September 1981
Medical certificate:	Current
Start of duty period:	1330 hrs
Previous rest period:	16 hours 30 minutes

The controller arrived at London Heathrow in 1985 and qualified in aerodrome control in May 1985; he was validated in approach control and approach radar control in May 1986. He became involved in controller training in 1988 and was acting as a Mentor to the Air Departures controller.

1.5.2	Air Departures controller:	Female aged 36 years
	Licence:	Initial issue 11 July 1981
	Ratings:	Aerodrome control issued 11 July 1981
		Approach control issued 8 September 1981
		Approach radar issued 11 July 1982
	Medical certificate:	Current
	Start of duty period:	1330 hrs
	Previous rest period:	16 hours 30 minutes

The controller arrived at London Heathrow in July 1997 and was still undergoing refresher training. She had also been at Heathrow as a controller from 1985 to 1995 and had then been validated in aerodrome control, approach control and approach radar control. In the intervening period, she had been engaged in ATC related, but non-operational, duties.

1.5.3	Air Arrivals controller:	Male aged 49 years
	Licence:	Initial issue 9 October 1970
	Ratings:	Aerodrome control issued 9 October 1970
		Approach control issued 9 October 1970
		Approach radar issued 9 October 1970
	Medical certificate:	Current
	Start of duty period:	1330 hrs
	Previous rest period:	16 hours 30 minutes

The controller arrived at London Heathrow in 1987 and qualified in aerodrome control in June 1987; on 11 March 1988, he was validated in both approach control and approach radar control. He had been involved in training at LHR but other duties had precluded him doing any training during the few months prior to the incident.

Note: The LHR approach/approach radar control validations for these controllers lapsed when these functions were transferred to London Area Terminal Control Centre.

1.6 Aircraft information

Neither of the aircraft involved in the incident was equipped with the Airborne Collision-Avoidance System (ACAS).

Current proposals are that all turbine powered civilian aircraft, with a maximum take-off weight of 15,000 kg or with a maximum approved seating configuration of more than 30, which are registered in UK or operate in UK will require the fitment of ACAS by 1 January 2000. The ACAS equipment currently available for implementation is the Traffic Alert and Collision-Avoidance System (TCAS II). Studies are continuing as to whether there is a requirement for TCAS to be fitted to aircraft with more than 19 passengers seats or a maximum take-off weight in excess of 5,700 kg.

1.7 Meteorological information

1.7.1 Automatic Terminal Information Service (ATIS)

The 1320 ATIS broadcast included the following information:

" ***** THIS IS HEATHROW INFORMATION XRAY ONE THREE TWO ZERO HOURS WEATHER LANDING RUNWAY TWO SEVEN LEFT DEPARTURE RUNWAY TWO SEVEN RIGHT THOUGH PILOTS SHOULD EXPECT TO CHANGE TO ER TWO SEVEN RIGHT FOR LANDING AND TWO SEVEN LEFT FOR DEPARTURE AT TIME ONE FOUR ZERO ZERO HOURS TWO ZERO ZERO DEGREES ONE THREE KNOTS ONE FOUR KILOMETRES IN RAIN CLOUD SCATTERED ONE ONE ZERO ZERO FEET OVERCAST ONE FOUR ZERO ZERO FEET TEMPERATURE ONE EIGHT DEWPOINT ONE FIVE QNH NINE NINE NINE MILLIBARS PILOTS BE ADVISED THAT WINDSHEAR HAS BEEN REPORTED RUNWAY TWO SEVEN LEFT APPROACH BETWEEN EIGHT HUNDRED AND ONE THOUSAND FEET WITH A LOSS OF SPEED OF BETWEEN TEN AND ONE FIVE KNOTS ***** "

1.7.2 Weather actual

The actual weather at 1350 hrs was recorded as follows:

Surface wind was 180°/10 kt, varying between 130° and 210°; visibility was 2,800 metres in heavy rain; cloud was 3 oktas at 800 feet, 6 oktas at 1,100 feet and 8 oktas at 1,400 feet.

Flight crew at LHR, and controllers in ATC confirmed that the weather had been good but that heavy rain was falling at the time of the incident.

1.8 Aids to navigation

Not relevant.

1.9 Communications

1.9.1 Aircraft

Aircraft on approach were on different frequencies from aircraft on departure and there was no requirement for the crews to monitor the other frequency. At the time of the incident, SAB 603 was on the Air Arrivals frequency of 118.7 MHz and both BAW 818 and AFR 813 were on the Air Departures frequency 118.5 MHz. Both frequencies were recorded automatically and clear recordings were made of the period covering the incident. All transmissions and replies were made in accordance with standard Radio Telephone (R/T) procedures.

1.9.2 Air Traffic Control

Air Arrivals, Air Departures and the Mentor were sitting adjacent to each other and each was wearing an approved headset which incorporated a 'Boom' microphone. The controllers were only in R/T contact with aircraft on their respective frequency i.e. Air Arrivals could only speak to and hear aircraft on frequency 118.7 MHz and Air Departures was only in contact with aircraft on frequency 118.5 MHz; the Mentor was using the Air Departures frequency. The controllers also received telephone messages through one earpiece of their headset. There was no electronic communication between the two air controllers; any necessary communication was verbal. All ATC frequencies and telephone messages were recorded automatically and clear recordings were made of the period covering the incident. There is no system to record any verbal exchanges within the ATC control room.

1.10 Aerodrome information

1.10.1 Background information

The Heathrow Airport aerodrome control operation is complex and busy. The task is split into air and ground movement control with the former task being sub-divided into Air Arrivals and Air Departure positions. Air controllers are not only required to issue appropriate landing and take-off clearances but also to integrate inbound and outbound flights and ensure that the requirements of other airspace users in the area are taken into account. To reflect the size and complexity of the task, the airspace surrounding the airport has been accorded a Class A classification in accordance with Annex 11 to the Convention on

International Civil Aviation; details are published in the UK Aeronautical Information Package (UK AIP). In such airspace, all aircraft are required to operate in accordance with Instrument Flight Rules (IFR) and under an air traffic control clearance. Controllers are required to provide standard separation between aircraft. This can be achieved by the provision of either vertical or horizontal separation. In the case of Heathrow, this is either 1,000 feet vertically or a minimum of 2.5 nm radar separation. In accordance with the Manual of Air Traffic Services (MATS) Part 1, these minima may be reduced in the vicinity of the aerodrome under any of the following conditions:

'(a) Adequate separation can be provided by the aerodrome controller when each aircraft is continuously visible to this controller; or

(b) Each aircraft is continuously visible to the pilots of other aircraft concerned, and the pilots report that they can maintain their own separation, or

(c) When one aircraft is following another the pilot of the succeeding aircraft reports that he has the other in sight and can maintain separation.'

1.10.2 Separation requirements

The International Civil Aviation Organisation (ICAO) requirements, laid down in Annex 14, are that parallel runways should be a minimum of 760 metres apart in order to permit 'segregated parallel operations' (Defined in Annex 14 as: 'Simultaneous operations on parallel or near-parallel instrument runways in which one runway is used exclusively for approaches and the other runway is used exclusively for departures'). The two main runways at LHR are parallel and are 1,415 metres apart.

MATS Part 1 requires that, for airborne aircraft: 'Standard vertical or horizontal separation shall be provided, unless otherwise specified, between . . . . All flights in Class A and B airspace . . .'. The normal minimum prescribed radar separation is 3 nm although LHR has been approved to operate to lower limits of 2.5 nm minimum radar separation on final approach under certain circumstances.

1.10.3 Normal operations

LHR uses 'segregated parallel operations' as a normal mode of operation but, for 'noise reduction' reasons, the westerly runway roles are reversed each morning and afternoon. With this operation, provided that aircraft on approach complete their landings, there is no risk of conflict. However, when a landing aircraft

commences a missed approach, there will be a potential breach of minimum separation with any aircraft taking off.

1.10.4 Visual Control Room (VCR)

The Heathrow Visual Control Room (VCR) is manned by a Supervisor, five air traffic controllers and various supporting staff. Three of the controllers deal with Ground Movement and two, Air Arrivals and Air Departures, are responsible for all movements on the respective arrival and departure runways. The Air controllers' positions are on a raised dais, facing east and west, to allow a good view of the runways and the approach and departure tracks, although the VCR roof interrupts sightings of aircraft climbing away when close to the airfield. Both Air positions are fully equipped including flight progress strip displays and the controllers have access to dedicated radio telephony and telephone facilities together with Air Traffic Monitor (ATM) and Surface Movement Radar. Air Arrivals occupies the northerly position (i.e. on westerly operations the left hand console), with Air Departures sitting to the south. Although space within the VCR is constrained, there is sufficient room available to enable training staff to be adjacent to each of the operational positions. Co-ordination between all of the staff is direct person to person without the use of any electronic medium. Such co-ordination is not automatically recorded.

1.10.5 Aerodrome Traffic Monitor (ATM)

An ATM is provided to assist in achieving maximum runway utilisation and aerodrome capacity. Operation of an ATM is not associated with a particular air traffic control rating and, although it displays radar data, it must not be used as a surveillance radar to provide approach radar services. At LHR, both Air controllers are provided with an individual ATM to assist them in their task. The equipment consists of a high brightness monochrome display utilising radar data and allows confirmation of airborne aircraft position and identity. It is operated by control panels and a menu/windows system manipulated by a rollerball/cursor. Controllers can select a pre-determined set of ranges (10 miles, 15 miles, 20 miles or 30 miles) and may use either a preset central position or an off-centre function to allow for personal choice. At Heathrow, the ATM has a filter to reduce interference from aircraft on the ground. There is also an Approach Monitoring Aid (AMA) associated with the ATM which provides an alert if the aircraft is not on the final approach track.

MATS Part 2 for LHR details the following use for which the ATM can be used:

'(a) Determine the landing order, spacing and distance from touchdown of arriving aircraft.

(b) Assist in providing initial separation in the event of a missed approach. It may be assumed that Mode C readouts on arriving aircraft have been verified unless otherwise notified.

(c) Confirm that the initial tracks of departing aircraft are coincident with the allocated SIDs/departure clearances.

(d) Verify, when possible, that the correct SSR code has been selected by departing traffic and to correct when necessary.

(e) Assess a specific departure interval between aircraft departing from the same runway. Where 2 minutes separation is specified, a departure interval of at least 5 nm may be used as an alternative for aircraft on diverging tracks only.

(f) Assess a specific departure interval between aircraft departing from parallel runways provided that the tracks of the aircraft involved do not converge.

(g) Monitor Air Departures from different runways where the (SID) tracks will cross. Vertical separation based only on pilot reports may be used.

(h) Ensure that arriving, departing and overflying helicopters do not conflict with the tracks of arriving or departing fixed wing traffic.

(i) Pass traffic information to pilots when required.

(j) When requested, pass range from touchdown.

1.10.6 Arrival procedures

Aircraft inbound to Heathrow are radar vectored onto the final approach track by controllers in the Terminal Control (TC) room at the London Area and Terminal Control Centre (LATCC), West Drayton. The TC controller will normally retain control of inbound aircraft until such time as the pilot reports that he is established on the ILS or, during a surveillance radar approach, that he can continue the approach visually at which time transfer to Air Arrivals takes place. It is the responsibility of the TC controller to establish the necessary separation between aircraft, which will be either equal to, or greater than, any vortex wake spacing requirements, but Air Arrivals monitors the aircraft on the ATM to check that the spacing requirements are being achieved. No instructions to alter speed on the final approach can be issued by Air Arrivals without obtaining the approval of

TC. Similarly, no other instructions or advice can be offered to aircraft which would reduce the separation established by TC until the aircraft crew are flying with visual reference to the surface when reduced separation, applicable within the vicinity of the airport, can be used. Air Arrivals issues landing clearance when appropriate.

1.10.7 Departure procedures

The LHR Ground Movement Controller (GMC) is responsible for aircraft taxiing for departure from the time that they are authorised to push back until they are transferred to Air Departures. Taxi clearance is given from the parking stand to the appropriate runway holding area. Once no further ground movement confliction exists, control of the aircraft is passed from GMC to Air Departures and the accompanying Flight Progress Strip (FPS) is passed by hand for display on the Air Departures controller's board. Aircraft intending to enter the airways system are required to be cleared via one of a number of Standard Instrument Departures (SIDs) which detail position and altitude requirements. Compliance with the SID ensures that the aircraft remains within controlled airspace and that a degree of separation is achieved from aircraft operating on other SIDs and from aircraft operating to the north of Heathrow within the Northolt Radar Manoeuvring Area. The knowledge that departing aircraft will be following a pre-determined track and a minimum climb gradient also allows controllers to plan separation for aircraft operating within the Heathrow Control Zone on Special Visual Flight Rules (SVFR) clearances.

The Air Departures controller co-ordinates the departures in accordance with MATS Part 2, Chapter 6 for London Heathrow Airport. This document details restrictions on separation requirements and the controller must comply with these while optimising the departure rate. However, the controller must take into account wake turbulence considerations and many additional factors. These include standard separations depending on whether following aircraft are on the same SID and an awareness of the 'Speed Group' of the respective aircraft. To assist the controller, all departing aircraft from LHR are initially restricted to 250 kt (300 kt in the case of Concorde) whilst flying below Flight Level (FL) 100.

Transfer of control to the appropriate outbound radar controller is made as soon as possible after resolving any aerodrome conflictions but the aircraft's FPS is retained in the Air Departure controller's display for at least five minutes after the aircraft's departure time.

1.10.8 Missed approach procedures

The missed approach procedures in use at the time of this incident had been developed over a number of years in the light of operational experience. Previously, each runway had procedures which took the aircraft away from the parallel runway towards a Non-Directional Beacon (NDB) at which low level holding could take place. However, due to the dynamic nature of the task, flights rarely completed the procedures and were regularly radar vectored, during the initial stages of the missed approach, back into the arrival sequence. In the light of comments made by flight crew and operators, a common missed approach procedure was introduced which required flights to climb straight ahead to 3,000 feet and then to proceed as directed by ATC. This allowed controllers the tactical freedom to vector the aircraft back into the arrival sequence.

At the time of the incident, the missed approach procedure for aircraft approaching any of the east/west runways at Heathrow, published in the UK Aeronautical Information Publication (now re-issued as the Aeronautical Information Package), was for aircraft to 'climb straight ahead to 3,000 feet, then as directed by ATC'. The LHR ATC missed approach instructions for controllers (Appendix C) amplified this procedure but included a note that: 'Normally missed approaches from Runways 27 R/09 L will be turned, after co-ordination, towards the north and from Runways 27 L/09 R towards the south. ..... The aerodrome controller may issue a tactical heading to an aircraft executing a missed approach to resolve an immediate confliction.' The instruction also included the statement that: 'Aircraft carrying out a missed approach shall not be instructed to make any turns below 1,500 feet QNH unless there are overriding safety reasons.'

A missed approach increases the workload of the Air Arrivals controller. Apart from co-ordinating with Air Departures, there is a requirement to activate the alarm (to warn the VCR supervisor, Terminal Control, Northolt and the SVFR controller), liaise with the Terminal Controller over headings for the missed approach and pass instructions to that aircraft, while continuing to work the constant flow of aircraft on approach to land. Furthermore, if an accident occurs, or the runway is obstructed, he must also liaise with the Aerodrome Fire Service (AFS) or initiate actions to clear the runway.

Following the incident, LHR management issued a replacement instruction for missed approaches (Appendix D). This confirmed the procedures already in effect but, amongst other aspects, stressed that: 'if a decision is made to turn a missed approach aircraft towards the departure runway, the Air Arrivals controller must ensure that specific authority is obtained from the departure controller and acknowledged. The arrival controller may issue a tactical heading to an aircraft executing a missed approach to solve conflictions with departing traffic.'

Missed approaches were acknowledged by the National Air Traffic Services Ltd (NATS) Heathrow Technical Committee as 'potential emergency situations'. In such circumstances, the Technical Committee considered that the procedures should give the flexibility to regain standard separation as soon as possible. Therefore, it would be unusual for an aircraft to complete the published missed approach procedure before the controller intervenes with tactical instructions.

1.11 Flight recorders

Not relevant.

1.12 Wreckage recovery and examination

Not relevant.

1.13 Medical and pathological information

There were no medical contributions to the causes of the incident.

1.14 Fire

Not applicable.

1.15 Survival aspects

Not relevant.

1.16 Tests and research

1.16.1 Following this incident, a Principal Psychologist from the Centre for Human Sciences at the Defence Evaluation and Research Agency (DERA) Farnborough, was contracted by the AAIB to report on the human factors likely to have a bearing on the incident. The report was based on this incident and an earlier incident on 18 December 1992 together with a visit to Heathrow and a meeting with ATC staff. The objectives were to identify promising lines of enquiry for improvements in flight safety rather than firm recommendations for changes in current practice.

He considered that the specified instruction for dealing with missed approaches (NATS Heathrow Unit Supplementary Instruction 29/97 effective 11 September 1997, issued following the incident on 27 August 1997) appeared comprehensive and sound in principle. However, practice and principle inevitably correspond imperfectly in real systems. He based his report on the scope for deviation in the system and considered the effects of this under the following three headings:

a. **The co-ordination process.** Co-ordination between Air Arrivals and Air Departures is essentially verbal, but is, potentially, enhanced by their close proximity and by the fact that each has an ATM. However, the advantages are limited by Air Arrivals typically sitting more than a metre away from the Air Departures flight strip display and not having an uninterrupted view of all the progress strips; a re-arrangement of the displays may be appropriate. Additionally, the extent of blanking of the centre portion of the ATM at present may be more than necessary and a review to minimise the present blanking could be considered. Finally, with the number of missed approaches occurring, there were probably occasions when a breakdown in communication happened but with no subsequent investigation because the lapse did not result in a serious incident; a monitoring scheme could be put in place to determine the frequency of incomplete co-ordination and to characterise the form and causes of it.

b. **The effects of expectation.** On average, most controllers should expect to experience about 8 missed approaches per year and will have a reasonable idea of what to expect by the time they have completed their local validation. However, it may take several years before a controller has experienced the full range of challenges that may be posed by a missed approach. Expectation in this context is a fundamental part of skilled behaviour; it reduces workload and has a powerful effect on decision making, attention and even on perception. Training is a powerful tool to complement or even pre-empt actual missed approaches and the quality of instruction is more important than the complexity of the hardware; the training at LHR appears both sensitive and imaginative.

c. **Workload.** The visual control room (VCR) is a busy and noisy environment. Under normal operations, both Air Arrivals and Air Departures are working hard but within tolerable limits. Missed approaches represent a potential source of rapidly escalating workload. However, the workload increases more significantly for Air Arrivals because of the additional tasks imposed and because the normal flow rate is continuing. On the other hand, Air Departures can suspend departures by not giving take-off clearances. Consideration of re-assigning tasks stemming from the missed approach to reduce the workload of Air Arrivals would be difficult without compromising the controller's responsibility for the aircraft on frequency. One possibility would be for the missed approach aircraft always to follow a standard procedure; the Air Departures controller would then have the responsibility for ensuring separation. In principle, all the missed approach and standard instrument departures could be designed to ensure separation during missed approaches without the need for co-ordination between the two controllers.

The psychologist concluded his report with the comment that, whatever the future improvement in ergonomics or training, or revision of instructions, co-ordination failures should be expected to occur. Routine monitoring of co-ordination during all missed approaches is necessary; this should allow early identification of future trends or problems.

1.17 Organisational and management information

1.17.1 Training

LHR has its own in-house simulator and training personnel. The equipment in the simulator suite is not totally representative of that in the VCR and the room itself is much quieter than the VCR; this could lead trainees to underestimate the difficulty of communicating in the real environment. Both the human factors psychologist team member and the DERA psychologist involved in the investigation commented that these apparent shortcomings are not altogether unusual in simulators and can be overcome, to some extent, by imaginatively designed training scenarios. At LHR, the training appears well considered and effective given the constraints placed upon it.

The training of controllers is tailored to suit the trainee's ATC experience and ability in order to achieve the required level of competence. The training required will generally be different between those with no prior ATC experience and those coming from another unit or having had a break from operational controlling. Prior to being allowed to conduct solo duties, a controller will have been judged by local unit management to have reached the required standard and will then have undergone a satisfactory assessment of competence.

Typically, a new arrival with no previous experience would undergo initial classroom and simulator training in Aerodrome Control including Air Arrivals and Ground Movement Planning. This would be followed by a period of approximately 6 weeks live training in Air Arrivals being monitored by an experienced Mentor; this provides a useful period to allow the trainee time to settle into the operational environment. The initial classroom training on missed approaches is very limited due to the trainee's level of experience and understanding and therefore, during this period, the Mentor would take the lead in any missed approach events.

After the initial live training, the trainee returns to the training section for classroom and simulator work on GMC and Air Departures. At this stage, a higher level of appreciation of missed approaches can be attained since the trainee can now relate better to the conflict areas; however, there is still insufficient understanding to develop fully all the necessary actions by Air Departures during

missed approaches. Thereafter, the trainee returns to live training in both Air Arrivals and Air Departures. The trainee is still under the supervision of a Mentor who retains overall responsibility; however, as time passes and the trainee gains experience and competence, the Mentor allows the trainee greater flexibility.

Prior to a controller being considered for a certification of competence the trainee returns to the training section for an emergency/unusual incident training course. This consists of videos, lectures (including actions in the event of a missed approach) and simulator work covering a wide number of emergency scenarios and a high number of missed approaches. It is only at this stage that the trainee has sufficient knowledge and capacity to appreciate fully the problems of missed approaches. A video of a previous incident is shown to provide a real example of the co-ordination and teamwork required during a missed approach; at this stage, the trainee is well used to working as both Air Arrivals and Air Departures under minimal supervision. During this period, the trainee will experience approximately 10 different missed approach scenarios in the simulator. Successful completion of this phase leads to the final competence assessment; the average time for a new trainee to progress to this stage is 9 months.

Experienced controllers or those returning to LHR would be given training commensurate with their previous experience and/or the period of time away from controlling. However, all would be required to complete the emergency training course and successfully complete the competence board.

Thereafter, all controllers are subject to continual monitoring by Local Competency Examiners and by annual continuation training; this annual training involves classroom and simulator work. During this period, emergency and unusual situations are chosen from a pre-determined list. However, missed approaches are one of three topics which are always covered. They are discussed in the classroom and then the controller is exposed to various scenarios during the simulator session.

All three controllers involved in this incident were totally familiar with the operational environment at LHR.

1.18 Additional information

1.18.1 Controllers' working hours

Limitations on controllers' working hours are detailed in 'The Scheme for the Regulation of the Hours of Civil Air Traffic Controllers in the UK' issued by the Civil Aviation Authority (CAA). The purpose of the scheme is to ensure, so far

as reasonably possible, that controller fatigue does not endanger aircraft thereby supporting controllers in providing a safe and effective service.

The scheme details maximum duty and operational periods, together with requirements for breaks and intervals between periods of duty. At LHR, at the time of the incident, no operational duty period was to exceed a maximum of two hours, followed by a break of not less than 30 minutes. Furthermore, in recognition of the complexity and demands of the task, the Air Departures position was limited by local instruction to a maximum of 90 minutes.

All personnel on duty at the time of the incident had complied with these limitations.

1.18.2 ATC Separation Monitoring Function (SMF)

Subsequent reference to the SMF equipment, which monitors aircraft separation but is not contemporaneously displayed to controllers, recorded that the closest the aircraft came to each other was 200 feet vertically and 0.16 nm horizontally; at this point, the highest aircraft was at 2,400 feet agl.

1.18.3 Previous incidents

A very similar incident occurred at LHR on 18 December 1992 and this resulted in a recommendation by the Joint AIRPROX Assessment Panel (JAAP) for the CAA to review the missed approach procedures at LHR. A review was completed by the NATS but it was decided, and agreed by the CAA, that the procedures were satisfactory when enhanced by improved ATC training. A further incident occurred in April 1996 (reported in the AAIB Bulletin 7/96) in which the cause was attributed to ineffective co-ordination between Air Departures and Air Arrivals.

A survey of landings and missed approaches at LHR from January 1996 to August 1997 shows that, with an average of over 18,000 landings per month, there are approximately 43 missed approaches each month. The main reason for missed approaches is that the runway is still occupied by the preceding aircraft. The rate of missed approaches has shown a slight increase from those in 1994 and 1995. An investigation is not initiated for missed approaches unless it is considered that there has been an infringement of separation requirements.

1.18.4 NATS investigation

Shortly after the incident, the Chief Executive of NATS initiated a n investigation; the terms of reference of the NATS Team were as follows:

'1. To determine the circumstances of the Airprox C i ıcident in accordance with procedure SP301 (NATS Safety M .nagement Procedure).

2. To determine the sequence of events which led to the ir :ident, the immediate action taken, and the operational effects.

3. To ascertain if relevant procedures and instructions wer : complied with.

4. To determine the causes of the incident and any contr butory, or aggravating, factors.

5. To make appropriate recommendations.

6. To produce a detailed report of the inc dent by 19 September 1997.'

The NATS Team concluded that the direct cause of the incident was ineffective co-ordination and communication between the two controllers. A ditionally, they made two recommendations for changes to the wording of th e LHR missed approach procedure; one to reinforce the need for co-ordination p ior to the issue of instructions to the pilot, and the other to emphasise that all 'd eparting traffic' was potentially 'conflicting traffic' to missed approa hes. These recommendations were included in the replacement instruction iss ed by LHR.

1.18.5 Psychological aspects

In addition to the report commissioned from the DERA by the AA B (described at paragraph 1.16.1), the AAIB co-opted a psychologist from the C/ A to work with the investigating team.

1.18.6 Controller interviews

The three controllers involved were interviewed separately. All th ree co-operated fully with the investigation and all were agreed on the sequence of events; there were no conflicting statements made. Relevant contents of the interviews are detailed below:

1. The flight crews complied with all instructions.

2. Air Arrivals informed Air Departures about the missed approach.

3. Air Departures informed Air Arrivals about the 'Midhurst' departure and stated that she would turn the aircraft to the west.

4. Air Departures did not advise Air Arrivals about the 'Brookmans Park' departure because she did not consider it as a confliction.

5. The Mentor agreed with all the actions that Air Departures was taking and never felt it necessary to assume control.

6. All controllers were aware of the fact that missed approaches from Runway 27L are normally turned left.

7. Air Arrivals decided to turn SAB 603 right because he considered that a left turn would have been a possible confliction to the 'Midhurst' departure and a right turn would cause less disruption as he was not aware of the 'Brookmans Park' departure.

8. Both the Mentor and Air Departures expected the missed approach aircraft to be turned left.

9. The Mentor had never seen an aircraft turn right from a missed approach to Runway 27L.

10. All three controllers considered that the atmosphere and noise in the VCR leading up to the incident was normal and that they were not distracted.

11. The three controllers had worked together many times.

12. Air Departures had noticed no changes in the duties and procedures for Air Departures and only a few minor ones in Air Arrivals since her previous time at LHR.

1.18.7 Immediately after the incident, all three controllers were relieved from duty. Then, following a table-top exercise with Manager ATC, Unit Training Manager and a Local Competency Examiner, the two current controllers completed a simulator session before being allowed to re-assume their duties. Both were offered but declined the use of counselling. Air Departures, who was under training, also participated in the table-top exercise. Thereafter, she received counselling and agreed with management that she could resume her duties when she wished. She recommenced her training and, after a successful competency assessment, assumed solo duties from 11 March 1998.

1.19 New investigation techniques

None.

2 Analysis

2.1 Introduction

The incident occurred when the weather at LHR deteriorated to conditions below that required by SAB 603 on approach. In consequence, the commander initiated a standard missed approach. Air Arrivals saw the aircraft climbing, acknowledged the missed approach to the crew and activated the missed approach alarm. He also informed his colleague, Air Departures, of the manoeuvre and received the information that AFR 813 was airborne on a 'Midhurst' SID and that AFR 813 would be turned onto a westerly heading. However, he neither saw nor was informed that another aircraft, BAW 818, was also just taking off on a 'Brookmans Park' SID. Based on the information that he had received, Air Arrivals turned SAB 603 to the right to achieve maximum separation with AFR 813 and also to minimise any disruption to the latter aircraft's flightpath. This resulted in SAB 603 and BAW 818 coming into close proximity to each other. Air Departures failed to inform Air Arrivals of all the aircraft on departure at the time of the missed approach because she did not consider BAW 818 as a confliction. This omission was apparently endorsed by the Mentor since he failed to amplify the information passed. Although Air Departures was sitting in the controller's position, the Mentor retained overall responsibility for the duty.

All of the controllers involved were familiar with the procedures at LHR and had worked together many times. They had been on duty for some 20 minutes and none considered that the environment of the VCR or fatigue was a factor in the incident.

A missed approach is not an unusual occurrence at LHR although it is acknowledged by the LHR Technical Committee as a potential emergency situation; however, strict adherence to the published instructions would have prevented this incident. This leads to the conclusion that a human failing, i.e. a breakdown in communications, was the only cause of this incident. However, the fact that two experienced controllers, albeit one undergoing refresher training, failed to comply with the procedures raises the possibility that there may be additional factors. Accordingly, this analysis examines other aspects which may be relevant to the incident; these include instructions and orders, training, the VCR working environment and the relative workloads of Air Arrivals and Air Departures including the additional factor of the presence of the Mentor. Human factors are a significant element in this incident and are discussed in some detail.

2.2 ATC instructions

Prior to the incident, the extant instructions for dealing with missed approaches were contained within MATS Part 2 for LHR; the appropriate instruction, which was dated February 1997, is reproduced as Appendix C. This confirms the normal missed approach as: 'Climb straight ahead to 3,000 feet then as directed by ATC'. It also contains a note to the effect that 'Normally missed approaches from Runways 27R/ 09L will be turned, after co-ordination, towards the North and from runways 27L/ 09R towards the South.' It also states that 'The aerodrome controller may issue a tactical heading to an aircraft executing a missed approach to solve an immediate confliction.' Other relevant instructions are that Air Arrivals and Air Departures are to co-ordinate with each other to establish separation between the 'go-around' and any conflicting departing traffic. These regulations are clear but assume a satisfactory conclusion to the instruction to 'Co-ordinate'; there is also a subjective consideration as to what constitutes 'conflicting departing traffic'. After the incident, all three controllers were aware of the contents of the instruction. However, the actions of Air Departures was based on the supposition that Air Arrivals would turn SAB 603 to the left. She did not consider that BAW 818 was a confliction and therefore did not inform Air Arrivals of its departure. The Mentor agreed with all the actions of Air Departures and subsequently stated that he had never seen a missed approach from Runway 27L being turned right.

Following the incident, a Unit Supplementary Instruction (USI) was published by LHR management on 11 September 1997; the text replaced entirely the existing missed approach procedures in MATS Part 2 for LHR and the USI is included as Appendix D. It clarified the actions required of Air Arrivals and Air Departures and fulfilled the recommendations made by the NATS investigation team i.e. to reinforce the need for co-ordination prior to the issue of instructions to the pilot and to emphasise that all departing traffic was potentially conflicting traffic to missed approaches.

The new instruction clarified certain aspects of procedures in a way that indicates that the previous instruction was not as clear as it could have been.

2.3 Training

Both Mentor and Air Arrivals controller had received training in the handling of missed approaches as part of the Emergency Continuation Training (ECT) programme. Furthermore, all three were experienced in operating at LHR; Air Departures considered that she had noticed no changes in the duties or procedures of Air Departures and only a few minor changes in Air Arrivals since her previous time at LHR.

During discussions with the controllers, none made any comment that they misunderstood the missed approach procedures and the impression was that they were all very familiar with them. Logically, this would indicate a satisfactory training and monitoring system and indeed the training staff are motivated and imaginative in their approach.

The ECT programme is designed to provide necessary training in those unusual occurrences which controllers may face only rarely in the day to day course of the control task. In this context missed approaches can be included, although they are not particularly rare events with the number of missed approaches averaging 43 per month. Time and limited resources preclude providing experience in all possible emergency scenarios. What is feasible, however, is to provide a relatively broad experience in the handling of unusual events and to build controllers' confidence in their own abilities to deal with them.

The training issues raised by this incident are, however, not altogether straight forward. If asked, even prior to the incident, any one of the controllers involved would have been able to describe accurately the correct course of action to be taken in handling a missed approach. In all probability, this would also have included a consideration of the appropriate direction of turn and an emphasis on the need for co-ordination in the event of a manoeuvre such as a missed approach from Runway 27L being turned right. The issue then is not the level of knowledge each controller possessed, but rather the manner in which that knowledge was utilised on the day in question and the factors which eventually led to the incident. What needs to be emphasised in training, therefore, is not only the basic knowledge of how to perform the task, but also information on the types of error which can occur and some explanation of the underlying mechanisms which contribute to this human error. Errors in communication should come high on any list of training requirements in ATC. Reports from past incidents are a rich source of data on the types of communications problems which occur and constitute valuable practical examples for training purposes. However, training can not be relied upon to 'plug the holes' which might be caused by missing, inadequate or ambiguous procedures.

2.4 VCR working environment

As stated in paragraph 2.1, none of the controllers considered the environment of the VCR as a factor in the incident. A subjective opinion from the DERA psychologist (paragraph 1.16.1) is that the room is busy and noisy. However, it has evolved from experience into a layout where the controllers are familiar and comfortable with it. Any changes being considered should therefore be required to demonstrate a significant improvement.

The only significant aspect detected by the investigation involved the ATM. At the time of the incident, there was an area filtered out in the centre of the display to reduce the clutter produced by returns from aircraft transponding but still on the ground. The incident highlighted the value of the ATM for indicating potential conflicts but the artificial blanking effectively deprived the controllers of the only way of establishing the aircrafts' relative positions. It would be sensible to minimise the current blanking in terms of altitude or range to ensure that the display is fully effective whilst minimising extraneous information. Accordingly the following recommendation was made on 6 February 1998:

'The National Air Traffic Services Ltd should reduce the present blanking on the Air Traffic Monitor screens at London Heathrow Airport to maximise the operationally relevant information presented to controllers. [Recommendation 98-20].'

This recommendation was fully accepted by NATS.

2.5 Workloads

The workload of Air Arrivals and Air Departures is high but tolerable. However, the relative workloads of the two controllers alters substantially when a missed approach occurs. With the system in operation at the time of the incident, the work of Air Departures can be relieved when a missed approach occurs. Air Departures is mainly concerned with maintaining a departure flow rate but aircraft need a clearance before commencing take off; the controller can simply reduce the workload by not giving a clearance. On the other hand, Air Arrivals has no such control over his/her workload. Apart from co-ordinating with Air Departures, there is a requirement to activate the alarm, liaise with the terminal controller over headings for the missed approach aircraft and pass instructions to that aircraft, while continuing to work the constant flow of aircraft on approach to land.

It would appear sensible to reduce the workload on Air Arrivals and to reduce the amount of co-ordination required at a time of suddenly increased activity. However, before making any recommendation it would be better to consider the influence of human factors; this is done in subsequent paragraphs.

2.6 Human factor considerations

The major element in this incident, from the human factors perspective, is the breakdown in communication among the individuals involved i.e. Mentor, Air Departures and Air Arrivals.

An important element of Air Traffic Control is communication. It is not altogether surprising, therefore, that communication breakdown occurs or that it should figure so prominently in the occurrence of incidents. The issue is to understand why communication fails and what can be done to prevent such failure in the future or, at least, to mitigate its effects.

Communication between people has a number of positive elements; it can be immediate, flexible and relevant to the situation in hand. However, it can also be incomplete, ambiguous or even non-existent. Communication among human beings is prone to a number of human failings including expectation (hearing what one wants or expects to hear); distraction; slips of the tongue and lack of clarity which may or may not be caused by equipment problems. It can also be affected by the perspective of the people communicating in which the situation is so clear to one party in the communication loop that he or she assumes it must be equally obvious to everyone else and so fails to communicate fully.

In modern aviation, human communication still plays a large and necessary part. This may change with the wider utilisation of technological advances but, with the current level of technology, accurate person to person communication is vital. The communication related problems which contributed to this incident are dealt with in turn.

2.6.1 Assumption and expectation

The positive role that expectation plays in skilled behaviour has already been alluded to but it is the more negative aspects of expectation and assumption that are of greater relevance to this incident.

All three parties involved made assumptions concerning both the situation and the actions of their colleagues. The overriding assumption made by Air Departures and the Mentor was that the aircraft on missed approach would be turned left. Missed approaches are not a rare occurrence at the unit and both the Mentor and trainee had a good deal of experience in dealing with them. Indeed, the Mentor stated that he had never previously witnessed a missed approach from Runway 27L being turned right. The assumption was therefore made that SAB 603 would be turned left away from the departure runway and Air Departures, acting on this expectation, failed to inform Air Arrivals of the second departure i.e. BAW 818 since she perceived the main requirement at the time as dealing with AFR 813. In this case, the expectation concerning the future actions of Air Arrivals led to incomplete and inadequate communication of the traffic picture. Air Arrivals, in turn, assumed that the only aircraft to affect the missed approach was AFR 813, since he would have expected to have been informed of any other imminent departures.

2.6.2 The role of procedures

Expectation can lead to communication failure but does not always have a negative outcome. If robust, unambiguous procedures are in place and followed, it is possible to capitalise on expectation in that all the players in a given situation know what they are expected to do and, in addition, what others will be doing. This goes a long way to reducing both the uncertainty in the situation and the need for person-to-person communication which is prone to error. This helps to ensure a more prompt and effective response. However, even this is not fail safe and relies on any deviation from the set procedure to be communicated to those who need to know. Nevertheless, the safety and integrity of a system cannot, and ideally should not, be predicated on something as potentially fallible as human communication. Although person-to-person communication is valuable, in that it can provide redundancy in a system by serving as a back up, it is no substitute for effective procedures.

Placing emphasis on following procedures does not preclude the possibility of taking tactical action which may run counter to the procedure. For example, in the event of a missed approach due to an aircraft technical malfunction, where an aircraft may not be able to follow a pre-determined flightpath. However, such an event would be the exception to the standard, anticipated procedure and would need effective communication among the individuals involved.

2.6.3 Mentor/trainee interaction

While attention has justifiably been placed on the communication between Air Departures and Air Arrivals, the interaction between the Mentor and trainee also warrants consideration.

The function of the Mentor is not an easy one and the controller acting as Mentor performs a dual role. He or she must fulfil the training function while, at the same time, ensuring the safe and efficient management of the traffic being controlled. On the job training requires that the trainer make some fine judgements as to how much or how little to intervene in what the trainee is doing. If training is progressing satisfactorily, the degree of direct intervention will be gradually reduced over time until the trainee is, to all intents and purposes, working alone (but still being monitored). One difficulty many Mentors experience is that of maintaining vigilance as the trainee becomes more skilled and direct intervention less necessary. The training situation in this incident, though not unique, was somewhat unusual in that the trainee was an experienced controller, having begun work at the unit in 1982 where she remained for eleven years before taking up a non-operational ATC position. At the time of the incident she had been back at the unit as a trainee for approximately one month. The

Mentor was therefore faced with the task of monitoring a trainee with whom he had worked previously and who already possessed many years ATC experience. This is not a situation conducive to maintaining adequate vigilance. In this situation, Air Departures assumed that the Mentor would pick up on any omission on her part and also ensure adequate co-ordination with Air Arrivals.

The communication between Air Arrivals and Air Departures was inadequate. Air Departures did not mention BAW 818 while Air Arrivals turned SAB 603 in an unusual direction without the required co-ordination. Air Arrivals stated, however, that, had he known about BAW 818, he would have turned the missed approach aircraft left in the manner anticipated by his colleagues. Overall, assumption and expectation led to ambiguous and faulty communication.

2.7 Other aspects

2.7.1 One other relevant aspect was that not all of the parent companies of the aircraft involved were not aware of the incident until the next day when they were informed by the AAIB. While it is understandable that the crews would not be informed immediately because of any possible adverse reaction, it is a requirement of MATS Part 1 that the ATC unit inform the 'Aircraft Operator' of the AIRPROX. On this occasion, the omission did not affect the investigation but evidence can be lost following late or incomplete notification.

2.7.2 None of the aircraft was equipped with ACAS. There are advantages to having this equipment even when approaching an airport and present plans are that the larger public transport aircraft operating in UK will have TCAS II fitted by January 2000. However, the closer they are to the runway, the more crews will concentrate on take off or landing. In this instance, TCAS may have given the crews more 'situational awareness'; it may not have prevented the initiation of the incident but may have helped to prevent it developing.

2.8 Summary

The basic cause of this incident was a breakdown in co-ordination. However, historical evidence is that an error will occur at some stage whenever co-ordination is required between individuals. This will happen even with comprehensive training, well considered and clear procedures and instructions, and high calibre individuals. The instructions detailed in MATS Part 2 for LHR were quickly revised after the incident and are now clearer and more comprehensive. However, emphasis placed on the need for effective co-ordination during training will only have a time limited value; the effect will decrease as time passes. Following the incident in December 1992, improved training was introduced; this failed to prevent a similar incident in April 1996 and

also failed to prevent this latest incident. Finally, the LHR controllers have a well deserved reputation for competence throughout the flying community. Therefore, it would seem sensible to minimise the amount of human co-ordination required at a time of suddenly increased activity.

Ideally, both the missed approach aircraft and the departing aircraft should be on pre-determined flight paths where the probability of conflict is minimal. On those occasions where conflict occurs the responsibility for providing a satisfactory resolution should then rest with the controller with the lowest workload. Considering the various departure tracks and the relative workloads between the two controllers, it would be most effective if the aircraft executing a missed approach established an initial track away from the departing runway. Air Departures would then have the responsibility to manoeuvre departing aircraft away from the pre-determined and anticipated track of the aircraft making the missed approach.

Of the approximately 40 missed approaches per month currently experienced by LHR, almost all are for reasons unrelated to aircraft technical malfunctions. In the unlikely event of a missed approach due to an aircraft technical malfunction, where an aircraft may not be able to follow a pre-determined flightpath, it is accepted that tactical and more drastic intervention may be required by the controllers. Therefore, the following recommendation was made on 6 February 1998:

'The National Air Traffic Services Ltd should ensure that the missed approach procedures at London Heathrow Airport are revised to minimise the potential for confliction with departing traffic and to reduce the requirement for ATC co-ordination. [Recommendation 98-19]'

This recommendation was fully accepted by NATS. The amended procedures required consultation with airlines, simulation to validate the new missed approach procedures, and the dissemination of those procedures in aeronautical documents. The proposed implementation date for the new missed approach procedures is 10 September 1998. Following implementation, the procedures will be subject to the NATS Safety Management Process which will continually monitor the new procedures and highlight any operating or procedural deficiencies.

3 Conclusions

(a) Findings

(i) All three controllers were properly licensed, medically fit and adequately rested to operate their shift.

(ii) The Air Departures controller was still undergoing training and thus operating under the supervision of the Mentor.

(iii) The Air Departures controller did not inform the Air Arrivals controller that BAW 818 was taking off.

(iv) The Mentor did not advise the Air Arrivals controller that BAW 818 was taking off.

(v) There was nothing in the extant ATC procedures which precluded the Air Arrivals controller from turning SAB 603 to the right but he did not co-ordinate with Air Departures before doing so.

(vi) When the Mentor detected the potential confliction, he acted correctly and quickly to advise the two operating controllers.

(vii) Once they became aware of the confliction both the Air Departures and Air Arrivals controllers acted quickly and correctly to resolve the situation.

(viii) The flight crew in both BAW 818 and SAB 603 complied fully with all ATC instructions.

(ix) None of the flight crew in either BAW 818 or SAB 603 saw the other aircraft during the incident.

(x) The commanders of BAW 818 and SAB 603 were unaware of the incident until advised by the AAIB.

(xi) The AIRPROX reporting procedures detailed in MATS Part 1 were not fully complied with in that the aircraft operators were not informed of the incident.

(b) Causes

The following causal factors were identified:

(i) Co-ordination between Air Arrivals and Air Departures during the missed approach of SAB 603 was incomplete, primarily because neither Air Departures nor the Mentor advised Air Arrivals that BAW 818 was airborne, but also because Air Arrivals did not obtain agreement from Air Departures before turning SAB 603 to the right.

(ii) The ATC procedures current at the time of the incident for the integration of the missed approach aircraft into the departure flow placed too great a reliance on potentially fallible human communication at a time of increased workload.

(iii) The LHR ATC instructions relating to missed approaches were not sufficiently clear or comprehensive regarding the co-ordination required and the definition of a conflicting aircraft.

4 Safety recommendations

The following recommendations were made during the course of the investigation:

4.1 The National Air Traffic Services Ltd should ensure that the missed approach procedures at London Heathrow Airport are revised to minimise the potential for confliction with departing traffic and to reduce the requirement for ATC co-ordination.
[Recommendation 98-19 made 6 February 1998]

4.2 The National Air Traffic Services Ltd should reduce the present blanking on the Air Traffic Monitor screens at London Heathrow Airport to maximise the operationally relevant information presented to controllers.
[Recommendation 98-20 made 6 February 1998]

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