BUREAU OF AIR SAFETY INVESTIGATION
REPORT

Investigation Report
9301481

Boeing 747-400 and Federal Airports Corporation Safety Vehicle, Car 9, Runway Incursion at Sydney (Kingsford Smith) Airport NSW 24 May 1993

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Bureau of Air Safety Investigation

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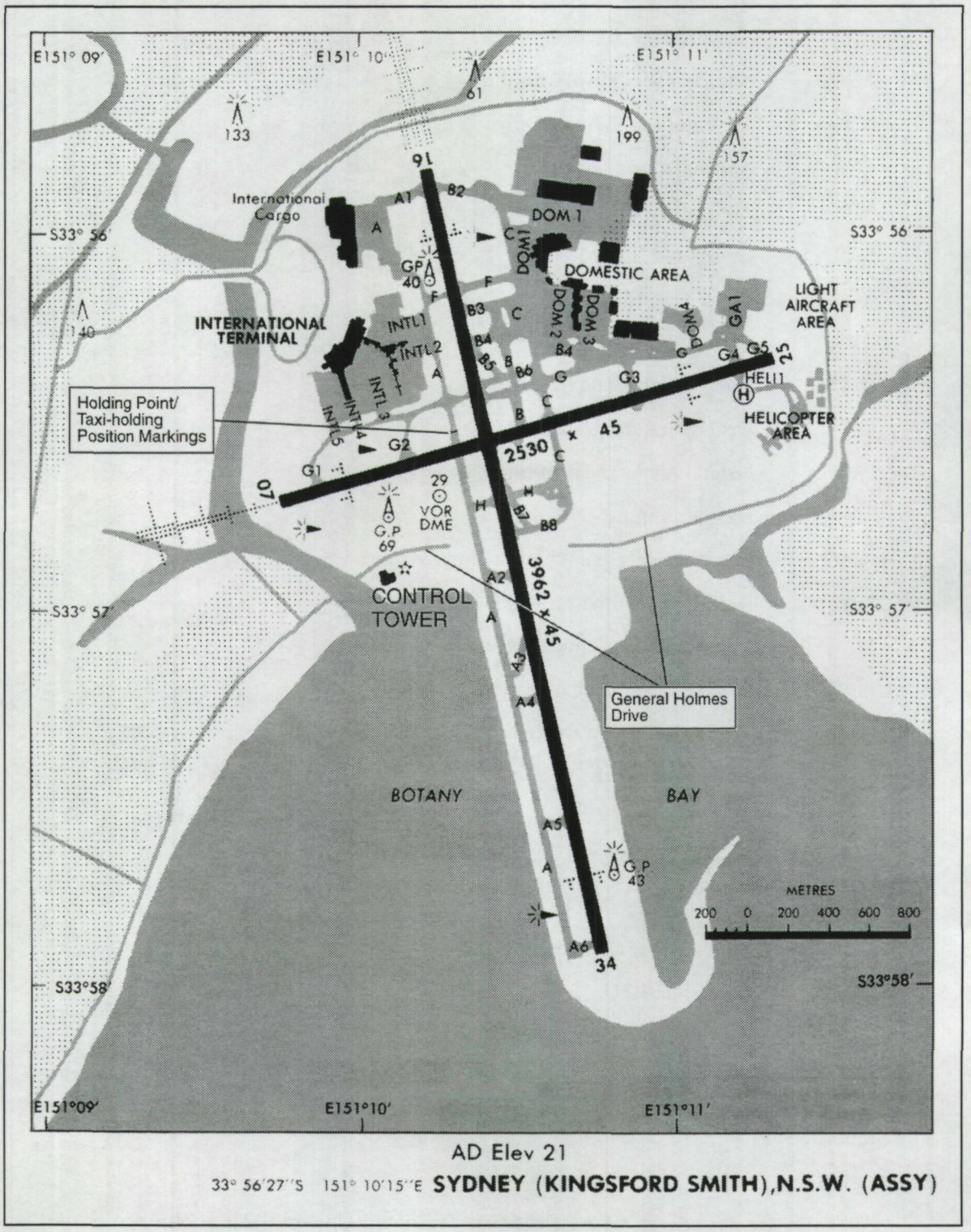
CONTENTS

GLOSSARY OF ABBREVIATIONS AND TERMS

AACC	Area Approach Control Centre
ADC1	Aerodrome Controller
ADC2	Aerodrome Control Coordinator
ADSO	Airways Data Systems Officer
AGL	Above Ground Level
ATC	Air Traffic Control
CAS	Computed Air Speed
COORD	Tower Co-ordinator
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
EST	Eastern Standard Time
FAC	Federal Airports Corporation
ft/min	Feet per minute
ICAO	International Civil Aviation Organisation
KLM	KLM Royal Dutch Airlines
MAGS	Movement Area Guidance Signs
MATS	Manual of Air Traffic Services
N_1	Engine Fan Speed Expressed as a Percentage
NOTAM	Notice to Airmen
PH-BFA	Registration of KLM Aircraft
SMC	Surface Movement Controller
SMR	Surface Movement Radar
STWR	Senior Tower Controller
UTC	Co-ordinated Universal Time

Note: The terms 'taxi-holding position markings' and 'holding position markings' are commonly referred to as the Holding Point and all three terms are used synonymously in this report.

All times are Eastern Standard Time (Co-ordinated Universal Time plus ten hours) unless otherwise stated.



AD Elev 21

33° 56′27″S 151° 10′15″E **SYDNEY (KINGSFORD SMITH),N.S.W. (ASSY)**

Figure 1: Layout of Sydney Airport

SYNOPSIS

At 2015 hours on 24 May 1993 PH-BFA, a Boeing 747-400 aircraft, was nearing touchdown on runway 07 at Sydney (Kingsford Smith) Airport, having received a clearance to land from air traffic control. At the same time, a Federal Airports Corporation safety vehicle, Car 9, was conducting a search for reported debris on a portion of taxiway 'A' near runway 07. During the search, the vehicle crossed the taxi-holding position markings and entered the 07 runway strip. The crew of PH-BFA observed this incursion and carried out a go-around manoeuvre from a low altitude.

It was determined that the safety officer in Car 9 had inadvertently crossed the holding point as a result of not seeing the holding point lighting/markings provided at the intersection of taxiway 'A' and runway 07.

1. FACTUAL INFORMATION

1.1 Sequence of events

Boeing 747-400 aircraft PH-BFA, departed Bangkok, Thailand, at 0714 hours local time on 24 May 1993 on a scheduled passenger service to Sydney, New South Wales, with a planned flight time interval of 8 hours 2 minutes. The flight proceeded normally, with the aircraft eventually being cleared by air traffic control for an approach to runway 07 at Sydney (see figure 1). The night, though dark, was fine and clear with a westerly wind of 3 kts, visibility in excess of 10 km, and no significant cloud. Final approach was flown manually by the first officer at a reference speed of 140 kts in the flaps-30 configuration, which was in accordance with a calculated landing weight of approximately 230,000 kg.

At 2014:36 EST, the aircraft was cleared to land by the ADC.

At 2014:39, an aircraft reported to the SMC that there appeared to be some sort of debris on taxiway 'Alpha', north of runway 07. The SMC called for an airport safety vehicle to inspect the area. Car 9, driven by an airport safety officer, responded to that call from a position on the eastern side of the International Terminal. The vehicle, which displayed a flashing amber light, in addition to normal head and tail lights, was driven along the eastern side of taxiway 'Alpha' in a southerly direction towards runway 07. No authorisation was given for the vehicle to enter runway 07.

As PH-BFA flared for landing (see figure 2), the captain observed a vehicle approaching the runway. He immediately instructed the first officer to go around and, at approximately 2016, PH-BFA was observed to commence a go-around from a position near taxiway 'Alpha'. The crew carried out this manoeuvre from a height of about 4 ft and the aircraft was radar vectored by ATC for a landing on runway 16 at 2031. During the initial overshoot, the captain reported to ATC that there had been a car on the runway.

The driver of Car 9 said he had been carrying out the taxiway inspection at a speed higher than normal for this task. This resulted from his assumption that taxiway 'Alpha' could soon be needed by landing aircraft. He chose to expedite his inspection to facilitate the continued use of that taxiway but inadvertently passed beyond the holding point and entered the 07 runway

strip before realising his error. The driver commenced a turn to the right but saw an approaching aircraft, apparently on the runway. He stopped the vehicle with heavy braking and immediately reversed back along taxiway 'Alpha'.

1.2 Injuries to persons

No injury to any person resulted from this occurrence.

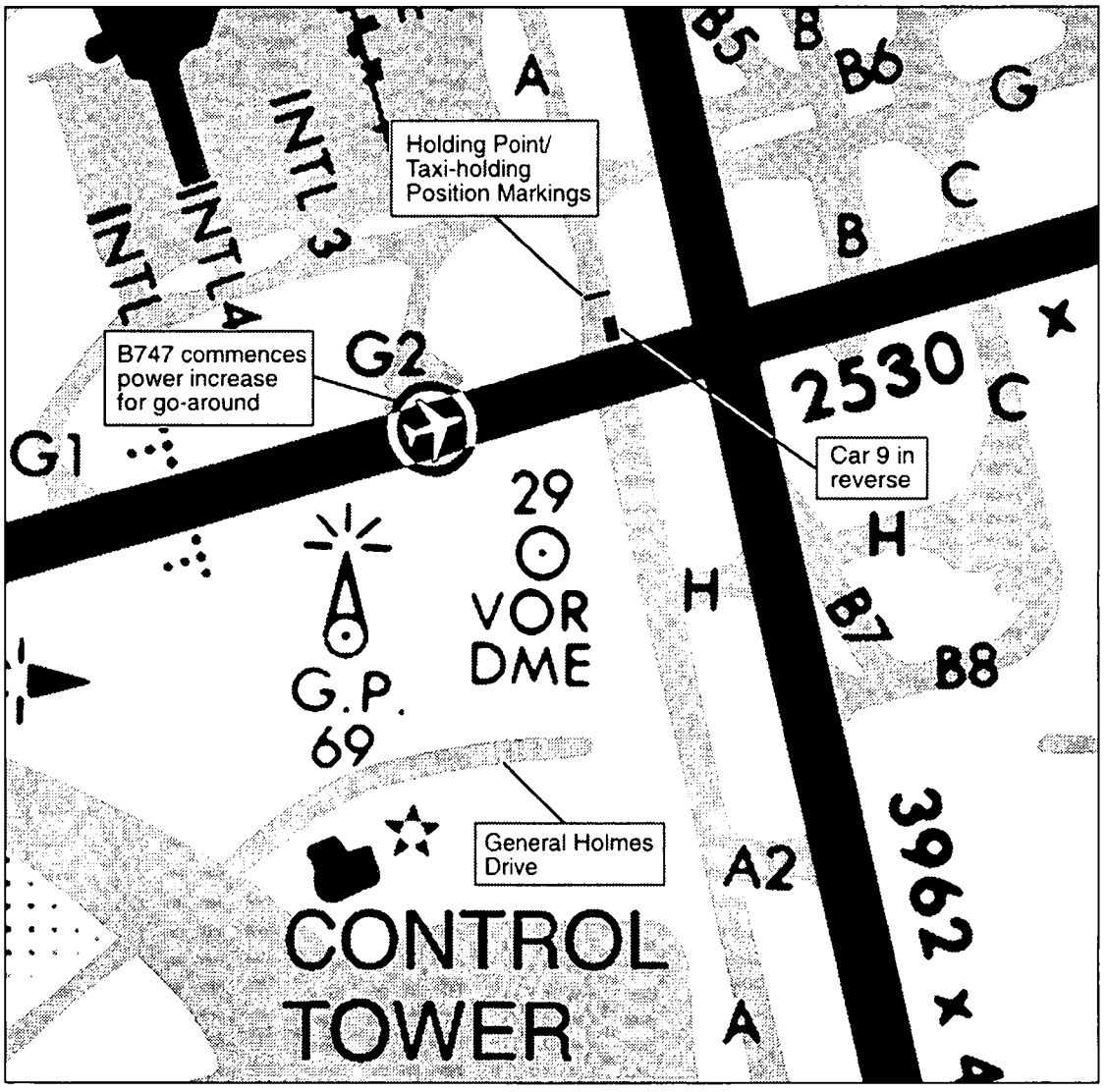


Figure 2: Approximate Positions of PH-BFA and CAR 9 at the commencement of power for the go-around [aircraft and vehicle not drawn to scale for ease of identification]

1.3 Damage to aircraft

No damage to the aircraft resulted from this occurrence.

1.4 Other damage

No damage to other property was recorded.

1.5 Personnel information

1.5.1 Crew of PH-BFA

Captain: The captain was aged 38 years and held an Airline Transport Pilot Licence

appropriately endorsed for B747-400 aircraft. He had approximately 8,000 hours flying experience, of which 5,000 were on B747 aircraft.

First officer: The first officer was aged 33 years and held an Airline Transport Pilot Licence appropriately endorsed for B747-400 aircraft. He had approximately 4,000 hours flying experience, of which 700 were on B747 aircraft.

Second officer: The second officer was aged 26 years and held an Airline Transport Pilot Licence appropriately endorsed for B747-400 aircraft. He had approximately 5,000 hours flying experience, of which 1,000 were on B747 aircraft.

1.5.2 Air Traffic Services personnel

All staff held current ratings appropriate to the positions they occupied. They had all received performance checks within the required statutory period.

Senior tower controller: The STWR was aged 44 years and had held an Air Traffic Control Licence for 24 years and a STWR rating for 4 years. At the time of the occurrence the STWR was occupying the COORD position in addition to his STWR function.

Aerodrome controller: The ADC1 was aged 36 years and had held an Air Traffic Control Licence for 9 years and an ADC rating for 10 months.

Aerodrome control co-ordinator: The ADC2 was aged 35 years and had held an Air Traffic Control Licence for 9 years and an ADC rating for 2 years.

Surface movement controller: The SMC was aged 44 years and had held an Air Traffic Control Licence for 23 years and a SMC rating for 5 years. He also held a STWR rating.

1.5.3 Federal Airports Corporation personnel

Safety officer: The safety officer in Car 9 was aged 49 years and had held an authorisation to operate as a safety officer at Sydney Airport for 7 years. He had been passed fit for work on 21 May 1993 following three weeks of sick leave. His eyesight was unimpaired.

1.6 Aircraft information

PH-BFA, a Boeing 747-400 series passenger aircraft was serviceable at the time of the occurrence.

1.7 Meteorological information

At the time of the occurrence the Sydney Automatic Terminal Information Service was broadcasting information 'Mike' which indicated that the weather conditions were fine and clear, with a westerly wind of 3 kts. The visibility was in excess of 10 km and there was no significant cloud. Witness reports indicated that it was a dark, clear night.

1.8 Aids to navigation

Both the Instrument Landing System and all runway lighting for runway 07 were serviceable and there were no significant NOTAMs relating to these aids current at the time of the occurrence.

1.9 Communications equipment

There were no reported unserviceabilities in the radio communication equipment of Sydney Tower, PH-BFA or Car 9.

1.10 Aerodrome information

1.10.1 The aerodrome

The Federal Airports Corporation operates Sydney (Kingsford Smith) Airport. The complex includes two sealed runways, 16/34 and 07/25, which are 3,962 m and 2,529 m in length respectively. Numerous taxiways give access to the whole of the movement area, each is identified by a letter and, where necessary, a number.

The sealed portion of runway 07/25 has a slope of 0.1% up to the east and is 45 m wide, with a 6 m wide, low-strength sealed shoulder on each side.

Each side of this sealed portion is an area set aside to provide protection for aircraft using the runway and is not normally available for use by vehicles, personnel or aircraft. It is referred to as the 'runway strip' and includes the runway.

The runway strip is 150 m wide and must normally be clear of obstructions for operations on the runway.

The distance from the threshold of runway 07 to taxiway 'Alpha' is 875 m.

Most taxi holding positions at Sydney Airport were marked in the old manner and not in accordance with the current ICAO Annex 14 recommendations (see figure 3). However the Aeronautical Information Publication AGA and the Rules and Practices for Aerodromes indicate that Australia will be progressively changing to the ICAO-recommended markings as taxi holding positions are repainted.

The rapid exit taxiways were found to have either a single white dotted line to mark the runway strip or no line at all. Although aircraft are unlikely to use these taxiways for access to the runway, vehicles do so regularly.

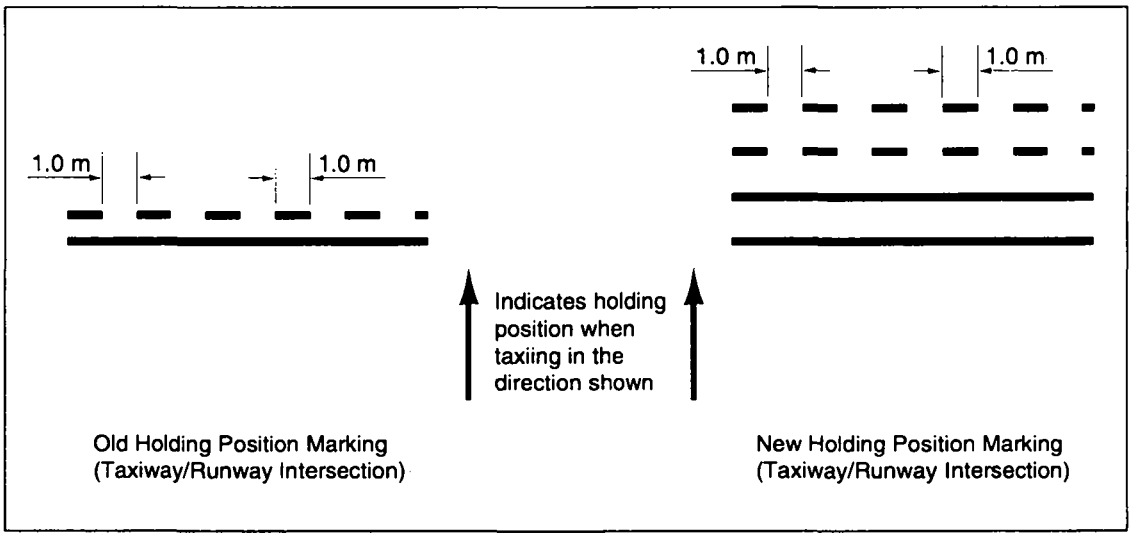


Figure 3: Difference between the Old and New Holding Position Markings

There were no MAGS to signify the position of the runway or the holding point. These signs are designed to inform pilots/drivers of specific areas of relevance, coincident with the section of movement area involved, e.g. runways. The ICAO *Manual of Surface Movement Guidance and Control Systems* refers to two basic types of signs—'mandatory instruction signs' and 'information signs'. Mandatory instruction signs are red with white inscriptions and are designed to be used to convey an instruction which is to be carried out unless otherwise advised by ATS. Examples include stop signs, no-entry signs, and holding-position signs.

Information signs are either black with yellow inscriptions or yellow with black inscriptions and are used to indicate a specific location or destination or to provide other relevent information.

The lighting provided on the taxiway was in accordance with ICAO Annex 14. It consisted of green centreline lights with three amber holding-point lights positioned to the centre of the taxiway perpendicular to the direction of travel. These amber lights are referred to as Clearance Bars and are unidirectional, being designed to give maximum effect when an aircraft/vehicle approaches the runway from a position on or near the taxiway centreline.

Annex 14 also recommends that at taxi-holding positions where enhanced conspicuity is necessary, taxi-holding position lights be installed. This recommendation is usually made in relation to reduced visibility but is not limited to such situations. The lights are flashing amber and are positioned one each side of the holding point as close as possible to the taxiway edge.

A fault was reported in the taxiway lighting at the intersection of taxiway 'Alpha' and runway 07, but this fault related to the southern side of the intersection and was not considered a factor in this occurrence.

Aerodrome works had been carried out on taxiway 'A' near the runway 07 holding point approximately 48 hours prior to the occurrence. These works consisted of 'coring and slotting' and resulted in a significant amount of dust being created on the taxiway.

At the time of the incident, runway 16 was in operation for departures, and runways 16 or 07 were in operation for arrivals.

1.10.2 The Sydney air traffic control tower

The tower is situated off the aerodrome to the south-west of the intersection of runways 16 and 07. General Holmes Drive, a major arterial road, runs between the tower and the aerodrome. It is appropriately lit for road traffic.

The tower is configured with four operator positions facing northwards from an elevated tower cabin. There is a supervisor's console positioned behind the main console and an ADSO position on the reverse side of the main console. The ADSO performs data processing duties and does not have an ATC licence.

The tower roof is supported by six beams and the position of one of these is such that it partially obscures the view of the taxiway 'Alpha'/runway 07 intersection from the ADC operating positions. The SMC's view of this intersection is not so restricted.

From left to right, viewed from behind, the operator positions and part of their functions are as follows:

SMC: The occupant of this position is responsible for ground separation by issuing instructions, clearances and information to all aircraft and vehicular traffic operating on the manoeuvring area of the aerodrome, excluding the duty runway(s). Surface movement radar is available to the controller for reference only.

COORD: The occupant of this position relays procedural messages to and from other airways units and has various operational functions including the activation of emergency services.

ADC 2: The duties of this position include the relay of departure/arrival sequencing information to and from the ADC 1 and other airways units such as the approach/departures cell in the AACC. The officer shares access to a SMR display with the ADC 1.

ADC 1: The duties of this position include the responsibility for maintaining separation between arriving and departing aircraft and for ensuring that the runway is clear for use by such aircraft.

STWR: This is a supervisory position and the occupant is responsible for overseeing all operations within the control tower.

1.10.3 Control tower operations

The ADC must ensure that the runway is clear of obstructions prior to issuing a clearance to land or take off. In relation to ground vehicles, the ADC works in conjunction with the SMC to maintain runway integrity.

The SMC has control of vehicles on the manoeuvring area and ensures that they remain clear of the runway strip until a specific request to enter or cross a runway is received. If no such request occurs, the SMC assumes that the vehicle will remain clear of the runway strip even though that vehicle may be working up to the edge of the runway strip/holding point.

Specific ATC clearance is required before any driver can operate within the runway strip.

The Manual of Air Traffic Services chapter 6 details the procedures and responsibilities for Aerodrome Control:

> The Tower Controller and Surface Movement Controller have authority to issue or withhold permission for pedestrian or vehicular use of the manoeuvring area. When such movements are permitted, they shall be controlled by the use of radio or light signals from the control tower.

At Sydney, movement by safety officers is controlled by radio on the published SMC frequencies of 121.7 MHz and 122.3 MHz.

MATS also specifies that where an entry clearance is required for any active runway, the SMC shall request the clearance from the ADC1. In the case of vehicles, this request is normally performed after the SMC has received such a request from a particular vehicle and the vehicle is then transferred to the ADC frequency of 120.5 MHz.

1.10.4 Federal Airports Corporation safety officer operations

Safety officers supervise the day-to-day activities that occur on or near the movement areas of the airport. They provide, amongst other things, an escort service for non-radio equipped vehicles, for pedestrians and any other movement area services, to ensure that aerodrome works are conducted in a safe manner. Safety officers are required to ensure that personnel and equipment remain clear of runways and taxiways and they must remain with any group or individual that needs access to a runway. Safety officers supervise persons who have little or no aviation safety training to protect them and aircraft from possible damage or injury.

There can be several safety officers on duty at any one time, with a shift supervisor located in Car 2. Other safety officers usually operate from Cars 3, 4, 5, 6, 7, 8 and 9. Cars 2, 5 and 7 are on a 24 hour roster and the other vehicles are staffed during busy periods. Safety officers in cars 3, 4, 6 and 9 operate on a 12-week rotating roster involving four three-week periods in each vehicle. Car 8 is operated only when necessary. Car 5 has responsibility for aerodrome serviceability and bird hazard monitoring. Cars 5 and 7 normally roam the aerodrome assisting Car 2 in everyday functions such as supervising aerodrome works, whereas Car 4 normally operates the Domestic Apron areas. Car 6 is in the General/Corporate Aviation Parking areas and the helicopter facility. Car 9 operates the International Apron areas. All cars can be used on any part of the aerodrome at any time depending on how busy a particular area becomes, and all safety officers are authorised to operate in any area as required. All vehicles are identically equipped to allow utilisation in any area and for any purpose.

Safety officers are able to talk to each other or to FAC management via a non-operational (UHF) radio frequency. This facility is used to minimise transmissions on the operational (VHF) ATC frequencies.

1.11 Flight recorders and recorded data information

1.11.1 Cockpit voice recorder

The aircraft was equipped with a CVR with a recording duration of 30 minutes. The most recent information continuously overwrites the oldest information so that the last 30 minutes are always available.

The CVR was not considered for the purpose of analysis.

1.11.2 Digital flight data recorder

The aircraft was equipped with a Sundstrand universal flight data recorder P/N 980-4100-DXUN. On this aircraft the DFDR recorded 89 engineering and 188 discrete parameters.

The recorded data showed that the Instrument Landing System approach was stable with no abnormalities apparent. The aircraft was being handflown with the flight director providing localiser and glideslope guidance. The CAS ranged between 147 kts and 150 kts during the final minute of the approach and the average rate of descent during this period was approximately 790 ft/min.

At 1016:16 UTC, recorded N_1 data showed that power began to be reduced on all engines during the landing flare.

At 1016:23 UTC, recorded N_1 data showed that power began to increase on all engines indicating that a go-around had commenced. The radio altitude at this time was 4 ft AGL (i.e. wheel height above the runway). This was also the minimum value recorded during the go-around. Analysis of the recorded data showed that the aircraft was approximately 680 m past the runway threshold at this time.

The engines accelerated from approximately 46% N_1 to maximum values of approximately 104% N_1 in 4 seconds. The minimum CAS recorded during the go-around was 142 kts.

Analysis of the recorded data showed that at the estimated time 1016:25 UTC, the aircraft passed through the runway intersection with taxiway 'Alpha'. The recorded radio altitude varied between 8 ft and 10 ft at this time.

By 1016:29 UTC, the aircraft had passed through a radio altitude of 50 ft and the aircraft's rate of climb quickly increased to approximately 4,000 ft/min.

1.12 Wreckage and impact information

Not relevant.

1.13 Medical and pathological information

Not relevant.

1.14 Fire

Not relevant.

1.15 Survival aspects

Not relevant.

1.16 Tests and research

1.16.1 Previous related incidents

A search of the Bureau's database revealed three other incidents involving runway incursions by

ground vehicles at Sydney. Each of these involved ground vehicles towing aircraft across runway 16 and in all three occurrences ATC did not issue a clearance to cross the runway. They occurred on 11 September 1990, 31 December 1991 and subsequent to the incident of this investigation, on 5 June 1993.

1.16.2 Comparison of incursion rates (selected aerodromes)

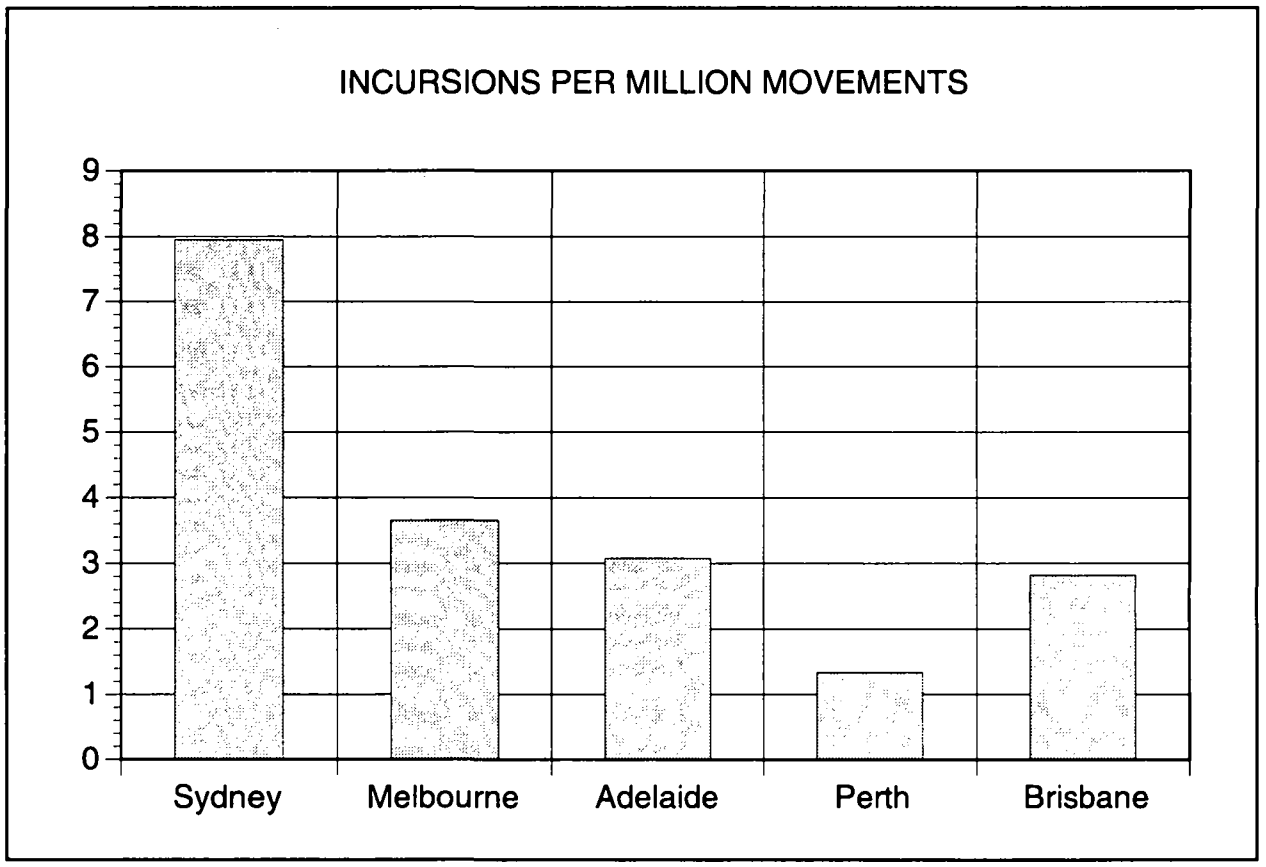


Figure 4: Australian runway incursion rates 1982–1992

The figures quoted relate to aircraft, vehicle and pedestrian runway incursions and do not include any occurrences which involved simultaneous operations on crossing runways.

Figure 4 depicts the rate of runway incursions per million aircraft movements in five major Australian airports. These figures were derived from information held in the BASI occurrence database and from Department of Transport and Communication movement figures. They cover a 10-year period from 1982 to 1992.

The figures show that Sydney Airport has 7.95 incursions per million movements with Melbourne having the next highest rate at 3.66, indicating that Sydney has an incursion rate well over twice that of Melbourne.

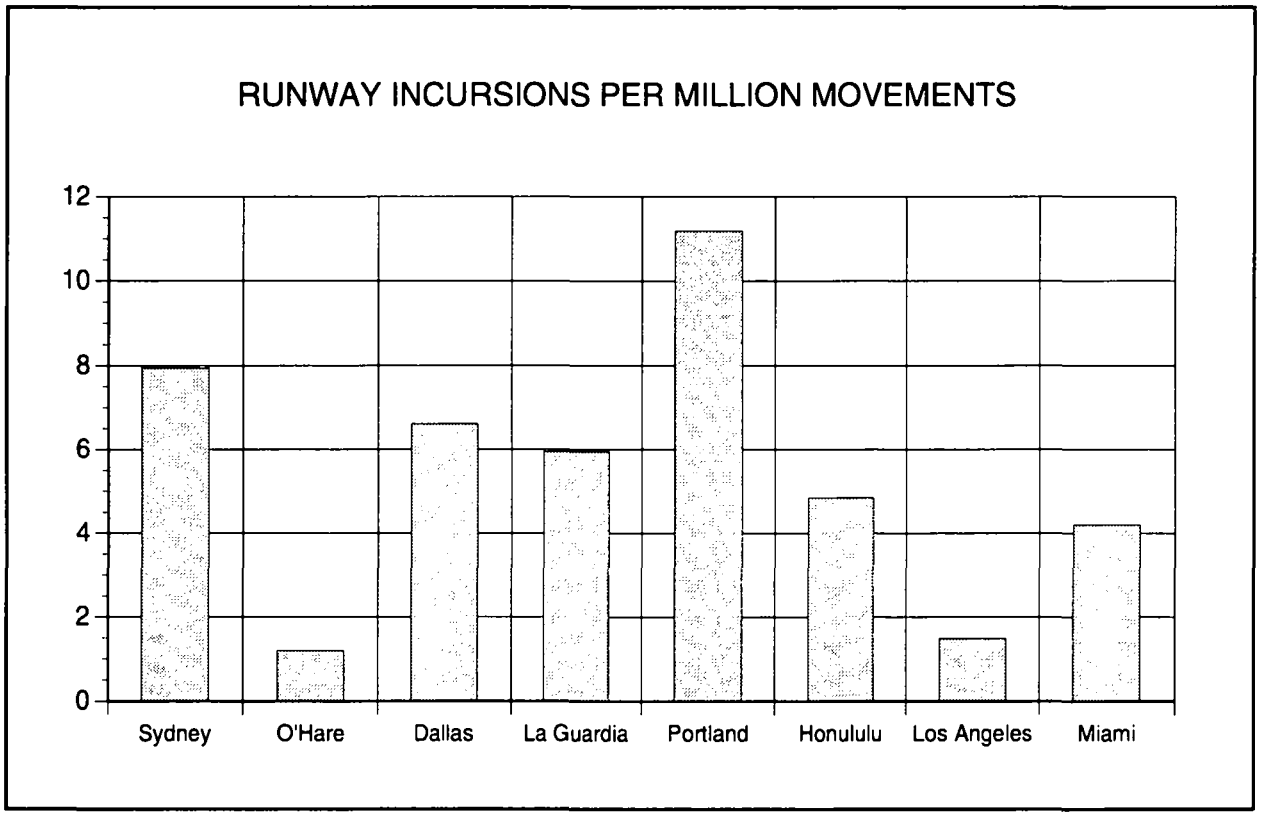


Figure 5: Comparison of runway incursion rates

Figure 5 also portrays runway incursions per million aircraft movements and compares Sydney Airport to a series of major airports in the United States. The figures for Sydney were again taken from the decade 1982-1992. The US figures are from 1991-1992 and are derived from the *Aviation Safety Statistical Handbook* published by the Federal Aviation Administration (FAA) in June 1993.

These figures show that the incursion rate is higher at Sydney than at many major American airports.

1.17 Additional information

1.17.1 Aircraft performance

The recorded performance of the aircraft during the approach to runway 07, and during the subsequent go-around, was consistent with normal operation.

1.17.2 Clearances—safety officer's responsibilities

Whenever safety officers are on the manoeuvring area they are required to activate the rotating beacon on the roof of the vehicle and be in continuous two-way radio contact with the SMC. Although they are authorised to move freely about the aerodrome, they must not infringe upon the runway strip without specific permission from ATC. This permission is granted in one of two ways:

(i) *Crossing a runway.* The Safety Officer requests permission to cross an active runway from the SMC. If granted, the SMC instructs the vehicle to cross the runway and obtains an acknowledgment from the driver. However, this is not in a read-back format.

(ii) *Entering a runway.* The Safety Officer requests permission to enter the runway in the same way as (i) above. In this case the SMC instructs the vehicle to hold short of the runway and, if the ADC1 can accommodate the request, transfers the vehicle to the ADC frequency. A clearance to enter the runway is then issued by the ADC1 only after successful two-way radio contact is established.

1.17.3 Car 9—responsibilities

The driver of Car 9 monitors the safety aspects of the International Aprons and maintains two-way radio contact with the SMC (Apron) frequency on an operational frequency separate to that of the main tower. At approximately 2000–2030 the SMC (Apron) frequency closes down for the night and Car 9 is transferred to the main SMC frequency for the remainder of the shift (approximately 2115). This results in Car 9 maintaining radio communication with the SMC and, as the officer is fully rated for general safety officer duties, Car 9 is free to answer any request for service in the same way that other cars would have done throughout the day. If Car 9 is needed for other duties during the hours of operation of the SMC (Apron), the officer is contacted via the FAC on the 'non ops' frequency. If the request requires the vehicle to travel from the International Apron onto the general movement area, the operational radio frequency is changed to SMC.

If the driver of Car 9 answers a request from the SMC to investigate a possible problem on a taxiway, the officer is fully authorised to carry out such an action. It would be considered appropriate for that particular vehicle to perform the task without reference to Car 2 if the position of the vehicle were close to the taxiway in question.

1.17.4 Training of FAC safety officers

The turnover rate of safety officers currently employed by the FAC at Kingsford Smith Airport is low. The need for training since the inception of the FAC has therefore been limited. Exact details of the training undertaken by the safety officer involved, or the date on which the training was initiated or completed, could not be determined. Such details were apparently lost during the transition from the Department of Aviation to the FAC. Anecdotal evidence suggests that most new recruits in the past had previously been employed as ground personnel. The officer involved reflects this pattern.

When persons were recruited as safety officers, they undertook a week of classroom instruction followed by an average of three weeks in the field with an experienced safety officer. The Safety Officers' Handbook dating back to the time at which the officer underwent his course provided details of the elements covered in the ground training. These included radio procedures, determining runway availability, emergency closures of a portion of a runway due to a disabled aircraft and sweeping operations on apron and adjacent taxiways.

After induction training, safety officers at Sydney airport received no ongoing or recurrent training.

The employment award for Ground Services Officers, including safety officers at Kingsford Smith, was restructured in April 1992. A new training curriculum is being developed to complement the award. The award and training are specific to Kingsford Smith; however the need to provide training which is uniform across all FAC airports has been recognised. The skills and knowledge required for the functions of each level of ground personnel at Kingsford Smith have been determined, and training is being developed to meet these needs. Safety officer tasks have been restructured so that rather than receiving complete training in all the tasks now undertaken by a safety officer, training and salary increments are staggered. The date on which the new training program is to be introduced has not yet been determined.

1.17.5 Recency

The Safety officer had operated Car 9 around the International Terminal for the three days following his return from sick leave. The FAC does not have any formal practices in place to ensure that officers are proficient in their duties following an extended period of leave. Procedures demand that drivers brief their successors on the general status of operations and changes which have occurred during their duty period. The officer involved obtained information from the previous driver about changes/works which had occurred during his absence.

The Safety officer had driven along taxiway 'Alpha' just before sunset on the day of the occurrence.

1.17.6 Proficiency

The FAC does not formally assess the proficiency of its safety officers. Poor performance is brought to the attention of the Safety Manager by shift supervisors (i.e. the safety officer in Car 2).

The Safety Manager indicated that the officer involved had been involved in no previous incidents and that he was considered to be a competent officer.

1.17.7 Summary of B747 crew's comments

The captain was occupying the left control seat and acting as the non-flying pilot. The first officer occupied the right control seat and was the pilot flying. The second officer occupied a seat midway between and behind the front control seats.

The aircraft was cleared to land on runway 07 but as the aircraft was flared at 30 ft the captain and second officer saw a small car approaching the runway from left to right, on what they later thought was taxiway 'Golf'. They said the vehicle was coloured yellow and white but did not notice a flashing light. They said they saw the vehicle headlights continue moving towards the runway. The captain was not sure if the vehicle would stop and instructed the first officer to go around. At that point the aircraft was at a height of about 10 ft with the throttles closed. They both believed the headlights travelled forward until they were in line with the runway edge lights. The aircraft climbed away without problems and a landing was later made on runway 16.

The second officer said he observed the radar altimeter reading 6 ft at go-around. The aircraft did not contact the runway.

The flight crew stated they were all well rested, having had a layover of 72 hours in Bangkok prior to the flight to Sydney.

1.17.8 Summary of air traffic controllers' comments

The controllers on duty agreed that the traffic level was light to moderate and that the B747 was cleared to land when 3–4 NM from touchdown. All remembered visually checking the runway for obstructions at regular intervals until the aircraft was about to land.

It was known that a safety officer was operating in the vicinity of the taxiway 'Alpha'/runway 07 intersection, but all controllers expected the driver to remain clear of the runway strip as it was a requirement for safety officers to request a clearance before entering the runway. As such a request was not received, it was expected that the vehicle would remain clear.

The lights of the vehicle were seen near the intersection at the time that the crew of PH-BFA advised of their go-around, but no controller could say whether or not the vehicle was infringing runway 07.

Two controllers remembered looking at the SMR and seeing a return near the holding point

moving north at high speed. All officers indicated that the SMR was not reliable for targets moving at slow speeds and they considered that this may be why none of them observed the vehicle passing the holding point southbound. The performance of the SMR was observed during the investigation and the opinions given on its reliability were found to be accurate.

Although three controllers mentioned that the glare from the road lights on General Holmes Drive occasionally caused problems when viewing taxiways to the south-west of the runway intersection, they thought that this was not a factor in the occurrence.

All controllers mentioned that one of the roof support pillars obstructed visibility from the tower cabin.

1.17.9 Summary of safety officer's comments

On receiving the report of debris on taxiway 'Alpha', the safety officer believed that the job had to be completed quickly. He saw a number of aircraft on approach and believed that at least one would require the taxiway to facilitate the landing sequence. The officer stated that he conducted the search at a speed faster than usual, in order to get the job done prior to the arrival of the aircraft. This faster speed was still slow in relation to normal public road driving speed.

The safety officer slowed as he approached the holding point lights; however his attention was centred on locating the debris rather than the lights. He noticed a patch of concrete dust and tried to determine whether this was the debris which the aircraft had mentioned. He did not recognise the proximity of the dust to the holding point lines. Although the officer stated that the dust was someway north of the holding point lights, BASI investigators noted that this patch was actually in the vicinity of the holding point markings, slightly obscuring them.

When the driver's attention was directed back to the taxiway, he recognised that he had gone beyond the holding point. He then stopped the car and reversed behind the holding point. He believed he encroached the runway strip by two car lengths.

As a result of the investigation, the following factual information was obtained by the investigation team and, while not being specific to this occurrence, is dealt with under this section because it is nonetheless relevant to the factors affecting the occurrence.

1.17.10 Airside driver testing

At the time of the occurrence a person was permitted to operate a vehicle on aprons, perimeter roads, or other specified areas airside on Sydney Airport only if the driver:

- held a valid aviation security card;
- held an authority to drive airside;
- held a current NSW state drivers licence;
- was able to operate the vehicle(s) concerned in a competent manner with responsibility being accepted by the driver's company.

1.17.10.1 Federal Airports Corporation

The FAC is primarily responsible for issuing authorities to drive airside. However, at Sydney airport, the Corporation does not use a structured theory or practical test when issuing the authority. Candidates are verbally tested by the safety officer shift supervisor on theoretical and general knowledge associated with airside driving. In the case of safety officers, practical testing of a potential driver's ability is performed during the course of that officer's training and is again monitored by the shift supervisor. When an officer's skill and knowledge level is deemed adequate by the shift supervisor, he/she is issued with an authority to drive airside.

1.17.10.2 Airlines

Qantas Airways Ltd and Ansett Australia have a delegation to issue authorities to drive airside to their employees and those from associated companies. The authorities are issued at the sole discretion of the airline involved, with no input from the FAC.

Qantas Airways Ltd issues all its authorities to drive airside through Qantas Security. The drivers are trained by the Qantas Engineering Department and the amount of training varies with the complexity of the driving task. The drivers of the larger tugs, such as those employed to tow aircraft, experience a more comprehensive training schedule than those who drive the smaller trolley tugs. In addition to meeting a short theory test requirement, these heavy tug drivers may receive two to three months of on-the-job training with a leading hand trainer before they are endorsed to drive airside on the type. Qantas, as with Ansett, have no licensing requirements specific to the taxiway/runway operations.

Ansett Airlines issues all its authorities to drive airside through its ramp training section. The authority covers all aspects of airside driving; however the ramp training section only trains candidates who will potentially work with aircraft operating in a revenue producing capacity (i.e. aircraft with paying passengers or freight on board). This work would involve jobs such as the pushing back of aircraft and luggage cart towing.

Each airline's engineering department is responsible for the towing of aircraft for positioning and/or maintenance purposes. The drivers of these tugs are usually licensed aircraft maintenance engineers, trained within the airline's engineering department and endorsed to drive the tugs by the department's leading foreman. Such tug work may involve towing aircraft on practically any aerodrome movement area, including across active runways. However, there are no licensing requirements specific to the taxiway/runway operations that these drivers may undertake.

2. ANALYSIS

2.1 Air Traffic Services personnel

ATC relies on safety officers to remain clear of the runway strip unless specifically instructed to the contrary. This agreement is entrenched in their training because safety officers supervise untrained personnel operating on the aerodrome. ATC relies on the safety officers to provide this service and is accustomed to watching safety officer vehicles operate up to the edge of the runway strip without an entry request.

In this case Car 9 was operating in response to a SMC request for assistance on a particular taxiway and no mention was made of any expectancy that the car would enter the runway. Additionally, the driver of Car 9 made no request to enter runway 07.

2.2 Aircrew performance

The performance of the flight crew was consistent with a high level of crew co-ordination and aircraft handling accuracy. As the aircraft was flared for landing, the captain and second officer both saw a small car approaching the runway. The Captain, being unsure if the vehicle would stop, instructed the first officer to go around. Recorded data showed that seven seconds elapsed from the time the throttles were retarded for landing until the go-around was commenced, at a wheel height of 4 ft. Some six seconds later, the aircraft had passed through a height of 50 ft, with the rate of climb rapidly increasing to about 4,000 ft/min.

2.3 Safety officer's performance

The haste at which the safety officer conducted his search reflected the service-orientated role of FAC safety officers, i.e. the requirement to keep the airport operating at an optimum capacity. This perception meant that the safety officer's attention was primarily concentrated on locating the debris to the partial exclusion of cues which could have alerted him to the proximity of his vehicle to the holding point lights and markings.

On the night in question the holding point lines which were usually used by the safety officer for guidance were partially obscured by concrete dust. The cues available were therefore limited to runway strip gable markers and unidirectional lights in the centre of the taxiway. The gable markers and lights would have been at the periphery of the safety officer's visual field as he approached the holding point, and may have been obscured by the vehicle window posts. As reported in the Bureau's report *Limitations of the See-and-Avoid Principle* (ISBN 0 642 16089 9), peripheral stimuli are more difficult to detect when attention is focused on a central task.

There was no indication that the safety officer was suffering from stress or that the duties assigned to him taxed his physical or mental abilities.

The actions of the safety officer on the day of the incident do not profile a negligent employee. Rather, they suggest that even given high motivation, there is always potential for a human to make mistakes. Consequently the aviation system must have multiple layers within the safety net. In this case the captain of the aircraft took the initiative and went around.

2.4 Attention

Humans have only a limited capacity to process information. While attention enables the individual to select the stimuli to be perceived, it is often necessary to divide attention between tasks, as the safety officer had to do—he was required to check his position relative to the holding markers while locating the debris. Unfortunately, in such situations, if one element of task dominates the attention, the other may go unchecked and this may lead to error.

2.5 Taxiway markings and lighting

Whereas the taxiway lighting met the basic ICAO recommendations, the unidirectional shielding had the effect of dimming the intensity of the three amber lights significantly when viewed from the side. When this factor was combined with the situation where the yellow holding point markings were of the old style, and were partially obscured by concrete dust, the safety officer probably would have had some difficulty recognising the exact location of the holding point.

The dust, which was left as a result of aerodrome works, is considered pertinent because the layer was thick enough to allow tyre tracks to be left two days after the works on the taxiway 'Alpha'/runway 07 intersection had been completed.

The FAC has started a MAGS implementation program, and to ensure efficient operations at night, consideration will need to be given to the lighting of such signs. Had MAGS been installed, the signs would have been placed on either side of the taxiway and would have been particularly visible to the driver, who was proceeding on the eastern half of taxiway 'A'.

All cues regarding the location of the holding point rely on the visual system. In view of the implications of crossing the holding point, it may be necessary to extend the cues to those which may provide noise or sensation. As a result of the investigation, the FAC commenced evaluation of thermoplastic markers. These markers are layers of paint raised above the taxiway by 5 mm and which, when driven over in a car, give the sensation of going over small bumps. At the time of writing this report, the markers were still being evaluated by the FAC.

2.6 Training and authorisation of safety officers and other airside drivers

The Sydney Airport FAC has responsibility for the provision and training of airport safety officers and for the issuing of all authorities to drive airside to their own staff and to other airport users. Although safety officers appear to have been monitored reasonably well, albeit informally, throughout their training schedule, at the time of the occurrence there was no structured testing of the officers designed to coincide with the issuing of such authorisations.

Given the age profile of the current safety officers, there will be an increasing need for recruitment and training in future years. The FAC will need to ensure that a standardised training program is in place so that the level of service and proficiency presently provided by the safety officers is not undermined. Although plans to formalise safety officer training and qualification existed at the time of the occurrence, they had not been finalised. The FAC issued Technical Instructions relating to Airside Vehicle Control in September 1992, and the training and regulatory changes were included in the Sydney Airport Airside Vehicle Control Handbook on 14 September 1993. The instructions apply Australia-wide and are being implemented by each location as soon as it is practical to do so.

Whereas the FAC issue some authorisations themselves, the lack of formalised procedures is accentuated by the delegation of authorisation issue to the airlines. The FAC exercises no direct control over the airlines in the issuing of these authorisations, or in what is taught during the training of the airline drivers. Additionally, they have not ensured quality control through an adequate monitoring program.

At the time of the occurrence, the FAC was developing regulations that will require all drivers with a Category 3 (all movement areas) authority to drive airside, to gain that authorisation directly from the FAC. This will leave the airlines with responsibility for issuing Category 1 (Perimeter Roads) and Category 2 (Perimeter Roads and Aprons) authorities only.

Formal proficiency checking has the potential to reveal deficiencies in the performance of all holders of authorities to drive airside, and such checking could be developed in conjunction with the new training program.

3. CONCLUSIONS

3.1 Findings

1. The safety officer was physically fit for duty.
2. All personnel were suitably licensed and/or rated to perform their respective duties.
3. Car 9 approached the holding point on the eastern side of taxiway 'Alpha' at a speed that, while being comparatively slow for a public road vehicle, was nonetheless faster than that with which the driver would have normally performed the search task.
4. The safety officer did not see the holding point taxiway lighting or ground markings.
5. The taxiway holding point lighting was in accordance with ICAO Annex 14.
6. The taxiway holding point markings were not in accordance with ICAO Annex 14.
7. The taxiway holding point markings were in accordance with AIP AGA.
8. The taxiway holding point markings were partially obscured by dust.
9. The safety officer neither asked for, nor was given, a clearance to enter the 07 runway strip.
10. Car 9 crossed the holding point and entered the 07 runway strip while the driver's attention was directed towards the eastern side of taxiway 'Alpha'.
11. ATC was aware of the vehicle's presence near the taxiway 'Alpha'/runway 07 intersection but expected the driver to keep the vehicle clear of the runway strip.
12. The SMR was not giving reliable radar returns on Car 9 due to the comparatively slow speed of the vehicle.
13. The crew of PH-BFA observed a vehicle infringe upon the 07 runway strip and, as the captain was unsure of its intentions, executed a go-around.
14. The safety officer realised his infringement and immediately reversed his vehicle to vacate the runway strip.
15. The training program for airport safety officers had been varied and inconsistent with no official syllabus maintained.
16. Observation of the taxiway 'Alpha'/runway 07 intersection by ATC can occasionally be affected by both the tower roof support pillar and/or the street lighting on General Holmes Drive.
17. The absence of MAGS detracted from the opportunity for the safety officer to observe his position relative to the runway strip.
18. The rapid exit taxiways were not adequately marked for holding clear of the runway strip.
19. Issuance of authorities to drive airside was delegated by the FAC without adequate control.

3.2 Significant factors

1. The safety officer did not see the taxiway holding point lights or markings.
2. The vehicle infringed upon the 07 runway strip while the driver's attention was directed to the eastern side of taxiway 'Alpha'.

4 SAFETY ACTIONS

4.1 Interim Recommendations

As result of this investigation the following Interim Recommendations were made:

IR930089: The Bureau of Air Safety Investigation recommends that the FAC ensures that maintenance and or construction sites located on or in proximity to aerodrome movement areas are cleared of debris immediately after work on the area is complete. This includes the removal of dust and dirt, and is particularly important when work is conducted in the vicinity of aerodrome markings.

FAC Response: *Following receipt of this recommendation an instruction was issued to all Corporation airports on 05 July 1993 stating,*

"...please ensure that you have in place local instructions which cover the need for reinstatement of markings where these are affected by adjacent works, prior to returning a taxiway/runway to operational use..."

In addition Sydney (Kingsford Smith) Airport had issued Safety Directives 30, 31 and 32 .

IR930091: The Bureau of Air Safety Investigation recommends that the Federal Airports Corporation accelerates the implementation of the New Taxi-holding Position Markings, with particular emphasis on airports with high traffic volume and/or complex runway/taxiway systems.

FAC Response: *Following receipt of this recommendation an instruction was issued to all Corporation airports on 6 July 1993. In addition Sydney (Kingsford Smith) Airport is trialling raised thermoplastic holding point markings to assess the sensitivity of vehicles and aircraft when crossing the holding point. Cat's-eyes have also been installed at the edge of the taxiway to provide an additional reference for vehicles travelling along the taxiway shoulder which may not be in line of sight of the normal taxiway holding point lights.*

A formal report of the trial will be forwarded on receipt from Sydney.

BASI comment: The following FAC head office memorandum, to all relevant FAC personnel, was forwarded to the Bureau detailing the action taken as a result of IR930091:

Rules and Practices for Aerodromes (RPA) Chapter 11, paragraphs 8.5 to 8.7 of March 1991 detail the "new" ICAO Pattern "A" and "B" taxi-holding position markings

- *at the time of issue, the CAA gave aerodrome owners instructions to progressively replace the exisisting "old" markings as re-painting became necessary.*

As a result of a recent runway incursion at Sydney (KS) Airport, the Bureau of Air Safety Investigation (BASI) has recommended that the FAC accelerate the implementation of these new markings, particularly at our airports with high traffic volume and/or complex runway/taxiway systems.

This office supports the BASI recommendation and your action to provide the new taxi-holding markings is required immediately please.

IR930116: The Bureau of Air Safety Investigation recommends that the Federal Airports Corporation install Taxi-holding position markings and lights on all Rapid Exit Taxiways, with particular emphasis on major airports such as Sydney. These markings and lights should be discernible to ground based vehicles approaching the runway strip and therefore be to the standard required for normal Taxi-holding Positions.

FAC Response: *Sydney (Kingsford Smith) Airport is trialling a single raised white thermoplastic marking with unidirectional lighting placed at 6m intervals. Again a formal report will be forwarded on receipt from Sydney.*

A number of potential problems have however been identified if a standard aircraft holding point is to be used. To ensure adequate clearances with the runway, that is if the worst case aircraft (B747-400) inadvertently took the rapid exit taxiway to join the runway, the position of the holding point would have to be significantly further back from the runway strip line. This may in some cases be close to the main parallel taxiway and cause confusion to pilots and possibly place an undue restriction on vehicle traffic could [sic] *operate safely up to the runway strip.*

4.2 Final Recommendations

The Bureau of Air Safety Investigation recommends that:

R930180: The Federal Airports Corporation introduce more stringent control of the issue of authorities to drive airside. This should ensure that applicants receive thorough, standardised training on all aspects of airside driving, including:

(a) Air Traffic Control procedures and phraseology;
(b) aerodrome layout;
(c) vehicle/personnel safety considerations (i.e. jet blast, etc.).

These training and authorisation requirements should cover all applicants and authorisation holders, and are particularly important for drivers operating in the runway/taxiway environment. In addition, periodic assessment of a candidate's proficiency should be included in the authorisation requirements.

FAC Action Already Taken: The Corporation issued a new Airside Vehicle Control Handbook on 14 September 1993. The handbook documents improved training and authorisation procedures for applicants for, and current holders of, an authorisation to drive airside.

R930181: The Federal Airports Corporation accelerate the installation of movement area guidance signs (MAGS) at Sydney airport. Installation of MAGS at all major Australian airports should be considered.

4.3 Safety Advisory Notifications

As a result of this investigation the following Safety Advisory Notice is issued:

SAN930178: The Bureau of Air Safety Investigation suggests that the Civil Aviation Authority review the effects of glare from the street lights of General Holmes Drive on night operations in the Sydney Airport Air Traffic Control Tower.

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