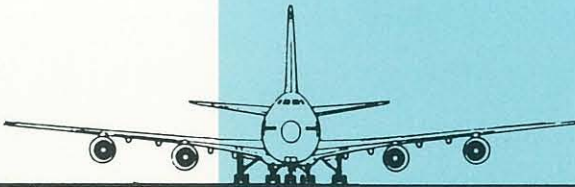
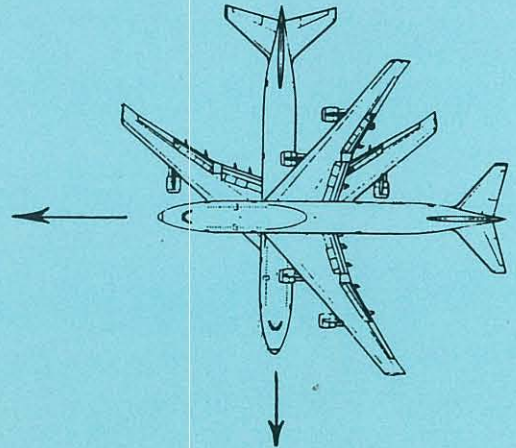
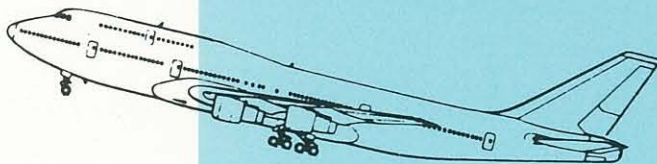


# SPECIAL INVESTIGATION REPORT

BUREAU OF AIR SAFETY INVESTIGATION

**BASI REPORT B/902/3307**



**Near Collision on Runway 34  
Sydney (Kingsford Smith) Airport  
11 September 1990**

**BASi**  
Bureau of Air Safety Investigation





Department of Transport and Communications

Bureau of Air Safety Investigation

SPECIAL INVESTIGATION REPORT

B747-300 Aircraft VR-HIJ  
and

B747-300 Aircraft VH-EBT under tow

Near collision on runway 34  
at Sydney (Kingsford Smith) Airport  
on 11 September 1990

Report B/902/3307



Released by the Director of the Bureau of Air Safety Investigation  
under the provisions of Air Navigation Regulation 283.

Department of Transport and Communications  
Bureau of Air Safety Investigation

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ISBN 0 642 16088 0

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## Units of Measurement

|                             |   |                       |
|-----------------------------|---|-----------------------|
| All speeds (IAS/CAS)        | - | Knots                 |
| All altitudes/heights       | - | Feet                  |
| All distances               | - | Metres                |
| All times/dates             | - | Eastern Standard Time |
| All Heading/bearings/tracks | - | Degrees magnetic      |

## Abbreviations

|            |   |                                      |
|------------|---|--------------------------------------|
| Cathay 100 | - | Radio call sign of VR-HIJ            |
| Red echo   | - | Radio call sign of tug towing VH-EBT |

## Definition

|    |   |  |
|----|---|--|
| V1 | - | V1 is the speed calculated as being the point at which the take-off may have been either abandoned or continued, even in the event of an engine failure. |
|----|---|--|

### SYNOPSIS

Qantas Airways Boeing 747-300 (B747) VH-EBT aircraft was towed across the path of Cathay Pacific Airways Boeing 747-300 (B747) VR-HIJ which had commenced take-off on runway 34 on a scheduled flight to Hong Kong.

The incident occurred at Sydney (Kingsford Smith) Airport on Tuesday 11 September 1990 at 1350 hours Eastern Standard Time.





# 1. FACTUAL INFORMATION

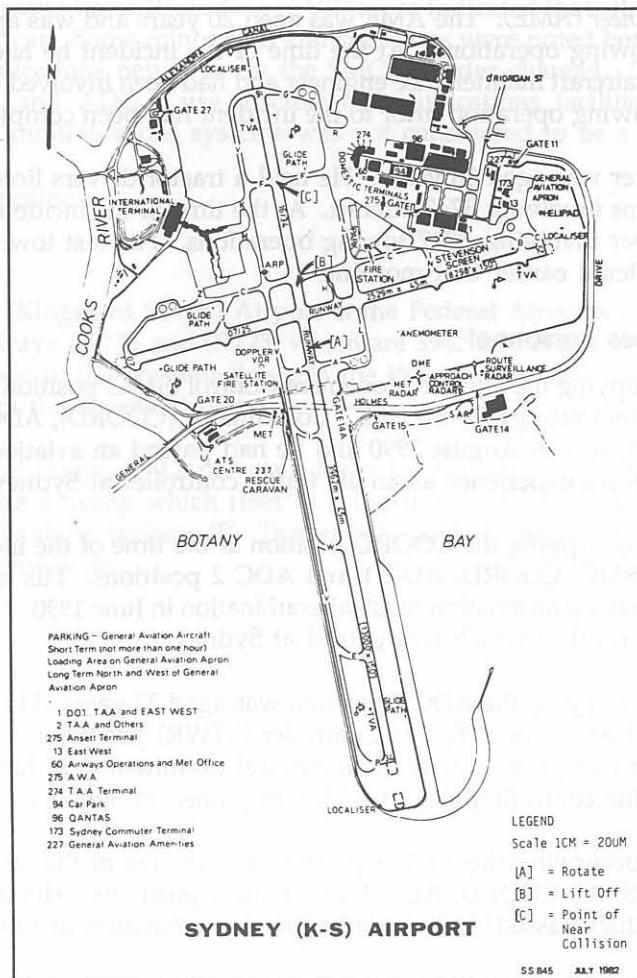
## 1.1 History of the Flight

At 1341.05 hours, B747 aircraft VR-HIJ operating as Cathay 100, commenced taxiing from the International Terminal for a departure from runway 34 on a scheduled service to Hong Kong.

Weather conditions were fine, with wind from the north-east at 10-15 knots. Simultaneous runway operations (SIMOPS) were in progress, with runway 07 nominated on the Automatic Terminal Information Service (ATIS) for arrivals and departures, and runway 34 for arrivals. The Aerodrome Controller (ADC1) had control of the full length of runway 07 and runway 34 south of the runway intersection. Due to the physical limitations of the airport, and to facilitate aircraft movements, runway 34 north of the runway intersection was considered to be inactive and under the control of the Surface Movement Controller (SMC 1). The northern section of runway 34 had been re-activated from time to time to allow for the departure and arrival of aircraft requiring the full length of the runway. Cathay 100 required the full length for take-off.

At 1348.15 hours Cathay 100 called ready at the runway 34 holding point and shortly afterwards was instructed to line up on the runway.

Cathay 100 was cleared for take off at 1350.24 hours. At that time a light multi-engine aircraft was on a four-mile final approach for runway 07. At 1351.00 hours SMC 1 cleared 'Red echo', (the tug towing VH-EBT, a Qantas B747 aircraft), to cross runway 34 at taxiway 'Foxtrot' (F) from the eastern side. Twenty-nine seconds later the words 'Stop that aircraft! Stop that aircraft!' were heard on the ADC frequency. Both ADC 1 and the Aerodrome controller performing Senior Tower Controller functions (ADC 2) immediately noticed the Qantas aircraft crossing the runway ahead of the departing Cathay aircraft. Cathay 100 was observed to rotate near the runway intersection and become airborne adjacent to taxiway Charlie (C), passing low over the Qantas aircraft which was straddling the runway. There was insufficient time for the SMC to react and warn the tug driver.



## **1.2 Injuries to Persons**

No injury to any person resulted from this occurrence.

## **1.3 Damage to Aircraft**

No damage to either aircraft resulted from this occurrence.

## **1.4 Other Damage**

No damage was reported.

## **1.5 Personnel Information**

### **1.5.1 Crew of B747-300 VR-HIJ**

*Captain:* The captain was aged 40 years. He held an Airline Transport Pilot Licence appropriately endorsed for command of B747-300 aircraft. At the time of the incident, the Captain had a total flying experience of 9627 hours, of which 2559 hours were on B747 aircraft. His last Sydney flight operation prior to 11 September 1990 was on 8 September 1990.

*First Officer:* The First Officer was aged 42 years. He held an Airline Transport Pilot Licence appropriately endorsed for co-pilot of B747-300 aircraft. At the time of the incident, the First Officer had a total flying experience of 5699 hours, of which 499 hours were on B747 aircraft. His last Sydney flight operation prior to 11 September 1990 was on 8 September 1990.

*Flight Engineer:* The Flight Engineer was aged 47 years. He held a Flight Engineer Licence endorsed for B747-300 aircraft. At the time of the incident, the Flight Engineer had a total flying experience of 10083 hours, of which 2935 hours were on B747 aircraft. His last Sydney flight operation prior to 11 September 1990 was on 8 September 1990.

### **1.5.2 Crew of B747-300 VH-EBT Under Tow**

*Aircraft Maintenance Engineer (AME):* The AME was aged 20 years and was approved to act as a brake safety person on B747 towing operations. At the time of the incident he had a total of 4 years and 9 months experience as an aircraft maintenance engineer and had been involved in B747 towing operations for 9 months. His last towing operation prior to the incident had been completed earlier that morning.

*Tug driver:* The tug driver was aged 36 years. He held a tractor drivers licence and was approved to conduct towing operations involving B747 aircraft. At the time of the incident he had a total of 6 years experience as a tug driver involving B747 towing operations. His last towing operation prior to the incident had been completed earlier that morning.

### **1.5.3 Air Traffic Services personnel**

*SMC:* The controller occupying the Surface Movement Control (SMC) position at the time of the incident was aged 45 years. He held ratings for the SMC, Coordinator (COORD), ADC 1 and ADC 2 positions. His last proficiency check was in August 1990 and he had passed an aviation medical examination in June 1990. He had 14 years experience as an air traffic controller at Sydney.

*COORD:* The controller occupying the COORD position at the time of the incident was aged 45 years. He held ratings for the SMC, COORD, ADC 1 and ADC 2 positions. His last proficiency check was in June 1990 and he had passed an aviation medical examination in June 1990. He had 20 years experience as an air traffic controller, all of which was gained at Sydney.

*ADC 2:* The controller occupying the ADC 2 position was aged 37 years. He held ratings for the SMC, COORD, ADC 1, ADC 2 and Senior Tower Controller (STWR) positions. His last proficiency check was in June 1990 and he had passed an aviation medical examination in June 1990. He had 20 years experience as an air traffic controller, all of which was gained at Sydney.

*ADC 1:* The controller occupying the ADC 1 position at the time of the incident was aged 40 years. He held ratings for the SMC, COORD, ADC 1 and ADC 2 positions. His last proficiency check was in August 1990 and he had passed an aviation medical examination in July 1989. He had 15 years

experience as an air traffic controller and had served at various locations, including Sydney, before recommencing duty at Sydney in August 1990.

## **1.6 Aircraft Information**

VR-HIJ, a B747-300 passenger aircraft, is owned and operated by Cathay Pacific Airways Limited. The aircraft was serviceable and its serviceability status was appropriately documented. The aircraft was departing from Sydney on a scheduled flight to Hong Kong at the time of the incident.

VH-EBT, a B747-300 passenger aircraft, is owned and operated by Qantas Airways Limited. The aircraft was under tow from the Qantas maintenance facility to the International Terminal apron.

## **1.7 Meteorological Information**

At the time of the incident the ATIS facility was transmitting 'Information Kilo'. This information indicated that the surface wind was from the north-north-east at 10 to 15 knots. The altimeter setting (QNH) was 1022 hectopascals and the temperature was 18 degrees Celsius. There were two octas of cloud at 4000 feet and the visibility was greater than 10 kilometres.

The runways were dry and the crosswind components on runways 07 and 34 were 11 and 10 knots respectively. Under these conditions, runway 07 was nominated for departures and runways 07 and 34 were nominated for arrivals. The ATIS also advised aircrew that SIMOPS were in progress.

No problems with visibility were reported by any of the controllers and weather conditions were not considered to have contributed to the development of this occurrence.

## **1.8 Aids to Navigation**

Not applicable.

## **1.9 Communications Equipment**

No problems were identified or noted with the radio communications facilities at Sydney tower. Examination of the Automatic Voice Recording (AVR) tapes indicated that all transmissions by the ADC 1 and the aircrew were clear. Some minor over-transmissions were noted between the operational and non-operational communications networks on the SMC recorder channel. There was no other radio interference. The SMC and ADC 1 use discrete communications facilities and frequencies. The serviceability of radio communications systems was not considered to be a factor in this occurrence.

## **1.10 Aerodrome Information**

### **1.10.1 The aerodrome**

The operator of Sydney (Kingsford Smith) Airport is the Federal Airports Corporation. The complex includes two sealed runways, 16/34 and 07/25, which are 3962 and 2529 metres in length respectively. Runway 07/25 has a slope of 0.1 per cent down to the West, is 45 metres wide, and crosses 16/34 at a point 2624 metres from the threshold of runway 34.

Runway 34 has an overall slope of 0.2 per cent down to the North and is 45 metres wide. In side elevation, the runway has a hump which rises to a maximum of 2.33 metres above the threshold of runway 34 and 4.42 metres above taxiway 'F'. Taxiways 'C' and 'F' are 2836 and 3414 metres respectively from the threshold of runway 34.

### 1.10.2 The Sydney control tower

The Sydney control tower is configured with four operator positions facing northwards from an elevated tower cabin located south-west of the intersection of runways 07 and 25. There is also provision for one additional supervisory position or shift manager.



From left to right, when at the operating workstation, the operators' functions and positions are as follows:

**SMC:** The occupant of this position is responsible for ground separation by issuing instructions, clearances and information to all aircraft and vehicle traffic operating on the manoeuvring area of the aerodrome, excluding the duty runway(s). This controller also has the use of Surface Movement Radar (SMR) for guidance only.

**COORD:** The occupant of this position relays procedural messages to and from other airways units, and has various operational and weather information liaison functions, including the alerting of emergency services as required.

**ADC 2:** The occupant of this position relays flight progress strips and departure/arrival sequencing instructions to and from the ADC 1 and other airways units such as the Approach and Departures control cell in the Area Approach Control Centre (AACC). He was also performing the STWR function at the time of the incident, due to the absence of the STWR controller and the light traffic density at the time.

**ADC 1:** The occupant of this position is responsible for maintaining separation between arriving and departing aircraft using the duty runway(s). This officer shares access to the SMR and a 20 nautical mile radius Terminal Area Radar (TAR) display with the ADC 2.

**STWR:** The occupant of this position is responsible for overseeing all operations within the control tower cabin. At the time of the incident the officer rostered for the STWR position was absent, attending to a non-operational task. As the traffic density was considered to be light, his presence was not considered essential at that time.

### 1.10.3 The operating workstation

The operating workstation is equipped with 'runway in use' press switch indicators at the ADC 1, ADC 2 and SMC operating positions. The facility consists of one illuminated locking switch for each runway nominated as under the jurisdiction of the ADC 1. Accordingly, if ADC 1 has jurisdiction of runway 07, the 'runway 07 in use' switch is selected. This can be done at either the ADC 1 or ADC 2 position as the facility is connected in parallel. The switch will continue to flash until acknowledged by the SMC.

The circuit is extended to a mimic panel with the same selection of switches at the SMC position. Once the facility is activated at ADC 1 or 2, the appropriate 'runway in use' switch begins to flash. Simultaneously, an audio alarm (clicker—as distinct from gong or bell used for other facilities, e.g. intercom) is activated.

The action of the SMC selecting that facility:

- (a) - converts the flashing lamp to steady;
- (b) - silences the audio alarm; and
- (c) - cancels the flashing indication at the ADC 1 and 2 as acknowledgement that runway 07 is under the jurisdiction of ADC 1.



Release of jurisdiction is the reverse process initiated by the ADC 1 or 2. The SMC cannot initiate any changes of jurisdiction.

The 'runway in use' lights for runways 16/34 and 07/25 were used in the following manner:

- (a) Day or night, runway 07 illuminated meant the full length of runway 07 was available to ADC for arrivals and departures and not available to SMC.
- (b) Day or night, runway 25 illuminated meant the full length of runway 25 was available to ADC for arrivals and departures and not available to SMC.
- (c) Day or night, runway 16 illuminated meant the full length of runway 16 was available to ADC for arrivals and departures and not available to SMC.
- (d) Day only runway 34 illuminated meant runway 34 south of the intersection of runway 07 was available to ADC for arrivals and departures and not available to SMC. The remaining length of runway 34 was available to the SMC only.
- (e) Night only runway 34 illuminated meant that the full length of runway 34 was available to ADC for arrivals and departures and not available to SMC. The system of 'runway in use' indicator lights as they were being applied to the multi-runway operations was a 'fail-unsafe' system, rather than a 'fail-safe' system. That is, once an error had been made, the system had no means of flagging it to the controllers.

At the time of the incident, the error was a failure to select a runway by means of the 'runway in use' light. There was, therefore, no change to any of the displays on the console. As a result of the ADC1 failure to select runway 34 north of the intersection as active for the Cathay 100 take-off, the SMC continued to move traffic across that section of the runway. He did not hear Cathay 100 cleared for take-off.

#### 1.10.4 Radar facilities

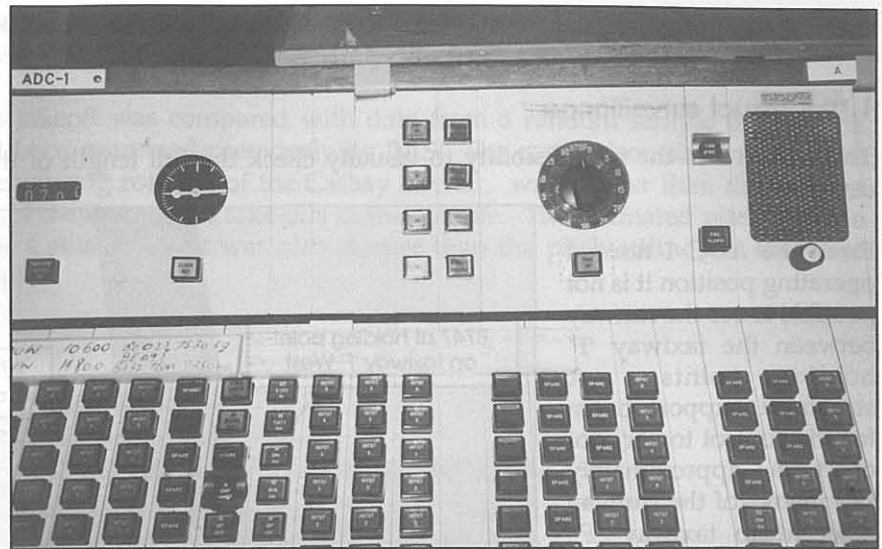
The only radar facility available for operational use within the confines of the aerodrome boundaries is the Surface Movement Radar (SMR).

The SMR equipment is primary radar which is not recorded. It cannot be used by ATC for traffic separation purposes. The primary function of the SMR facility is to assist the surface movement controller to control the surface movement traffic in periods of poor visibility.

Displays are provided at both the SMC and ADC 1/ADC 2 operating positions. One display is shared by ADC 1 and ADC 2.

The ADC 1/ADC 2 display is normally selected to provide surface level radar coverage over all runways and movement areas.

The SMC display is normally selected to provide surface level radar coverage over all runways and movement areas

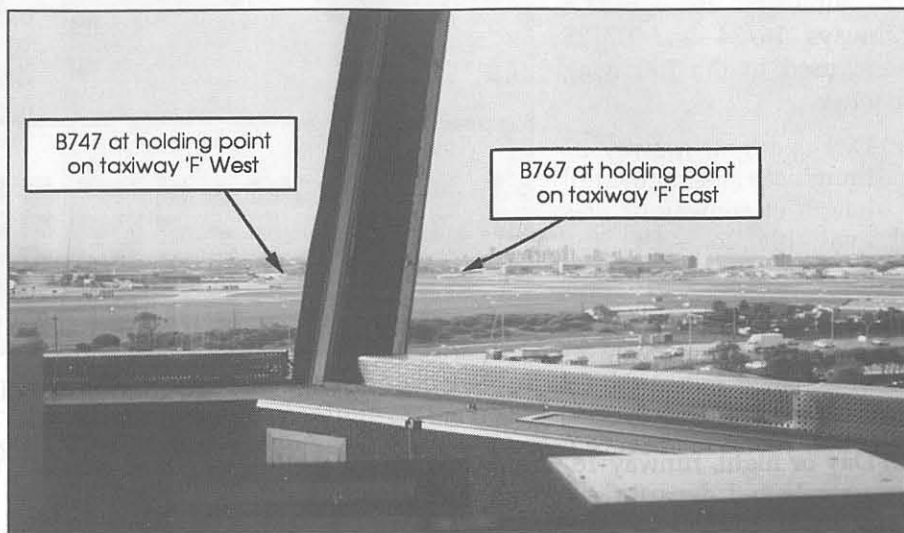


north of approximately taxiway 'Lima' (L), i.e., the southern end of runway 34 from 'L' to the threshold is not displayed.

### 1.10.5 Visual surveillance

The ADC 1 has the responsibility to visually check the full length of the duty runway prior to every departure.

From the ADC 1 normal operating position it is not possible to see the runway between the taxiway 'F' holding points. A structural support beam for the control tower roof obscures approximately 120 metres of the runway adjacent to taxiway 'F'. ADC 1 must move left or right of the console position at least one half metre to gain an unobstructed view of the runway.



Because of the nature of the task, the physical behaviour of the tower controllers changes as a result of the workload. In times of heavy traffic the controllers tend to stand and move about the cab much more than they do during periods of light workload.

For much of the time between coming on duty and the incident, the ADC 1 had been standing and moving about the cab. Shortly before the incident the workload decreased and the ADC 1 sat at the console.

### 1.10.6 Ground routing

The physical layout of Sydney airport runways, taxiways, maintenance facilities, and international passenger terminals requires that aircraft being towed between the Qantas maintenance facility and the International Terminal must cross runway 34.

At the time of the incident there was an added complication in that part of the taxiway systems at 'Golf' (G) and 'Victor' (V) were not available because of a taxiway upgrade works program. The normal towing route between the maintenance base and the International Terminal was not available. Aircraft were routed via taxiway 'F', or taxiway 'C' and/or runway 34, or a combination thereof, i.e., an aircraft could enter runway 34 from taxiway 'F' and follow along that runway to taxiway 'C'. Controllers indicated that this practice was not uncommon during SIMOPS when runway 34 was nominated as being active south of runway 07/25 only.

### 1.10.7 Information flow

Aircraft which require a runway other than that nominated for departures on the ATIS, are processed for the requested departure runway. The requirement is annotated on the appropriate flight progress strip and subsequently arrives for the ADC 1's use. The special requirement is then drawn to the attention of the ADC 1 by the ADC 2 'circling' the runway number on the strip. These actions were carried out by the controllers.

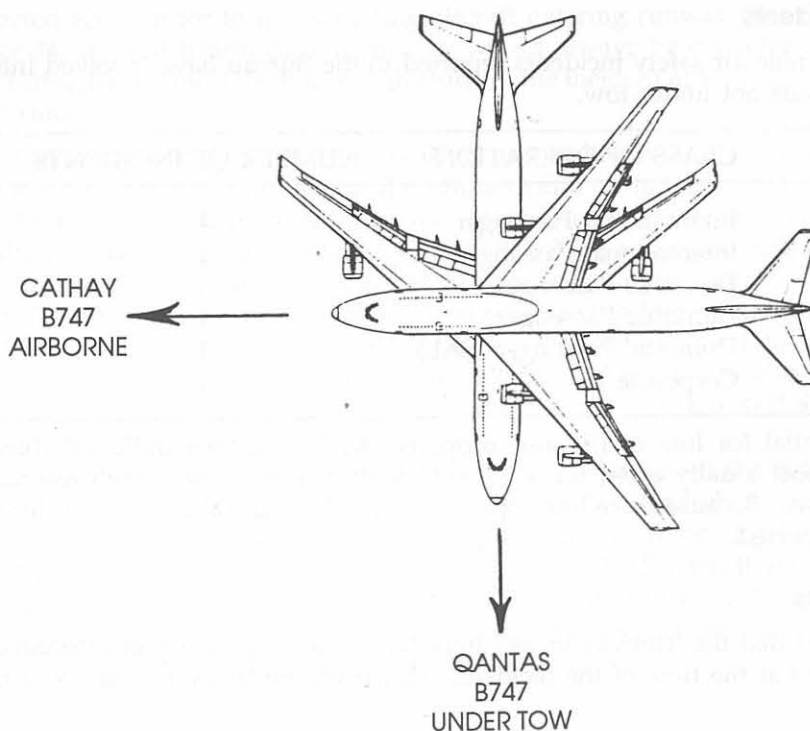
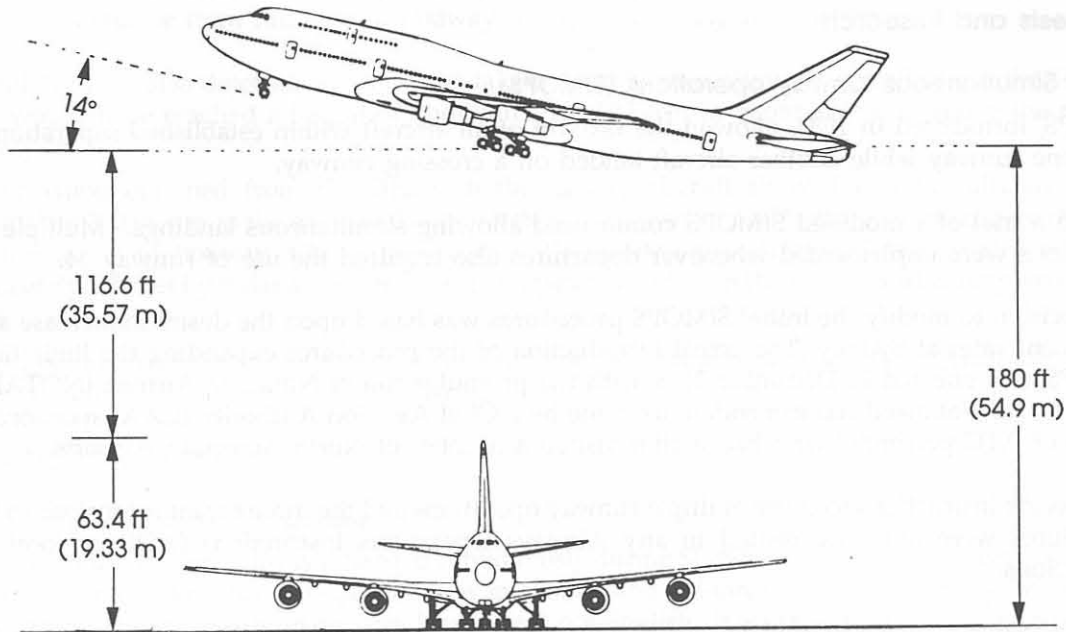
Whenever there was a change of runway status, an unrecorded voice exchange was completed between the SMC and ADC 1 controllers as acknowledgement of the status change. However, it was noted that there were no documented procedures to cover the responsibilities of each position in the event of a runway status change.

### 1.11 Flight Recorder

The Cathay aircraft was equipped with a Digital Flight Data Recorder (DFDR). The readout of the recorder determined that the distance from the start of the take-off roll until the aircraft rotated was

approximately 2400 metres. The aircraft became airborne 250 metres beyond the point of rotation. The height of the aircraft over taxiway Foxtrot was approximately 180 feet.

The DFDR information for this takeoff was compared with data from a random sample of take-offs for this aircraft type which had been examined previously by BASI. The comparison showed that the average pitch rate of 3.2 deg/sec during rotation of the Cathay aircraft, was greater than the average pitch rate of 1.8 deg/sec of any of the uneventful take-offs in the sample. The estimated pitch attitude of 10.6 degrees at lift-off for the Cathay aircraft was also steeper than the pitch attitude at lift-off of any of the take-offs in the sample.



## 1.12 Wreckage and Impact Information

Not applicable.

## 1.13 Medical and Pathological Information

Not applicable.

## 1.14 Fire

Not applicable.

## 1.15 Survival Aspects

Not applicable.

## 1.16 Tests and Research

### 1.16.1 Simultaneous runway operations (SIMOPS)

SIMOPS, introduced in 1983, allowed the take-off of an aircraft within established separation criteria from one runway while another aircraft landed on a crossing runway.

In 1985 a trial of a modified SIMOPS commenced allowing simultaneous landings. Multiple runway operations were implemented whenever departures also required the use of runway 34.

The decision to modify the initial SIMOPS procedures was based upon the desire to increase air traffic movement rates at Sydney. The actual introduction of the procedures expanding the limitations to SIMOPS was effected in December 1989 with the promulgation of Notice to Airmen (NOTAM) C11/89. This followed recommendations made by a Civil Aviation Authority (CAA) sponsored Study Group of ATC personnel who had earlier visited a number of North American Airports.

The specific instructions to cover multiple runway operations and the more recent extensions to SIMOPS procedures were not documented in any Airways Operations Instructions (AOI) or local orders/instructions.

Local procedures appear to have developed primarily from local check controller practices and techniques. These were subsequently modified according to the experience of individual controllers.

Further local modification could become necessary if a pilot advised ATC of an operational requirement to use a runway other than that nominated by ATC. Noise abatement procedures could also determine a different runway requirement.

### 1.16.2 Previous similar incidents

Since the beginning of 1990, nine air safety incidents reported to the Bureau have involved intrusions onto active runways by aircraft not under tow.

| AIRCRAFT TYPE | CLASS OF OPERATION       | NUMBER OF INCIDENTS |
|---------------|--------------------------|---------------------|
| B747          | International Passenger  | 4                   |
| DC10          | International Passenger  | 1                   |
| B757          | Domestic Passenger       | 1                   |
| B737          | Domestic Passenger       | 1                   |
| PIPER PA31    | Domestic Passenger (SAL) | 1                   |
| CESSNA C550   | Corporate Jet            | 1                   |

Each incident had the potential for loss of life and property. ATC personnel indicated during the investigation that it was almost a daily event for some vehicle or aircraft to accidentally venture onto active surface movement areas. Because there has apparently been little or nil risk of collisions, these occurrences have gone unreported.

### 1.16.3 Tower facility checks

Engineering checks confirmed that the 'runway in use' light facility was operating in accordance with Field Office Facility Schedules at the time of the incident. However, the investigation noted that the



facility schedule calls for a 'continuous buzzer' to be activated rather than the 'clicker' aural warning currently installed.

#### 1.16.4 B747 Take-off profile tests

A B747-2/300 flight simulator was used in an attempt to duplicate the flight profile of VR-HIJ on take-off from Sydney. As a result it was determined that the take-off could have been safely abandoned from the point where the crew first recognised that the aircraft under tow was entering the flight strip. Under these conditions it would have been possible to bring the aircraft to a full stop before reaching taxiway 'F'.

The distances determined from the simulator tests were:

- distance from brakes release to 143 kts: approximately 1538 metres
- distance from 143 kts point to a full stop: approximately 832 metres
- distance from full stop to taxiway 'F': approximately 1055 metres

The simulator tests also determined that if the take-off had been continued normally from the 143-knot point it would have reached a height of approximately 123 feet by radar altimeter above the runway at taxiway 'F'.

The information obtained from the DFDR in the Cathay aircraft showed that the aircraft rotated approximately 200 metres to the south of the intersection of runway 07 and became airborne approximately 140 metres south of taxiway 'C'. It passed over the Qantas aircraft at taxiway 'F' at a height of approximately 180 feet by radar altimeter. Vertical separation between the two aircraft was approximately 117 feet.

The flight path and take-off details of the Cathay aircraft were found to be consistent with information provided by air traffic controllers and other observers.

### 1.17 Additional Information

#### 1.17.1 Aircraft movement processing

Jurisdiction for the various runways changed continuously during SIMOPS and multiple runway operations due to controller local knowledge of past runway incursions and roll-throughs, particularly by international aircraft operated by crews whose primary language is not English. It was the practice of most controllers to adjust SIMOPS to accommodate any operation which was considered to have the potential to 'roll-through'.

During the morning of the incident, SIMOPS had been applied a number of times. Most of the morning the northern end of runway 34 from the intersection of 07/25 to the threshold of runway 16 had been under the control of SMC. Under normal SIMOPS circumstances where departures from runway 34 are required, the area of runway 34 from the intersection to the threshold of runway 16 is required to be selected active prior to the departing aircraft entering runway 34. Therefore, for departures from runway 34, the full length of that runway would always be considered active. Approximately five times during the period 1100 hours to the time of the incident at 1352, ADC 1 had activated the northern end of runway 34.

At the time of the incident the 'runway 07 in use' switch was selected to ON. The runway 34 switch was also selected ON indicating that the southern end of that runway was active. Except for the times when the northern half of runway 34 was active, the 'runway 16 in use' light was selected to OFF. Immediately prior to the departure of Cathay 100, ADC 1 had issued Qantas 1, a B747, with a runway 34 landing clearance with a requirement to stop short of runway 07. ADC 1 initially intended that Qantas 1 cross the runway and take taxiway 'F' for the international apron. However, in order to expedite the departure of Cathay 100, ADC 1 instructed Qantas 1 to vacate runway 34 via taxiway 'C', 577 metres closer to the 07 runway intersection. ADC 1 was also concerned with a light multi-engine aircraft carrying out a practice instrument landing system (PILS) approach to runway 07.

Qantas 1 vacated the runway at 1350.39. ADC 1 then assessed the situation and was confident that Cathay 100 would be able to depart before the arrival of the light aircraft on 07. He said he visually checked that the runway was clear and then issued a clearance for Cathay 100 to take off. He had concentrated so intently on satisfying himself that the PILS aircraft and Cathay 100 had separation at the intersection that he was distracted from the console runway selection. He did not realise that he had failed to select the 'runway 16 in use' light to 'ON'. At that time the B747 under tow was stationary at the taxiway 'F' holding point east of runway 34.

Once he was satisfied that no potential conflict existed between the departing B747 and the PILS aircraft, ADC 1 turned his attention exclusively to the PILS aircraft.

The flight progress strip for Cathay 100 correctly signified the requirement for the use of runway 34. However, ADC 2 did not notice the omission to select the runway 16 light to 'ON', which would have activated the full length of runway 34. SMC 1 did not hear the take-off clearance because he was communicating with ground stations on other frequencies.

The Cathay crew saw that the Qantas aircraft under tow was stationary at taxiway 'F' and expected it to remain there until they departed. During the take-off run, at a speed of about 143 knots, 10 knots below V1, the Cathay crew realised that the Qantas aircraft had commenced moving onto the runway. The Captain made the decision to continue rather than abandon the take-off and risk what he considered to be the inevitable consequences of a collision.

### **1.17.2 Standard operating procedures and documentation**

The standardisation and documentation of many of the individual operational and coordination practices and techniques were not formalised. The investigation also noted that Airways Operations Instructions (AOI) do not include specific provision or guidance material for coordination between SMC, COORD and/or ADC positions in the control tower. Provision of consistently effective air traffic services, and the avoidance of air-safety incidents, dictates that the procedures and techniques used by ATS personnel be as complete and as comprehensive as possible and that they be applied in a consistent manner.

Actual practices and interpretations of SIMOPS varied from individual to individual. Several factors which 'compromised standardisation' and which were identified by the 1987 Ratner report had not been addressed.

Ratner stated that 'the level of prescription and proscription of operating practices and techniques was insufficient in some cases and required in-depth re-examination'. Ratner made the recommendation (Recommendation 2) that the CAA 'standardise the application of well-defined, consistent, and uniform procedures, practices and techniques, including further prescription, proscription and detailed development where appropriate'.

Certain practices and techniques which were easily misinterpreted, lacked backup and/or protection against other human or system failures, were evident in this investigation, e.g. a handwave or a nod could indicate an acknowledgement, or alternatively a signal to wait ('I'm busy').

The need for standardisation and documentation was still apparent. The airways system was ill served by leaving this important area open to independent and ad hoc judgement.

### **1.17.3 Risk management**

Both the investigation team and the controllers interviewed were confident that any risk management considerations would have been based on the rationale that the entire length of the duty runway was available for performance calculations and emergency use. However, the investigation did not specifically address the origins of the risk management calculations conducted prior to the introduction of SIMOPS.

### **1.17.4 Runway encroachment**

The investigation team considered that there were three general types of encroachment on to airport movement areas which could result in collision:

- a) accidental entry
- b) mistaken route
- c) misunderstood clearance or instructions

The investigation team also considered that there were three basic ATS systemic failures which could contribute to runway encroachments:

- a) failure of information transfer
- b) system failure
- c) failure to correctly use the system.

This incident resulted from a combination of the systemic failures. The system for information transfer between the ADC and SMC controllers created the potential for an ambiguous open circuit. The 'runway in use' indicator light system was designed to support the information transfer by removing this ambiguity. Although there were no electronic or mechanical system failures per se, the information transfer between the ADC and SMC was ambiguous and had no failsafe features. Assumptions made by the SMC were correct while those of the ADC 1 were not correct. The variations in procedures adopted by some personnel for use of the 'runway in use' lighting system for runway 34 operations was also not failsafe.

## 1.18 Summary of Interview with Observers

### 1.18.1 Tug driver

After holding at the taxiway 'F' holding point east of runway 34, the tug driver was instructed by SMC to cross runway 34. The instruction clearance was unambiguous and acknowledged by the tug driver. When the tug had reached the western side of runway 34 the tug driver looked to his left along the runway and saw the Cathay B747 commence rotation near runway 07 and lift off shortly after. He said that the Qantas aircraft would have been on runway 34 as the Cathay aircraft passed low overhead.

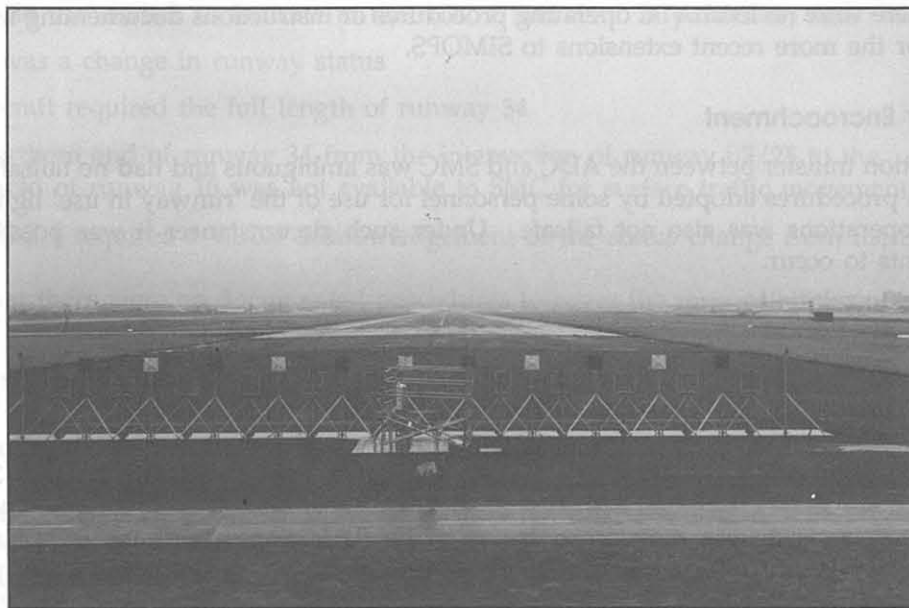
### 1.18.2 AME

The AME acting as brake-safety person on the B747 under tow, observed the Cathay aircraft rotate prior to the intersection of runway 07 and become airborne adjacent to taxiway 'C'. Because of the heat in the cockpit of the aircraft under tow, the engineer had opened the overhead escape hatch. He said that as the Cathay aircraft passed low overhead, the number one engine was aligned with the open hatch.

### 1.18.3 Other observers

The captain of a Boeing Dash 8 aircraft on taxiway 'F' east of runway 34 saw the Cathay aircraft as it became airborne near taxiway 'C'. He said that it passed low over the Qantas aircraft which was crossing the runway in front of his aircraft.

Statements by a helicopter pilot and a groundsman working on runway lights adjacent to runway 34 were consistent with the other observers' statements on the points of rotation and lift-off and the clearance between the two aircraft.



View along runway from 34 threshold.

At the time the photograph was taken a B747 was stationary at the taxiway 'F' West holding point. Light rain was falling; however the aircraft was clearly visible from the 34 threshold at ground level. Unfortunately the B747 is not clearly visible in the photographic reproduction.



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## **2. ANALYSIS**

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### **2.1 General**

SIMOPS were in operation and this permitted Air Traffic Controllers to nominate a departure runway and dual arrival runways on the ATIS facility, along with the notification that SIMOPS were in progress.

A pilot could advise ATC of an operational requirement to use another runway. Noise abatement procedures could also determine a different runway requirement.

A Notice to Airmen (NOTAM) C11/89 expanding the limitations to SIMOPS had been issued by the CAA. The NOTAM specified the conditions required to be met before ATC authorised such operations.

### **2.2 Air Traffic Service Personnel**

The relevant air traffic controllers on duty at Sydney tower were all suitably qualified and licensed for the tasks they were performing. There was no evidence that any of them were suffering from any physiological or psychological problems which might have affected their ability to carry out the duties and responsibilities of their respective positions.

The officers held multiple tower ratings and all were very experienced controllers. Workload at the time of the incident was considered by all officers to be light.

### **2.3 Change of Runway Status**

There were no documented procedures to cover the responsibilities of each position in the event of a runway status change.

### **2.4 Simultaneous Runway Operations (SIMOPS) Procedures**

The investigation team found that there had been a trial expansion to the application of SIMOPS. This expansion was based upon the American application which considers specific aircraft performance in determining actual landing distances required. Throughout this period of trial and evaluation of SIMOPS, multiple runway operations were also conducted, i.e., arrivals and departures were permitted on both runways subject to normal separation standards being met.

However, there were no local ATC operating procedures or instructions documenting multiple runway operations or the more recent extensions to SIMOPS.

### **2.5 Runway Encroachment**

The information transfer between the ADC and SMC was ambiguous and had no failsafe features. The variations in procedures adopted by some personnel for use of the 'runway in use' lighting system for runway 34 operations was also not failsafe. Under such circumstances it was possible for runway encroachments to occur.

### **2.6 Visual Surveillance**

The investigation determined that the tug towing the empty B747 was stationary when the ADC 1 visually checked the runway for the departing B747 on runway 34.

The ADC 1 did not select the appropriate 'runway in use' light to activate runway 34 north of the intersection, but acted as if he had activated it. Believing that all was well, his priority was to ensure that adequate clearance was maintained between the PILS aircraft and the departing B747. Any consideration of possible traffic crossing runway 34 north of the intersection was a lesser priority because as far as he was concerned the system was working as it should and it was not likely that there was any traffic crossing runway 34.

## **2.7 The Taxiing Phase**

The investigation concluded that there were no anomalies and no undue pressures evident on the technical crew or the air traffic service officers as the aircraft was prepared and processed for departure.

## **2.8 The Take-off Phase**

From the lined-up position on the threshold of runway 34, the aircrew were able to sight an aircraft (B747 under tow) holding to the right of runway 34 on Taxiway 'F'.

Approximately 30 seconds into the take-off roll the aircrew became aware that the previously stationary B747 was slowly approaching the runway from the right.

The captain made the decision to continue rather than abandon the take-off and risk what he considered to be the inevitable consequences of a collision.

## **2.9 Visual Aids**

Engineering checks confirmed that the 'runway in use' facility was operating correctly with visual and aural cues as specified in Field Office Facility Schedules at the time of the incident. The investigation noted that the Facility Schedule specified that a 'continuous buzzer' be activated rather than the actual 'clicker' found during the investigation. However this was not considered to have been a factor in this incident.

## **2.10 Access to Recorded Data**

As SMR is not used for separation purposes, the operational need to record the display does not exist. However, reconstruction of the events could have been expedited by the continuous recording of the complete environment with conventional video facilities.

## **2.11 Ground Routing**

The practice of releasing the northern section of runway 34 to the SMC during SIMOPS on runways 07 and 34 appeared to have had its origins in an effort to reduce SMC/ADC coordination requirements.

## **2.12 Information Flow**

When runway 34 was requested for departure, some controllers had devised a technique of selecting the 'runway 16 in use' switch to indicate to the ADC 2 and SMC in particular, that:

- (a) there was a change in runway status
- (b) an aircraft required the full length of runway 34
- (c) the northern end of runway 34 from the intersection of runway 07/25 to the threshold of runway 16 was not available to SMC for surface traffic movements
- (d) the ADC 1 required a verbal acknowledgement of the status change from the SMC.

It was noted that there were no documented procedures to cover the responsibilities of each position in the event of a runway status change.

## **2.13 Standard Operating Procedures and Documentation**

The standardisation and documentation of many of the individual operational and coordination practices and techniques were not formalised. The investigation also noted that Airways Operations Instructions (AOI) do not include specific provision or guidance material for coordination between SMC, COORD and/or ADC positions in the control tower.

Actual practices and interpretations of SIMOPS varied from individual to individual. Several factors which 'compromised standardisation' and which were identified by the 1987 Ratner report had not been addressed.

Ratner made the recommendation (Recommendation 2) that the CAA 'standardise the application of well-defined, consistent, and uniform procedures, practices and techniques, including further prescription, proscription and detailed development where appropriate'.

The need for standardisation and documentation was still apparent.

## 2.14 Risk Management

The investigation team concluded that any risk management calculations conducted prior to the introduction of SIMOPS would have been based on the rationale that the entire length of the duty runway was available for performance calculations and emergency use.

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## 3. CONCLUSIONS

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### 3.1 General

A large number of air traffic movements including surface vehicles are handled annually at Sydney Airport. The labour-intensive methods of controlling that traffic created the potential for serious human error.

Although many safeguards were built into the ATS system to minimise error, they did not eliminate the risk of this type of occurrence.

There are subtle commercial pressures by both the industry and the management of the CAA to respond to traffic growth at Sydney airport by tightening separation criteria by means of more precise control methods and introducing new technology.

BASI records indicate that the human-factor aspects, i.e., errors made by ATC and pilots, comprise the majority of instances where systems have failed to function as intended.

Continued traffic growth could increase the potential for human error and degrade the system capability for failsafe operation. However, automation to an excessive extent should also be treated with caution lest the unburdening result in work environments where controllers become less involved and thus de-skilled. Ratner Associates also addressed this issue in recommending development of sound work habits and maintaining job satisfaction and interest.

The investigation team has little doubt that the potential for this particular air-safety incident scenario has existed for many years. Despite the best efforts and will of the individuals on duty on this occasion, the final link of not completing one more sequence in the system operation revealed the system's fragility and vulnerability to failure.

The lack of documented SOPs was considered to be the major causal factor in this incident.

### 3.2 Findings

The investigation revealed that:

1. The air traffic controllers on duty were all suitably qualified and licenced for the tasks they were performing. Workload at the time of the incident was light.
2. The departing B747 had requested runway 34 and expected the full length to be available.
3. A vertical structural beam obscured approximately 120 metres of the runway 34 field of vision of the ADC 1 if he remained at the ADC 1 normal operating position. This area of obscured vision was adjacent to taxiway 'F'.
4. The 'runway 16 in use' switch was not selected and activated.
5. The engineering drawings called for a buzzer audio alarm for the 'runway in use' facility, not a clicker as installed. All other facilities were operational and functioning in accordance with the specific engineering standards.
6. ADC 1 visually checked that runway 34 was clear of obstructions prior to clearing Cathay 100 to take off.
7. Communication between SMC, ADC 1 and the crew of Cathay 100 and the aircraft under tow were clear and unambiguous.
8. The SMC was still processing surface traffic movements across runway 34 after the ADC 1 had cleared the departing B747 for take-off.
9. Jurisdiction for the complete runway complex was not retained continuously by the aerodrome controller during SIMOPS and multiple runway operations. The ADC 1 failed to select runway 16 to indicate to the SMC that the full length of runway 34 was in use.
10. Formal documented procedures authorising deactivation of runway sections and transfers of jurisdiction did not exist.

11. The methodology for indicating runway status changes was not failsafe. The system of runway selector lights and the procedures being used offered no means by which the system could tell the controllers that an error had been made.
12. Coordination procedures between operating positions were not failsafe and could be misinterpreted.
13. The mix of SIMOPS and multiple runway operations increased the complexity of aerodrome control.
14. There were no documented local unit SOPs or instructions to cover multiple runway operations or the extensions/modifications to SIMOPS, the flight progress strip annotations, or application of SMR.
15. Recorded data for the aerodrome environment was limited and the SMR facility is not recorded.
16. Information transfer between ADC and SMC was ambiguous and had no failsafe features. Non-standard, unpublished procedures were in use. The procedure adopted by some personnel to use the 'runway in use' lighting system for runway 34 operations also was not failsafe.

### 3.3. Significant Factors

1. There were no documented SOPs to cover SIMOPS and multiple runway operations.
2. The ADC 1 failed to select runway 16 to indicate to the SMC that the full length of runway 34 was under the jurisdiction of the ADC 1.
3. The ADC 1 concentrated his attention on the separation between the aircraft departing from runway 34 and the aircraft approaching runway 07 and was unaware that he had not activated the full length of runway 34.
4. The ADC 1 was unable to see the full length of runway 34 from the normal operating position.
5. Methodology for indicating runway status changes was not failsafe.
6. Coordination procedures between operating positions were not documented, were not failsafe and could be misinterpreted.



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## 4. RECOMMENDATIONS

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On completion of the preliminary investigation it was recommended that the Civil Aviation Authority (CAA) give consideration to ensuring that:

1. the complete runway complex remain under the jurisdiction of the aerodrome controller (ADC 1) during SIMOPS and Multiple Runway operations;
2. complete and comprehensive standardisation procedures be developed, documented and promulgated (as recommended by Ratner Associates) which specifically address anomalies in:
  - i) changes to runway status and configurations, including upgrade of the 'runway in use' facilities to failsafe
  - ii) coordination requirements between operating positions
  - iii) flight progress strip annotations; and
3. the implementation of the Ratner Associates recommendation number 2 be expedited.

The CAA subsequently advised BASI that the recommendations had been accepted and appropriate steps taken to implement the recommendations.

A further recommendation is that the CAA record SMR displays.