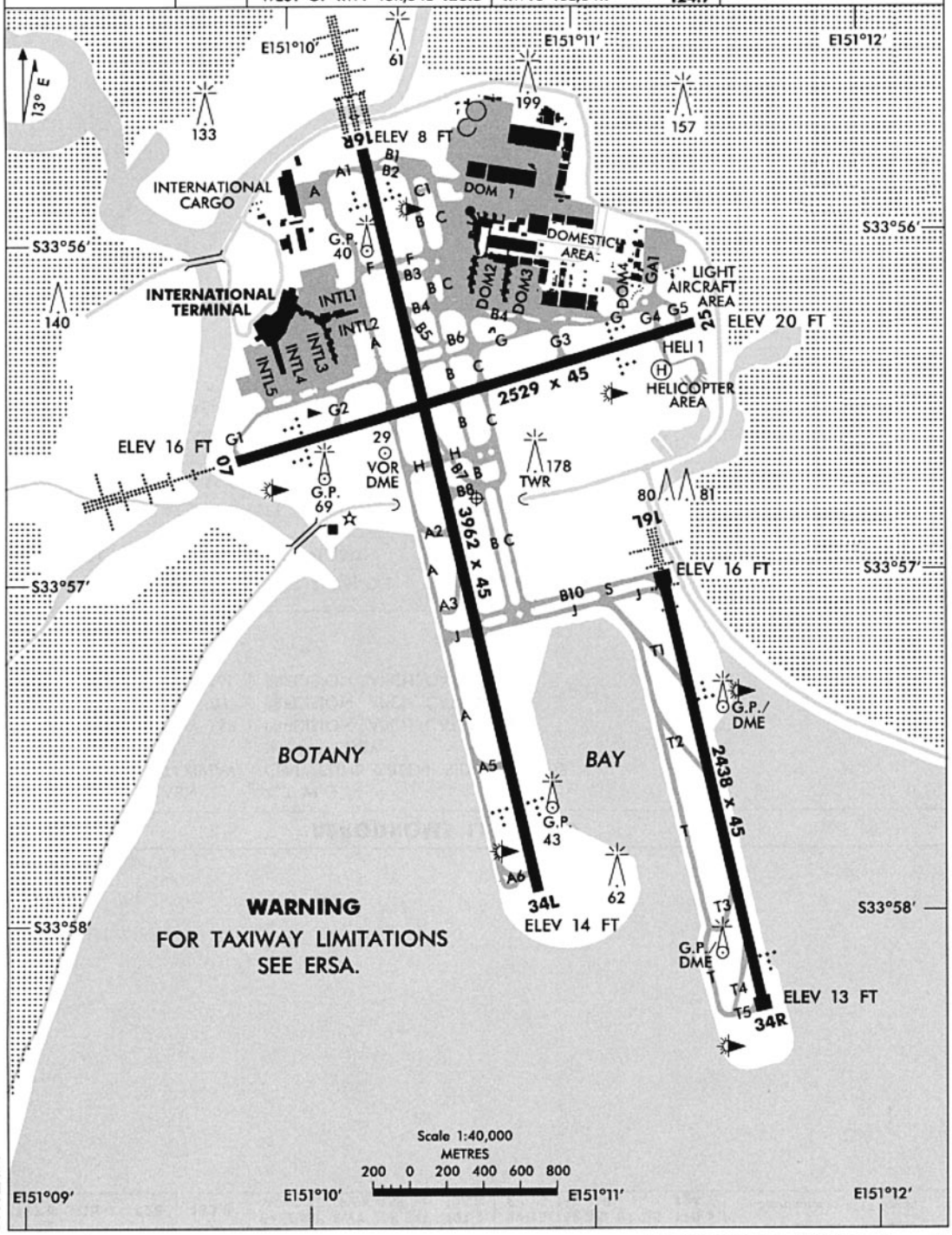
Changes: ATIS/ACD freq.

SYDNEY (KINGSFORD SMITH), NSW (YSSY)

ATIS	ACD	SMC	TWR	
127.6 115.4 428	133.8	EAST OF RWY 16R,34L 121.7 WEST OF RWY 16R,34L 126.5	RWYS 16R,34L,07/25 120.5 RWYS 16L,34R 124.7	Bearings are Magnetic Elevations in FEET AMSL



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Department of Transport and Regional Development

Bureau of Air Safety Investigation

Systemic Investigation into Factors Underlying Air Safety Occurrences in Sydney Terminal Area Airspace

Investigation Report B98/90

Released by the Secretary of the Department of Transport and Regional Development
under the provision of Section 19CU of part 2A of the Air Navigation Act (1920).

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SYNOPSIS

Following three breakdown of separation occurrences in the airspace of the Sydney Terminal Area (TMA), the Bureau of Air Safety Investigation (BASI) initiated a systemic investigation into the common factors underlying those occurrences. The investigation commenced on 22 June 1998 and was completed by 31 July 1998. Three further occurrences were identified during the course of the investigation. The systemic investigation has identified safety deficiencies primarily related to the management of change, and the rate and complexity of change faced by air traffic controllers operating in the Sydney Terminal Control Unit over the last four years. Resolving these management issues will further enhance the safe operation of aircraft in the airspace of the Sydney Terminal area. This report contains nine safety recommendations that have been developed to address identified safety deficiencies.

INTRODUCTION

Background

BASI has previously conducted a number of extensive investigations and studies of Air Traffic Services-related occurrences at Sydney Airport. These have included the investigation of a Simultaneous Operations (SIMOPS) occurrence (1992), the Aircrew Failure to Comply study (1994) and the investigation of a Simultaneous Opposite Direction Parallel Runway Operations (SODPROPS) occurrence (1997). The BASI Sydney Airport Monitoring Team continues to report at six-weekly intervals on Sydney Airport occurrences in order to track and analyse occurrence trends.

There were three breakdown of separation occurrences in the airspace of the Sydney Terminal Area over the period 22 May 1998 to 12 June 1998. These occurrences involved high-capacity aircraft conducting scheduled fare-paying passenger operations. BASI initiated on-site investigations for two of these occurrences and an office investigation for the other. The information gained from these investigations suggested common systemic safety deficiencies related to the rate and complexity of change. In particular, the changes over the past four years faced by Airservices Australia (AsA) air traffic controllers operating in the Sydney Terminal Control Unit (TCU). Safety deficiencies related to air traffic control techniques and separation assurance were also identified. Significant factors in each occurrence highlighted the limitations of human performance in the provision of air traffic control services.

The Bureau of Air Safety Investigation initiated an investigation to identify what, if any, systemic factors were underlying these air safety occurrences.

Methodology

Officers of the Bureau of Air Safety Investigation based themselves in the Sydney Terminal Control Unit between 17 and 21 July 1998. A total of 35 TCU controllers, with a wide range of experience and backgrounds in approach control, were interviewed during that time. Two tower controllers and one Aviation Data Systems Operator were also interviewed. Controllers were asked a standard set of questions requiring open responses. A survey questionnaire was developed and distributed within the TCU. Thirty responses were received and collated from this survey. In addition, discussions were held with four Airservices Australia Sydney Terminal managers. Quantitative data and qualitative information was also gleaned from Airservices Australia documentation in support of the investigation.

In the two weeks following the work conducted within the Sydney TCU, a series of interviews and discussions were held with representatives from airline companies that regularly operate into or out of Sydney. Canberra based managers from Airservices Australia, as well as managers from the Civil Aviation Safety Authority (CASA), were also interviewed.

Given the schedule that was set for the investigation and the completion of the draft report, BASI acknowledges that the investigation team was unable to make detailed comparisons with international practice. However, BASI is aware of two recent reviews related to the efficiency of Sydney Air Traffic Service operations that have considered international practice. Coopers and Lybrand and the National Air Traffic Service of the United Kingdom (NATS) conducted these reviews. Reports on both of these reviews were in draft form at the time of BASI's investigation and were not reviewed by the investigation team.

The terms of reference for this investigation have been included as attachment one.

1.0 SUPPORTING INFORMATION

1.1 OCCURRENCE SUMMARIES

1.1.1 BO/9801779

The airport and associated airspace were being operated in accordance with mode seven of the Sydney Long Term Operating Plan (LTOP) in which runway 25 was being used for departures while runway 34L and runway 34R were being used for arrivals. A Boeing 737 (B737), registration VH-CZV (CZV), had departed runway 25 at Sydney. When the aircraft was 6 NM north-west of Sydney airport the crew was cleared to climb to flight level (FL) 280. When it was 10 NM north of Sydney, the departures-north controller instructed the crew of CZV to turn right onto heading 060 degrees. The controller had noticed that CZV was not going to reach 9,000 ft in sufficient time to maintain separation with another B737, VH-CZK (CZK), which was on a LETTI 3 standard arrival route for runway 34R and maintaining 8,000 ft. Both aircraft were approximately 3 NM apart when traffic information was passed to the crew of CZV which was passing 8,400 ft. Lateral and vertical separation standards were infringed and there was a breakdown of separation. Subsequently, the crew of CZV reported sighting CZK and advised the controller that visual separation could be maintained.

Note: A breakdown of separation has occurred when prescribed lateral and/or vertical separation standards have not been met.

1.1.2 BO/9801905

The airport and associated airspace were being operated in accordance with mode nine of the LTOP in which aircraft departed over the north and north-west from runway 34L and to the east and north-east from runway 34R. Arrivals from the south were over Botany Bay on runways 34L and 34R. A B737 departed runway 34R at Sydney for Coolangatta via the runway 34R ENTRA ONE standard instrument departure (SID) and was on climb to 5,000 ft. The flight was under the control of the departures north controller. A Fairchild Metroliner III (Metro) was inbound to Sydney from the north and was tracking for a wide downwind leg for runway 34R following a diversion to the east for sequencing with preceding slower traffic. The Metro was maintaining 7,000 ft and the crew was in communication with the approach north controller, although on this track the aircraft was in departures north airspace.

The departures north controller elected to separate the two aircraft by climbing the B737 above the Metro and coordinated this with the approach north controller. The B737 crew was instructed to climb to FL 280 and expedite the climb through 8,000 ft. Subsequently, it became apparent that the B737 would not climb above the Metro in sufficient time to establish the required vertical or lateral separation standard of 1,000 ft or 3 NM respectively. The departures north controller instructed the crew to maintain 6,000 ft. However, as the B737 was climbing at between 4,000 and 5,000 ft per minute, it had reached 7,000 ft before the crew was able to arrest the rate of climb and commence descent. Because the minimum separation standard was infringed, the controllers passed essential traffic information to their respective aircraft. The crew of the B737 sighted the Metro and flew beneath it with 600 ft separation.

1.1.3 BO/9802135

The airport and associated airspace were being operated in accordance with mode nine of the LTOP. A B737 departed runway 34R at Sydney for Melbourne and was cleared to FL280 on a MARUB ONE SID with a Wollongong transition. This SID required crews to intercept the

075 Sydney VOR radial until 15 NM (waypoint MARUB) and then to turn right and track 144 degrees until passing 9,000ft. The crew complied with the requirements of this SID.

At the same time, another B737 inbound to Sydney on a CHEZA THREE standard arrival (STAR) for a landing on runway 34R had passed waypoint WHALE, located 20 NM east of Sydney, and was maintaining 7,000 ft. This crew complied with the requirements of this STAR.

When the departing B737 turned right to track 144 degrees in accordance with the SID, there was a breakdown in separation between the two aircraft. Separation was reduced to 2.5 NM horizontally and 500 ft vertically. Essential traffic information was passed to the crew of the departing aircraft, who sighted the other B737 and flew behind it.

1.2 RELATED OCCURRENCES

A further three Sydney TCU occurrences were highlighted during the course of the systemic investigation. The first occurrence involved the provision of a descent clearance to the crew of a British Aerospace 146 (BAe 146) that subsequently placed the aircraft within a restricted area in which firing of live ammunition was taking place. The second occurrence involved the provision of a climb clearance to the crew of a Beechcraft 76 that subsequently placed the aircraft in close proximity to a Partenavia 68. The third occurrence involved the allocation of an incorrect callsign and instructions to the crew of a BAe 146 that subsequently placed the aircraft in close proximity to a B737. Each of these occurrences was investigated internally by staff from Airservices Australia. The following is a summary of some of the contributing factors cited in the internal investigation reports of these three related occurrences and which highlight safety issues common to the three related occurrences investigated by BASI. (The order of these factors is not intended to reflect the order of significance of the factor, nor are the factors listed common to all three occurrences):

(1) controller technique;

(2) air traffic planning;

(3) fatigue;

(4) experience/knowledge levels;

(5) people management;

(6) staffing/rostering; and

(7) supervision.

Note: In accordance with legislation, Airservices Australia is required to report details of accidents, incidents and serious incidents that it has become aware of, to the Bureau of Air Safety Investigation. Airservices Australia also conducts its own inquiries into ATS related occurrences. Such inquiries may be conducted in parallel to BASI's investigations.

1.3 RATE AND COMPLEXITY OF CHANGE

1.3.1 Change management

The principles and processes that are required by Airservices Australia for the management of change are contained in the Airservices Australia Safety and Quality Management System Manual. The Civil Aviation Safety Authority has stated a requirement for Airservices Australia to control and manage safety hazards in any change to existing systems, equipment or procedures to ensure that unacceptable risks are mitigated against by the time the change is implemented. The integrity of change management must, among other things, 'be viewed

from a total system perspective and not in isolation', 'identify education and training levels' and 'recognise the lead times required for individual change initiatives to ensure timely implementation'. The assessment of proposals for change must consider a number of issues including, but not limited to, 'consultation with industry and staff', 'environmental issues', 'workload considerations' and 'implementation planning'.

Organisers of the Atlanta Olympics recommended a period of twelve months stability in Sydney transport infrastructure and operations, which includes Sydney airspace operations, prior to the heavy demands that are likely to be placed on the transport system during the Olympics in October 2000. As it relates to the activities of Airservices Australia, this period of stability had been recommended in order to allow controllers to become fully familiar with new systems, and for the systems themselves to present stable platforms.

1.3.2 Organisational pressure

The air traffic control system at Sydney has been evolving continually as traffic densities have increased, as technological improvements have been made, and to cater for the environmental impact of aviation on society. In particular, the non-acceptance by the community of Sydney, of relatively constant and concentrated exposure to aircraft noise, led to Federal Government policy related specifically to Sydney Airport noise management. The previous Government had adopted a noise policy such that the noise from departing and arriving aircraft affected the fewest people and the fewest suburbs in the area surrounding Sydney airport. Therefore, aircraft noise tended to be concentrated in parallel corridors roughly coincident with the extended centrelines of the parallel runways. Subsequently, in 1996, the new Government adopted a policy of 'noise-sharing' so that airport noise was shared more equitably over the surrounding suburbs of Sydney. This latter policy led to the development of the LTOP by Airservices Australia and associated working groups. The LTOP has been accepted by the Government and subsequently implemented by Airservices Australia.

The LTOP provides 'noise-sharing' by requiring changes to runway configurations and traffic patterns (a mode change) that result in directing the traffic over different segments of the community for periods of up to four hours at a time. In a media statement released on 29 May 1997 by the then Minister for Transport and Regional Development, the Honourable John Sharp MP, the Minister stated that 'safety will remain the paramount factor of the Plan. I will be making it clear to Airservices that no new procedures are introduced until all the necessary safety clearances have been obtained'. On 4 June 1998, the Minister for Transport and Regional Development, the Honourable Mark Vaile MP, also stressed 'the paramount importance of safety in the implementation of the LTOP'.

Airservices Australia is required to conduct a safety case, in accordance with a Memorandum of Understanding (pending development of appropriate legislation) with the Civil Aviation Safety Authority, prior to the implementation of a significant change to procedure. Safety cases follow a structured process to identify potential hazards with the procedure, and to implement mitigating strategies to control risk at a level acceptable to management. Safety cases were conducted for each of the mode changes contained within the LTOP.

Very few of the controllers interviewed understood the development process of a safety case. Those that did understand had previously been involved in the conduct of safety cases. Generally, these controllers were well experienced and working as stream specialists or team leaders and were therefore very familiar with Sydney airspace and air traffic control principles. Three of these more senior controllers reported to the investigation team that the intent of the safety cases was compromised. One of these senior controllers put a similar view in writing to local Airservices Australia management. The controllers believed the LTOP safety case was flawed. They indicated that they were required to substantiate their perception of the risk of

identified hazards in the safety case in response to pressure being applied by senior management for an early resolution that, in turn, was in response to the community noise lobby. They considered that their arguments about the risks of identified hazards were substantially ignored. In addition, controllers claimed that some of those involved in the development and analysis of the LTOP, including industry and community representatives, were not as familiar with air traffic control and aircraft flight principles and were therefore not as cognisant of the risks associated with the identified hazards. Senior management did not agree that pressure from the community noise lobby had any impact on their decision making in the development of the safety case.

The introduction of TAAATS (The Australian Advanced Air Traffic System) is imminent. The hardware is in place and the system is currently being delivered to air traffic control units within Australia. The controllers interviewed indicated that there had been significant organisational pressure for TAAATS to be delivered on time, and on budget. All of the Canberra Air Traffic Services managers, and one of the local Sydney TCU managers, expect TAAATS to be commissioned in the Sydney TCU in June or July 1999, a project date at least three months later than originally planned.

Before TAAATS can be commissioned in the Sydney TCU, a large number of training modules are required to be completed by controllers, new procedures must be developed and competency skills must be attained. The complete transition to TAAATS requires both the delivery of the system and the availability of a group of controllers capable of operating it. Interviews with controllers and local managers, and data from survey results, revealed a strongly held opinion that the Sydney controllers will neither be ready nor capable of a safe and seamless transition to TAAATS in the June/July period of 1999. The majority of controllers interviewed (92%) considered that, with the resources available and the reservations they held regarding some of the human-machine interface issues, the transition to TAAATS by June 1999 was an unrealistic project goal. These controllers recommended that TAAATS should not be commissioned in the airspace of the Sydney Terminal Area until after the Olympics.

1.3.3 Changes in the Sydney TCU July 1994 - July 1998

To provide a fixed window for the investigative team to consider, only those changes that have occurred in the past four years have been examined. By July 1994, the Sydney TCU had consolidated the transition to a structured airspace environment. From November 1994, Sydney airport was operating the parallel runways, utilising 16L/34R (the new short runway) and 16R/34L (the long runway). Runways 16L and 16R/34L were utilised for both takeoff and landings while 34R was used only for landings. Runway 07/25 (the crossing runway) was used only in circumstances when excessive crosswind was experienced on the parallel runways. By July 1995, the air traffic system in the Sydney TCU was being conducted such that aircraft were following predetermined flight paths, referred to as 'on rails', and within a controlled change management environment. This was in accordance with the recommendations made by Dr Robert Ratner in 1992 [1].

Since that time, there have been many changes that have had an impact on the controllers' workload and their workplace. The following significant changes to operating procedures, equipment or the environment have been implemented since July 1994.

[1] The Civil Aviation Authority and BASI had commissioned a comprehensive review of the capability of the ATS system of Australia to maintain safe separation between aircraft. The outcome of the review was 24 recommendations incorporated in a document known as the '*1992 Review of the Australian Air Traffic Services System*'.

July 1994	Sydney TCU had consolidated structured airspace.
November 1994	Commencement of parallel runway operations.
December 1994	Withdrawal of simultaneous operations (SIMOPS).
November 1995	The introduction of independent visual approaches.
December 1995	The new control tower was commissioned.
April 1996	Runways 07/25 were re-opened for more regular use during quiet periods.
June 1996	A new mode, using runway 25 for departures and runways 34L and 34R for arrivals was introduced.
October 1996	SODPROPS (simultaneous opposite direction parallel runway operations) was introduced, using the parallel runways for simultaneous arrivals and departures. Departures from runway 34R commenced.
December 1996	The proposed LTOP, as developed by Airservices Australia, was submitted to the Minister for Transport and Regional Development for consideration.
July 1997	The Minister issued directions to Airservices Australia and the Federal Airports Corporation to implement an amended version of the LTOP.
August 1997	Two new LTOP modes were introduced, which allowed runway 16 parallel departures with runway 07 arrivals, and runway 16 parallel departures with runway 25 arrivals.
December 1997	Departure flight tracks from Sydney were amended, which introduced new standard instrument departures, such as the MARUB SID.
April 1998	Extended hours for SODPROPS were introduced.
July 1998	Forecast changes include the relocation of the airways clearance delivery function from the TCU to the control tower in August 1998, the reconfiguration of Departures West airspace within the TCU in October 1998 coincident with the introduction of a Radar Information Service, the commissioning of the PARM (parallel approach radar monitor) in December 1998 and the commissioning of TAAATS in Apri1999.

During the calendar year of 1997, there were 142 Temporary Local Instructions (TLIs) published pertaining to the Sydney TCU. TLIs are the medium for publishing new, or amended, administrative or operational procedures, until such time as they are cancelled or have been incorporated into a parent document, such as Local Instructions. Whilst not all TLIs published in the Sydney TCU directly affect Sydney TCU controllers, they must nevertheless be referred to regularly to determine which are operationally significant. At the time of the investigation there were 51 current TLIs for the Sydney TCU. By comparison, approximately 20 TLIs were published during 1997 pertaining to the Brisbane TCU, while 23 TLIs were published pertaining to the Melbourne TCU.

Eighty percent of the Sydney TCU controllers reported being overwhelmed by the volume and complexity of some of these TLIs, some of which had been promulgated with minimum lead times. A number admitted that they did not always read or absorb the information contained in the TLIs and often relied on other controllers or the shift team leader to brief them when necessary.

The Airservices Australia Safety and Quality Management publication, 'Safety Net', contained a lead article on 'Change', which was published in issue three (May 1998). The publication of this article reflected the recognition by Airservices Australia of the negative impact of cumulative change and the importance of managing change without reducing levels of safety.

Importantly, it was stated to controllers that 'your involvement and commitment to any change process is vital to its success'. However, the BASI investigation obtained evidence from both survey results and interviews with Sydney TCU controllers that clearly indicated that commitment to change was not universal. When asked 'what, if any, was the main problem in Sydney', over 50 percent of those interviewed cited the volume and complex nature of the changes to Sydney Terminal Area procedures as their greatest safety concern, particularly changes associated with the continued implementation of LTOP.

Sydney TCU managers and those controllers involved in the development of the safety cases for SODPROPs and Stages One and Two of LTOP, indicated that the safety cases had been analysed in isolation. Whilst every effort had been taken to ensure that the change management process had been strictly adhered to, they conceded that the aggregated effect of change on the whole Sydney air traffic control system, and on the ability of the controllers to cope with the cumulative effect of the changes, had not been well considered. Many controllers felt that this was a difficult issue to address adequately without the expertise provided by appropriately qualified and experienced personnel. Only a few of the controllers who conducted the hazard analysis for the safety cases reported that they had undertaken training in risk management and analysis, including aspects of human performance limitations. They were not experienced in the specialised fields of risk analysis or human performance. For example, the LTOP Stage One safety case referred to the potential hazard, 'extent of change', and presented one mitigating strategy for that hazard as 'minimise change'. The safety case contained little further qualification of this mitigating strategy. The LTOP Stage Two safety case also referred to 'continuous change to ATS procedures'. A safety requirement to address this hazard was to 'ensure only essential changes, or those designed specifically to mitigate risks are implemented until post implementation review recommends otherwise'. One of the mitigating strategies for this hazard was that 'an independent assessment be undertaken, including human factors, to determine capacity for further change'. An independent review was completed by Praxis Critical Systems on 29 April 1998. This review was limited to changes to procedures covered by the LTOP Stage One safety case. An independent human factors assessment for the LTOP Stage Two safety case does not appear to have been undertaken.

Note: The development of formal safety cases commenced in 1997 in accordance with the Memorandum of Understanding between Airservices Australia and the Civil Aviation Safety Authority. Approximately 200 Airservices' staff have completed some systems safety training since that time.

1.3.4 Mode Changes

A mode change involves directing air traffic to a different configuration of runways and traffic patterns. Sometimes a mode change will have little impact on traffic processing and handling, while at other times the transition can be a lengthy and complex process involving significant holding or radar vectoring of aircraft in the terminal area. The transition from one mode to another involves a higher degree of risk because existing traffic must be transferred from one set of 'rails' to another and responsibility for these aircraft transferred between controllers.

Once a mode change is accomplished, the ability for mental processing, or cognitive, capability of a controller is reduced until such time as the new pattern of handling and directing traffic becomes familiar. Prior to 1995, there was an average of three mode changes per 17-hour period, which may not have included any mode change on a particular shift. In 1998, the average has increased to six mode changes per 17-hour period with some recorded cases of nine mode changes.

1.3.5 The complexity of air traffic management

Many controllers believed that the management of air traffic in the airspace of the Sydney Terminal Area had historically been regarded as complex. In the period prior to 'structured airspace', it was reported that only 20 percent of controllers had the ability to be trained and rated in Sydney approach control. A high degree of controller skill was necessary to cope with the level of complexity of the airspace and traffic density.

Sydney TCU controllers and their managers explained that the introduction of structured airspace, later followed by parallel runway operations, simplified air traffic management. It was reported that a 100 percent pass rate in the endorsement of controllers in the Sydney TCU had been achieved since these fundamental changes occurred in air traffic management. Those interviewed believed that controllers no longer required the high degree of skill that was needed to manage and control aircraft flexibly in the previous more fluid and unstructured airspace environment. They considered that control of air traffic had become more of a monitoring role than an active management role.

However, all those interviewed indicated that the LTOP, a set of procedures developed under the control of Airservices Australia, had introduced an increased level of complexity to air traffic management. The complexities of air traffic management introduced by the LTOP were identified as hazards in the conduct of the safety case and strategies were developed to mitigate their effects. There are instances where mitigating strategies for identified hazards have not been applied.

Controllers stated that the increasingly complex cognitive demands of LTOP had required individuals to redevelop some of the skills that were previously frequently required to control air traffic in unstructured airspace. The controllers added that this also meant that the more recently trained controllers needed to learn these more traditional skills in order for them to be able to continue to manage the air traffic safely and efficiently. It was identified in the analysis of Stage TWO of the LTOP safety case that some controllers would lose their endorsements in the more complex LTOP environment. Substance was added to these expectations by the recent breakdown of separation occurrences. The first two occurrences involved errors of judgement in the decision making process by controllers. A factor in the third occurrence was the controller's lack of knowledge of the procedure. The three occurrences also highlighted that, for a variety of reasons, controllers had taken aircraft 'off the rails', and had consequently reverted the airspace to a more unstructured environment.

Training has been provided to controllers to highlight the problems that may be encountered in each of the LTOP modes, prior to the implementation of a particular change. However, controllers reported that the training provided to prepare them for the complexities of airspace management using the crossing runways and the more complex modes of LTOP was considered less than adequate. Significantly, all the controllers interviewed agreed that refresher training was limited and ad-hoc at best. Refresher training has been cited as a one of the mitigating strategies for a number of identified hazards in the LTOP safety case. The controllers' view on their training is contrary to the view of some Sydney TCU and Canberra ATS managers, who have stated that the controllers were well prepared and, perhaps, even overtrained.

1.4 CULTURE

1.4.1 Background

Controllers and managers alike reported that air traffic control in a terminal area environment has traditionally been widely held as the pinnacle of air traffic controlling. Most controllers

spent many years of their career gaining experience in a variety of areas of air traffic control before gaining the opportunity to work in approach control. Sydney, by the very nature of its traffic density, was considered to be the most demanding of the approach control centres in Australia.

The contemporary approach to air traffic control training, which is practised internationally, is 'streaming'. The process of 'streaming' requires potential staff to undergo an extensive aptitude and selection procedure. New staff may be immediately trained for a position in approach control without the requirement to go through the apprenticeship of en route and tower control. Whilst the investigation determined that the average age of the Sydney TCU approach controllers interviewed was 41 years and that many of these controllers were a product of traditional training techniques, there is now a significant proportion of Sydney TCU approach controllers who are the product of the 'streaming' approach to training. In addition, a number of both the experienced and less experienced Sydney approach controllers reported that all their air traffic control experience had been associated with Sydney operations. The more senior 'line' controllers held concerns about Airservices Australia's approach to 'streaming'. They supported a mix of old and new selection techniques and training methodology whereby recruits are trained and tested for a base-level air traffic control qualification, then 'streamed' to either 'en-route', 'terminal area' or 'tower control'.

With the introduction of structured airspace and parallel runway operations, many of the more experienced controllers reported that they were starting to lose their traditional skills and that newer controllers did not possess the depth of knowledge from which to draw when a traffic problem became more complex. The majority of controllers interviewed reported a level of uncertainty about their work and an associated loss of confidence in their ability to manage traffic consistently and safely in all modes of operation, including transitions. In line with the principles of the 'teams' concept the majority of Sydney TCU controllers hold endorsements for seven radar control positions to operate nine different modes. Controllers are therefore required to be familiar with any of 63 possible combinations of operating positions, where they actively control aircraft.

Despite the evolutionary changes that had taken place in air traffic control and that had resulted in a shift in emphasis in the skills required of an approach controller, Sydney TCU and Canberra ATS managers indicated that some controllers in the Sydney TCU still held the view that their skills were 'superior' to other air traffic controllers throughout Australia. It was the managers' opinion that this view was held because the Sydney TCU aircraft movement rate was higher than other Australian air traffic control centres.

In his 1992 report, Ratner commented that Canberra ATS managers believed that field ATS staff 'didn't want to hear' or 'thought we had a hidden agenda' when attempts were made to communicate between Canberra managers and field ATS officers. Ratner added that the view held by field ATS staff was that Canberra managers told them 'too little too late' and that consultation with the field was not for exchange of views but rather to 'sell' what Canberra had already decided. Interviews held with Sydney TCU controllers and managers during this systemic investigation supported the existence of similar views.

1.4.2 Industrial unrest

A peak period of traffic movements in 1988 related to the Australian Bicentennial year celebrations was followed by industrial unrest in 1989. A number of controllers who currently work in the Sydney TCU were also working in the Sydney TCU at the time of the unrest. During interviews, a number of controllers and some of the managers agreed that residual ill feelings were still present in the Sydney TCU as a result of this unrest. Some held the view that

there was a certain level of distrust in relation to the motives of management when they sought to bring about some changes.

A number managers from both Canberra and Sydney, indicated that the human resource management aspects of the Sydney TCU had often been problematic.

1.4.3 Service ethos

For many years, the ethos of air traffic control has been 'safe, orderly and expeditious'. More recently and as a result of Government noise-sharing policy, Airservices Australia's order of priorities has changed to 'safety, environment and efficiency'. Whilst many of the controllers interviewed indicated that they believed that consideration of the environment was important, a number of controllers agreed that they were still finding this concept difficult to accept. Survey results indicated that 69% of controllers tried to comply with pilot requests for such things as track shortening, in order to process flights more efficiently. This has sometimes been at the expense of environmental considerations. All the controllers interviewed supported this view and a number added that they occasionally initiated such actions themselves because they considered that the flights were being unnecessarily delayed due to extra track miles and altitude restrictions placed on the flights for the purpose of noise-sharing. Many remarked that this was an issue of pride in their work. Interviews with airline operators revealed that they were finding similar difficulties with the new order of priorities as they were having an effect of the viability of their operations. More frequent requirements to fly extra track miles in accordance with SIDs, and restrictions on climb have imposed efficiency losses on these operators. Most operators reported that their crews often requested track shortening and unrestricted climbs and that controllers duly processed such requests on a number of occasions. This service ethos was recognised by Ratner in 1992, as a culture that conflicts with safety when traffic grows to capacity levels.

Controllers explained that they felt most satisfied when they were able to move a lot of aircraft. Consequently, a number of controllers and managers who were interviewed considered that the introduction of the LTOP had impinged on controllers' capacity to carry out their traditional role. Interviewees explained that this was a source of frustration, resulting in instances of controllers taking aircraft 'off the rails' in order to achieve perceived efficiencies in aircraft movements. The three occurrences that instigated the systemic investigation involved a relaxation of restrictions normally imposed by the structured airspace environment.

1.4.4 Morale

Ninety percent of controllers who participated in the staff survey indicated that the morale of controllers in the Sydney TCU was very low. A variety of reasons were cited in both the survey and the interviews to explain this low level of morale. The most common reason provided was the rate and complexity of change that the controllers had faced over the last four years and were expected to go through in the next year in order to meet deadlines for a variety of projects. Many stated that they were overwhelmed by this change and that it had introduced a level of uncertainty in their capacity to carry out their duties safely.

Intense pressure from a variety of sources was also cited by many controllers as being partly responsible for controllers' low morale. It was their opinion that this pressure was emanating from local and Canberra ATS management, the government, the media, and the community. Controllers, during their professional careers, had not previously experienced some of these external pressures. A number of controllers explained that these pressures had resulted in

many controllers feeling unduly stressed. Controllers also indicated that they felt that they were at the centre of competing goals between the industry demands for efficiency on the one hand, and the community's need to share aircraft noise on the other hand. There was also a strongly held opinion amongst controllers (86 percent) that the Sydney community holds them partly responsible for the noise problems.

1.5 TEAMS

1.5.1 Background

In his 1992 report, Ratner[2] referred to the recommendations of a previous Air Traffic Services review conducted in 1987. One of the key recommendations of the 1987 review was the implementation of the teams concept, involving 'the establishment of teams of controllers who generally work together, with a team leader who is responsible for training, checking, supervision, and performance quality. The team leader is expected to maintain a high degree of currency, but acts in a supervisory role in heavy traffic periods'. Team leadership was expected to provide 'much closer and more effective supervision and protects the system, to an extent, from individual performance deficiencies'. The 'teams' concept is widely used in Europe and North America. Ratner observed that by 1992, little progress had been made in implementing the 'teams' concept and made the following recommendation:

> 'Implement the "teams" concept as expeditiously as possible, integrating the QA philosophy in its operation. Consider team leader training as an essential ingredient of effective implementation of the team concept. Adequate training should allow team leaders to manage effectively their responsibility for development, enhancement, and assessment of their team members'.

The role and responsibility of the team leader is outlined in Airsevices Australia's Safety and Quality Management System Manual. The team leader is expected, amongst other things, to be a 'Full Performance Controller' and must provide an appropriate level of field supervision as well as formal assessment of staff. They are also responsible for standardisation within teams and, through team leader meetings, across teams. Team leaders are responsible for staff welfare and rostering as well as providing a conduit between the workplace and line managers. Team leaders are expected to spend approximately 60 percent of their time at an operational position or function and 40 percent of their time performing administrative duties associated with their team leader role. The team leader provides the fifth level of management within the management hierarchy of Airservices Australia and is the first line of operational management.

Team leader training is conducted in modular format, with the first session of training containing module one and two. This training is conducted over a period of four days and covers, among other things, key messages for team leaders, teams operating principles, communications styles and conflict resolution. The third module of training involves both the team leader and the team, and is intended to obtain feedback from teams in a controlled and thought provoking environment.

[2] '*1992 Review of the Australian Air Traffic Services System*, Expanded Summary, p13'.

BASI previously conducted a 'Review of Airservices Australia's Team Operations in Air Traffic Control and Flight Services'. As a result of this review, a Safety Advisory Notice (SAN) 970137 was released on 27 January 1998 to Airservices Australia. This review highlighted similar issues to those that have emerged from this investigation and included the following:

(1) operational support/supervision;

(2) team development activities; and

(3) team leader performance and evaluation.

1.5.2 Teams in Sydney Terminal Control Unit

The 'teams' concept has not been wholly implemented within the Sydney TCU. Local management reported that many controllers were not willing to embrace the concept when it was first promoted nationally some five years ago. Many of the current Sydney TCU team leaders explained that they undertook team leader training about four years ago but that teams were not implemented in Sydney until mid 1997.

All the controllers and the majority of managers conceded that 'teams' was not working in the Sydney TCU. They explained that teams were not 'walk-in walk-out' units but rather a mixture of at least two teams with many team members from other teams included for a variety of reasons, in any one shift. Many team leaders reported that they may not be on the same shift as some of their team members for significant periods of time and did not, therefore, have the opportunity to supervise and assess these team members with any level of consistency.

Those interviewed described that, in reality, teams in the Sydney TCU were formed for administrative purposes only, rather than for operational purposes. All team leaders interviewed explained that they spent in excess of 60 percent of their time on administrative tasks such as rostering, recreation leave allocation, writing check reports, input to projects and training packages, and the organisation of, and reporting on, team days. Some of their time must be spent at the control console in order to remain current on all of their endorsements. Team leaders considered that this left very little time for supervisory and check activities.

Sydney TCU controllers reported that one principle of the original 'teams' concept recommended that 'journeyman' controllers (controllers who are not yet endorsed on all approach control positions) were to be additional to the core of the team. In the Sydney TCU, 'journeymen' have been rostered as part of the team. Many controllers and managers reported that this has resulted in rostering being particularly difficult because of the limited number of positions 'journeymen' are able to work. It had also created difficulty for other controllers in remaining current on those positions essentially dominated by 'journeymen' during any one shift. This was cited as one of the reasons that some controllers were, at times, not exposed to a particular mode of operation for a number of weeks.

Three of the eight team leaders interviewed, reported that they were not confident in using all the endorsements they were required to hold. The main reason for this lack of confidence was the limited opportunity they had available to them to practise due to the time demanded of them to undertake administrative tasks and to meet the requirements of their supervisory and check role. Whilst the other five team leaders felt confident in using their endorsements, they also considered that they had limited opportunity to practise.

1.5.3 Training

Controllers highlighted a number of deficiencies in the current training regime. In general it was felt that training levels were less than adequate and that basic skills were no longer taught. Particular mention was made of the minimal amount of refresher training that was carried

out, including In Flight Emergency Response (IFER) training. Information provided by the team leader of the operational training section indicated that the only IFER training scheduled in the last two years was in May 1997. Most controllers completed the IFER module at that time. LTOP refresher training was carried out in February and March 1998 when all modes in operation at that time were reviewed. This refresher training was primarily carried out in order to comply with a national ATS requirement for controllers to undertake seven hours of refresher training within a 12-month period. While LTOP mode transition training was not provided as a stand alone module, training in runway changes was incorporated into other training modules. All the Sydney TCU managers felt that more refresher training was required, particularly as some of the mitigating strategies in the LTOP safety case referred to the need for refresher training. However, some Canberra ATS managers were of the view that some training was overdone and overspecialised.

In the view of many of the Sydney TCU controllers interviewed, skills training was lacking. For example, they considered that there was little, if any, training in conflict recognition and resolution. This was considered to be a particular concern in the case of the less experienced controllers who had only trained and worked in structured airspace.

Sydney TCU managers conceded that the operational training schedule had been affected by the allocation of staff to other areas such as TAAATS training. It was reported that two Full Performance Controller courses had recently been postponed indefinitely. This was the first time that training programs had been delayed for periods greater than six months. There was a perception in the operational training section that there were too many projects and too few resources and that this was having an effect on the availability of the ATS simulators.

The majority of the team leaders interviewed had undergone team leader training four years ago. None of these controllers have undergone any follow-up or refresher training. Many reported that they were unclear of their role. Module three, in which both the team leader and team members undertake joint training, has not been carried out in the Sydney TCU.

1.5.4 Standardisation

Interviews with Sydney TCU controllers and management revealed concerns about standardisation both within and between teams in the Sydney TCU. Controllers stated that standardisation had suffered since the teams structure had been introduced. It was also felt that there were significant differences in standards between experienced and less experienced controllers. In particular, controllers who had trained and worked prior to the introduction of structured airspace were seen as having a greater range and depth of air traffic control skills than controllers who had only run traffic 'on the rails'. As a result, some controllers reported that there were considerable differences in the quality of separation assurance provided by controllers in the Sydney TCU. In addition, the rate of procedural change in the Sydney TCU meant that even senior controllers considered that they had an inadequate knowledge of current procedures.

Sydney TCU managers and controllers also acknowledged concerns about standardisation. Standardisation was seen as a potentially negative aspect of teams that needed to be monitored. These managers believed that the previous Check Controller system was more efficient than relying on team leaders to monitor standards. It was suggested that part of the problem was a lack of resources due to staff being redeployed on operations support projects. One of the Canberra ATS managers agreed that while 'walk-in walk-out' teams were not necessary, it was unacceptable for controllers not to see their team leader for several weeks. Sydney TCU managers held some concerns about the selection and training of team leaders. A number of controllers also held this view. They believed that some of the team leaders did not possess the appropriate skills to carry out their supervisory and check responsibilities

adequately and, as such, were experiencing difficulty in maintaining the respect of their team. However, interviewees agreed that the current system was an improvement on the past as team leaders received at least some training, whereas previously a Check Controller was appointed primarily on the basis of experience.

There was evidence that some responsibilities were not being carried out by team leaders. For example, a CASA audit of the Sydney TCU revealed that team leaders were not randomly monitoring voice tapes for standard phraseology, as they were required to do.

The report on the internal investigation of one of the incidents raised concerns about the proficiency level of the controller involved in the incident. This controller had been recently rated in the Sydney TCU, having completed the first stage of his training in the operational training section. Reports by his simulator-training instructor indicated that, among other things, the controller had difficulty with conflict resolution and that he had a tendency to rely on aircraft performance when managing traffic problems. The internal report also commented that it was difficult to determine whether these problems remained during the 'on-the-job' phase of his training, as the training records were not sufficiently detailed to make any such determinations. The Airservices' investigating officer was later interviewed and added that she was concerned that this controller had been released from the operational training section, given the problems that had been identified. This controller was later involved in two breakdown of separation incidents within a period of 12 days. Fatigue was also cited as a contributing factor in this occurrence as the controller involved had undertaken both emergency duty and overtime shifts in the three week period leading up to the second incident.

1.6 ROSTERS

1.6.1 Background

The principles of rostering in air traffic control are laid down in the Air Traffic Services Enterprise Bargaining Agreement (EBA), 1996. The EBA was negotiated and agreed to by Civil Air, the Air Traffic Controllers' union. The rostering principles allow for a maximum of five consecutive rostered shifts, except that six consecutive shifts may be rostered with the consent of the local rostering committee. Two days free from duty must be rostered after a run of five consecutive shifts, and three clear days off are required after a run of six shifts. However, in practice, controllers may work considerably more shifts than they are rostered for if they choose to take up extra duty or overtime shifts. The EBA principles of rostering allow for up to ten consecutive shifts to be worked by a controller, including extra duties. Hence, in the extreme, a controller would not be precluded from having just one day off in 21 days. A controller involved in one of the recent occurrences had not had a two-day break for a period in excess of four weeks.

1.6.2 Sydney Terminal Control Unit roster

The current roster had been chosen by vote by controllers from two alternative rosters prepared by controllers. However, both management and controllers at the Sydney TCU felt that there were major problems with the roster. The main concern controllers' held about the roster was the amount of stress and fatigue it caused. Indeed, fatigue was cited as a factor in Airservices Australia internal inquiries into three of the recent occurrences. BASI's on-site investigation of two of these occurrnces supported this finding.

The roster followed a six week cycle with little structure although, typically, in the first three weeks of the cycle controllers worked three days on, two days off, four days on, and then three

days off. In the latter three weeks of the roster the pattern was typically four days on, one day off, four days on, and then one day off. The roster had been devised to provide more staff in the busy morning and evening periods and, as a consequence, did not include any day shifts. The structure of the current roster had made it more difficult for staff to swap shifts.

Controllers felt that the loss of the day shift and minimum staffing levels resulted in extra pressure and a greater resort to sick leave. The difficulty in swapping shifts was also strongly criticised. The other area most frequently mentioned as problematic and fatiguing, was the single day's breaks, which were preceded by a late shift and followed by an early shift. In addition, working a full 7.5 hour shift with only two 30 minute breaks was considered onerous by some controllers and the inability of 'journeymen' to work in all positions was seen as a complicating factor in applying the roster. However, not all comments about the roster were negative with some controllers stating that shift work was just part of the job and that there was no such thing as a perfect roster.

Sydney TCU managers conceded that the roster was partly responsible for poor morale in the Sydney TCU. Reinstating a day shift to the roster was seen as one way of reducing current dissatisfaction. However, the managers considered that there were insufficient staff to carry this out. Notwithstanding, the Sydney TCU managers agreed that the roster should take into account the cumulative effects of fatigue and that guidelines to ensure these effects were taken into account, should be developed. They considered that the current roster, together with the scope provided to controllers by the EBA guidelines, allowed controllers to place themselves at risk due to fatigue.

Analysis of the planned roster, and of the roster actually worked by a sample of controllers, did not reveal any periods of potentially excessive fatigue. The rosters were analysed using the Fatigue Modelling Program developed by the University of South Australia for Sleep research. Most fatigue scores fell into either the 'standard' or 'moderate' range, with only very occasional scores in the 'high' range. No scores fell in either the 'very high' or 'extreme' ranges. It was noted that some individuals had made themselves available for several emergency duty and overtime shifts during the current roster cycle and on previous roster cycles. The fatigue scores for these individuals were higher than for those who had worked normal roster cycles.

Training for TAAATS was undertaken by Sydney controllers as rostered overtime. In June 1998, TAAATS training was temporarily suspended for a period following an air safety occurrence because a number of controllers were stood down. An air safety occurrence generally reduces the availability of staff, due to the suspension of those directly involved in the occurrence, pending the outcome of an investigation. Other members of staff are called in on emergency duty or overtime. There was an insufficient pool of staff remaining to run both the roster and to continue the schedule of TAAATS training.

1.6.3 Sick leave and overtime

The average amount of sick leave taken by controllers in the Sydney TCU was high in comparison to the rate in other centres. Staff in Sydney took an average of approximately 19 days sick leave each in the twelve-month period to May 1998. By comparison, the rate in the Brisbane TCU was approximately nine days per person per year, and in Melbourne approximately 10 days per person per year. Sick leave rates for other staff at the Sydney TCU were also above average and ranged from 23 days per year for Flight Service staff to seven days per year for Finance and Administration staff. The Australian national average sick leave rate for employees in all sectors is approximately five days per person per year.

There was no evidence of any increase in the overall sick leave rate over the two years leading up to the recent occurrences. Monthly data for the period May 1996 to July 1998 followed a

seasonal trend with a higher rate in winter and a lower rate in summer. However there was no underlying trend increase. In contrast, the perception of the majority of the Sydney TCU managers was that there had been a recent increase in the amount of sick leave taken by controllers. It was also stated that a minority of controllers abused the unlimited sick leave allowance and then subsequently worked extra duty shifts instead. Problems with the roster were also seen as resulting in a greater amount of sick leave being taken. For example, there was a tendency for controllers to take sick leave around the single days off. Information from management at the Sydney TCU reported that there was an ongoing absenteeism management program in effect to address the problem of some controllers taking excessive sick leave.

1.7 SEPARATION ASSURANCE

1.7.1 Definitions

A definition of separation assurance could not be found in any of the Airservices Australia documentation. Notwithstanding, separation assurance is primarily reliant upon controllers issuing instructions that guarantee that aircraft will maintain separation standards from other aircraft and terrain, within a controller's area of responsibility.

Ratner stated in his report,

> 'Ineffective traffic planning is implicated in situations where a breakdown of separation incident could have occurred even though all aircraft complied with their given clearances. A separation breakdown did not occur in these situations simply because of randomness of timing: a breakdown could just have easily occurred. In view of the role inadequate planning has placed in many of the incidents that have occurred in Australia, it is appropriate to emphasise the differences between having separation and achieving separation assurance; the latter requires:
>
> - planning to ensure separation
> - execution of the plan so as to achieve separation
> - monitoring of the situation to ensure the plan and execution are effective.'

The separation standards for Instrument Flight Rules aircraft in a radar Terminal Area environment are 3 NM laterally and 1,000 feet vertically.

1.7.2 Separation assurance issues highlighted by recent occurrences

The on-site investigation conducted by BASI officers following the breakdown of separation occurrence on 11 June 1998, and the Airservices Australia internal investigation of the same occurrence, highlighted a similar safety concern. Both investigations determined that there was no separation assurance between the departure and arrival tracks of the MARUB ONE standard instrument departure (SID) and the CHEZA standard arrival route (STAR) because of the proximity of the two tracks and that there was no altitude restriction placed on departing aircraft.

Mode nine of the LTOP was in use at the time in which aircraft departed over the north and north-west from runway 34L and to the east and north-east from runway 34R. Arrivals from the south were over Botany Bay on runways 34L and 34R.

In this occurrence, the departing aircraft became airborne from runway 34R and turned right to intercept the 075 Sydney VOR radial to the east. At the waypoint MARUB (075 Sydney at

15 NM), the aircraft turned onto a heading of 144 degrees magnetic, towards the south south-east. This turn at MARUB required the departing aircraft to cross the 084 Sydney VOR radial, which was the CHEZA standard arrival route (STAR). While the inbound aircraft on the CHEZA STAR was required to be at 8,000ft or below by waypoint WHALE (084 Sydney at 20 NM), there was no altitude requirement imposed on the departing aircraft. If an altitude requirement had been imposed on the departing aircraft to provide separation assurance with the track of the inbound aircraft, and was part of the standard operating procedure for both flight crews and controllers, separation assurance would have existed.

In the Safety and Quality Management's V3 report on the occurrence, dated 26 June 1998, the Sydney ATC manager stated that:

> 'the Sydney 075 radial MARUB track does not comply with TCU Local Instructions 2-1 in that it does not provide 1.5 mile separation from the adjoining Approach airspace and therefore does not provide separation assurance'.

In accordance with the Aeronautical Information Publication (AIP), the departure instructions for an aircraft operating under instrument flight rules in controlled airspace, will be in the form of a SID or radar departure. Because the only SID available for southbound aircraft departing from runway 34R is the MARUB ONE SID, the Sydney ATC manager's recommendation stated that the MARUB 075 radial should:

1) be moved (relocated to a different radial) north of its present position; or
2) until it is moved, should not be used and a Radar 7 Standard Instrument Departure (which allows the use of the 066 outbound radial) should be used'.

As at the 26 July 1998, no further action had been taken on this recommendation.

During the course of the investigation, several controllers highlighted other separation assurance concerns. For example, high-capacity aircraft that are required to use runway 34L for departures to the north must initially track 290 degrees and climb to and maintain 5,000 ft. Aircraft are then turned to the east and remain at 5,000 ft until east of the coast. Aircraft that have departed from runway 34R are tracked to almost the same position on the coast in accordance with the relevant SID, and arriving aircraft overfly this same track at 6,000 ft. Controllers agreed that this was a complex and artificial point of potential conflict. Many believed that a problem could quickly develop if the controller was distracted or if aircraft, for whatever reason, did not fly in accordance with the issued clearance. Operators voiced similar concerns about the artificial conflicts and potential 'head-to head' situations created by the 'crossovers' of SIDs and STARs at low altitude.

Failure to comply incidents which have occurred in the Sydney Terminal Area airspace, in which aircraft have not been flown in accordance with the published SID or STAR, have also highlighted the need for controllers to closely monitor traffic and take positive action where necessary to maintain separation between aircraft.

At least two of the occurrences investigated by BASI have highlighted the practice by Sydney TCU controllers of relying on aircraft performance for separation.

1.7.3 LTOP safety case

Separation assurance between jets departing from runway 34R on a MARUB ONE SID and aircraft arriving via the CHEZA corridor was identified as a hazard in the safety case for the Sydney LTOP and associated airspace, version 3.3, which was implemented on 4 December 1997. The safety case stated that the mitigating strategy to address this hazard was that 'the 075 radial was chosen as the most southern radial to allow lateral displacement from the

CHEZA corridor'. A second strategy to mitigate this hazard was that vertical separation between departing and arriving airspace volumes would be retained at all times, unless there is an 'ATC or pilot failure to comply'.

Separation assurance between aircraft departing on 34L to the north and east with jets and non-jets departing 34R, together with aircraft arriving from the north was identified as an unacceptable hazard in the safety case. Mitigating strategies cited to reduce this to an acceptable level of risk included the provision of complex traffic scenarios in training, the use of 'traffic management' by controllers and that 'traffic planning' is emphasised in training. A further mitigation was the suspension of noise-abatement procedures.

Other hazards were annotated in the LTOP safety case and were identified as being 'unacceptable'. These included, but were not limited to, the following:

- continued instability of ATC operations;
- human factors reaction to ATS procedures changes;
- increased workload; and
- complex traffic pattern to the north of Sydney.

These hazards have been raised, in part, to the status of 'acceptable' by virtue of mitigating strategies such as 'controller briefing', 'refresher training', 'consistent and intensive practice', and 'traffic management'.

Whilst the refresher training carried out in February and March of 1998 had included aspects of LTOP modes, many controllers reported that they were still unfamiliar with some of the modes and mode transitions. They did not believe that the intent of the mitigating strategies of hazards identified in the safety cases had been met by such infrequent refresher training.

1.8 THE CIVIL AVIATION SAFETY AUTHORITY

The Civil Aviation Safety Authority (CASA) has a legal obligation as the safety regulator, under the Civil Aviation Act 1988, to monitor continuously the performance of the Australian aviation system.

CASA and Airservices Australia currently operate in accordance with a draft Legislative Instrument Proposal (LIP) promulgated in April 1996. The LIP specifies that CASA, as the regulator, must, amongst other matters:

(1) promulgate safety standards;

(2) review safety standards to ensure they continue to meet current needs;

(3) satisfy itself that service providers have the capability to meet the defined safety standards; and

(4) monitor the performance of the service provider against both the safety standards and the service provider's own internal performance standards.

One of the safety regulatory objectives of CASA is 'to reinforce aviation safety by regular review of the safety management arrangements employed by Airservices Australia in order to monitor its safety performance, identify risk factors and promote improvement in the system'. CASA is provided with access to the results of Airservices' internal monitoring and evaluation in order to identify trends and to assess those issues that are relevant to the safety integrity of the entire Australian civil aviation system.

In an out-of-session report to the CASA Board Safety Committee, dated 19 June 1998, the CASA Airways Surveillance Branch stated that it held concerns about the separation assurance techniques that were being used by the controllers during previous incidents, in which they

relied on aircraft performance rather than positive control. Of significance, the report stated the Airways Surveillance Branch's concerns about the undue strain that was being placed on the Sydney TCU controllers due to the additional non-ATS requirements related to LTOP (the requirement to change from more efficient modes of operation to noise-sharing modes of operation), and to the TAAATS transition program. It was considered that the strain may affect the TCU's capacity to continue to conduct it's present day-to-day operations. The recommendation contained in the report was that 'CASA must continue to monitor Sydney traffic management closely to assure the safety of the fare-paying passenger and also to ensure that the Airservices' recommendations flowing from this internal investigation are put into place'.

On 21 July 1998, the Chairman of the Board Safety Committee requested that CASA management provide advice on follow-up action that was being taken to address safety concerns identified in the out-of-session report about operations at Sydney Airport. At the Board Safety Committee meeting held on 30 July 1998, the Committee suggested this item be held over to the reconvened July meeting (to be held on 13 August 1998).

In an interview with management of the Airways Surveillance Branch, it was revealed that the Branch held concerns about the rate and complexity of change that was presently occurring in the Sydney TCU. It was considered that the demanding workload of some of the 'line' managers was making it very difficult for these managers to carry out their role effectively. It was also felt that rationalisation of resources within the TCU at this time was not advised because of further real and perceived pressure that this would introduce to the remaining controllers. It was suggested that some of the projects currently being undertaken should be reconsidered and more realistic time frames introduced. During the interview, there were occasions when management did not feel in a position to comment about some aspects of the systemic investigation. It was explained that CASA's role was to 'audit the process'.

In view of the fact that BASI was already proposing to conduct a systemic investigation to commence shortly after the CASA out-of-session report was released, the CASA Airways Surveillance Branch was reluctant to commence its own investigation concurrently with that of BASI, because of concerns held about the added stress that this might bring about in Sydney TCU controllers and local managers. BASI was advised that CASA would await the outcomes of the BASI systemic investigation before initiating any further action.

Airservices Australia senior management believed that, on occasion, information and direction about airspace management provided by CASA regional office, Sydney, conflicted with information provided by CASA staff from central office, Canberra.

1.9 AIRSERVICES AUSTRALIA SAFETY AND QUALITY MANAGEMENT (S&QM)

1.9.1 Role of S&QM

Airservices Australia has set up the Safety and Environment Directorate to oversee the management of safety throughout the organisation and to ensure that a safety management system is in place. The main goal of the Safety and Environment Directorate is to achieve a comprehensive safety management ethos across the organisation.

The Safety and Quality Management Branch (S&QM) of the Air Traffic Services Division (ATS) has the responsibility for the assessment and review of planned and systemic actions adopted by ATS in order to provide adequate confidence that the provision of air traffic services satisfies government, public and regulator requirements for safety and quality.

The Safety and Quality Management System Manual contains information about the roles and responsibilities of key personnel within the S&QM Branch, and on policies related to a variety of safety-related activities. For example, the Safety and Quality Management System Manual contains a reference to ongoing and refresher training, and states:

> 'to meet the demands of changing facilities and procedures and to maintain proficiency in situations not often encountered, ongoing and refresher training must be provided. The aim of this training is to maintain and update the knowledge and skills necessary to apply air traffic procedures in a safe manner'.

1.9.2 S&QM relationship with Sydney TCU

During interviews, some of the Sydney TCU managers and several controllers remarked that they did not feel S&QM provided them with appropriate support. This applied particularly when managers or controllers made recommendations and attempted to introduce improvements to safety. Many considered that too much responsibility for safety had been devolved to 'line' managers and team leaders and that senior management should play a more active role in these matters.

Internal investigation reports often contain recommendations for remedial safety action. It was reported that S&QM have been following these up in an ad-hoc fashion and have been essentially leaving the responsibility for follow-up to 'line' managers and team leaders. Controllers and managers remarked that they did not have regular contact with S&QM staff and that there was a general perception that S&QM had not been proactive in its approach to safety issues. One of the recent Airservices Australia internal investigation reports contained a recommendation related to S&QM which stated 'The human factors review of the Sydney TCU was recommended in the LTOP safety case in December 1997. This is an area where S&QM should be taking a proactive role in reviewing the general 'safety-health' of operational units, especially one in such a period of change as the Sydney TCU'.

On the other hand, S&QM did not appear to be given support from some areas of Sydney TCU management. It was revealed that a concerted effort had been made to initiate a similar investigation to that being conducted by the Bureau of Air Safety Investigation. A survey questionnaire similar to the one developed by BASI, had already been completed and was ready for distribution within the Sydney TCU. This questionnaire was forwarded to the then Sydney District Manager but was not supported by the manager and the proposal for S&QM to conduct an internal systemic investigation did not proceed. Notwithstanding, both the Sydney and Canberra S&QM managers fully supported the Bureau of Air Safety Investigation in their efforts to conduct a systemic investigation of the Sydney TCU.

The Manager of S&QM explained that a database for recommendations was currently under development and that this would allow for a more consistent approach to follow-up and standardisation activities by the S&QM Branch. S&QM had also recently introduced a confidential reporting system into Airservices, based on the same principles as the BASI Confidential Aviation Incident Reporting System, and it was reported that early results were encouraging.

1.10 OPERATORS

Chief pilots and safety personnel from five airlines, including international, domestic and regional airlines, and representatives from two airline associations, were interviewed during the course of the investigation. Whilst many of these concerns were tempered with efficiency

and viability considerations, the most common safety concerns are summarised below in the following paragraphs.

(1) Many operators were not comfortable with the increased complexity and artificial conflictions, particularly low-altitude crossing points, contained in the present SIDs and STARs.

(2) Operators of high-capacity aircraft were concerned about the safety implications resulting from the uncertainty about the landing runway. Frequently, crews operating aircraft into Sydney have not been informed of the runway for landing until the aircraft is approximately 30 NM from touchdown and well after the aircraft had commenced its descent. This has had the effect of creating a higher workload, particularly in an FMS equipped aircraft, at a time of naturally high workload in the Terminal Area airspace. Operators remarked that they would prefer the crews to be able to brief and prepare for the approach, including the possible missed approach, prior to top of descent in order for the them to be able to concentrate on other critical aspects of the approach and landing.

(3) Operators of high-capacity aircraft were concerned about the crosswind component of 25 kts that was acceptable for the continued use of runway modes at Sydney. The 'close-set' parallel runways 16/34 and the short length of 25/07 and 34R/16L, were cited as the reason for this concern. Whilst most agreed that it was within the crosswind capability of both the aircraft and the flight crews to use these runways in significant crosswind, there was general agreement that it had served to erode the safety margin. The International Civil Aviation Organisation (ICAO) has recommended that compliance with published noise abatement procedures should not be required in 'adverse operating conditions' such as when 'the crosswind component, including gusts, exceeds 15 kts'. It was reported that the International Federation of Airline Pilots Association (IFALPA) has recently 'black banned' the Amsterdam airport following an accident in which a Boeing 757 veered off the runway whilst the flight crew was attempting to land the aircraft in similar crosswind conditions. Amsterdam airport has similar noise-sharing requirements and crosswind policies to Sydney.

Note 1: The CASA standard for the displacement of parallel runways for SODPROPS is 860 m, while the ICAO standard for parallel operations is 760 m. The displacement of the parallel runways at Sydney is 1037 m.

Note 2: The Australian Aeronautical Information Publication (AIP) Sydney noise abatement procedures allow for the continued use of dry runways with a crosswind component of up to 25 kts and downwind component of up to 5 kts. Continued use of wet runways is permissible with a crosswind component of up to25 kts with no downwind component, or a crosswind of up to 15 kts with a downwind component of up to 5 kts.

In general discussions with operators, it was revealed that it was still common practice for aircrew to request track shortening and unrestricted climbs wherever possible. Most remarked that it was still not uncommon to have such requests granted despite the more complex airspace and the degree of uncertainty in traffic management that LTOP had introduced.

2.0 ANALYSIS

The three air safety occurrences that have been described involved high capacity air transport operations. The subsequent investigation of each incident raised similar issues that were of concern to the investigating officers. These issues suggested systemic safety deficiencies relative to airspace configurations, separation assurance and changes in runway configuration. Factors indicated possible limitations in human performance in the increasingly complex Sydney air traffic environment.

The similarity of the issues was the catalyst for a systemic investigation conducted by the Bureau of Air Safety Investigation. Specialist staff within BASI considered that the recent air safety incidents were manifestations of broader problems being experienced in the management of air traffic by controllers employed in the Sydney TCU. The systemic investigation revealed that the major concerns were focussed on the LTOP and the associated change to air traffic processing. This change was perceived to be imposed on Sydney TCU controllers in response to community demands for respite from aircraft noise rather than a more pressing need to increase efficiency in air traffic processing.

2.1 RATE AND COMPLEXITY OF CHANGE

Empirical evidence recognises that individuals will resist management's change efforts, particularly where such change has not been through a consultative process, or there is no local ownership of the change. Notwithstanding the likelihood that there has been resistance to some elements of change in the Sydney TCU, the sheer volume and scope of the change process appears to have been overwhelming for most air traffic controllers. The majority of the changes are unique to the Sydney area.

At least 15 percent of the controllers holding endorsements in the TCU were trained and rated in the less complex structured airspace environment, using the parallel runways. Since the crossing runway was re-opened for more regular use, traffic handling has become more complex and hazardous. Training to prepare these controllers for the complexities of airspace management using the crossing runways and the more complex modes of LTOP is considered to have been inadequate. In addition, refresher training has not been carried out in accordance with the requirements of the LTOP safety cases. Consequently, it can be assumed that the identified hazards remain at a higher level of risk if this matter is not addressed.

The goals of the LTOP Task Force and its working groups, including those conducting the safety cases, were to produce a document describing procedures that provided a balance between safety, consideration of environmental issues, and efficiency in aircraft movements. These goals may have been inconsistent with the traditional goals of the Sydney TCU controllers, who were originally trained to process air traffic in the most safe and expeditious manner without the need to consider environmental issues. Consideration of environmental issues is a more recent and now established concept, and many controllers are still coming to terms with the new order of priorities when they apply their air traffic management skills. Accordingly, commitment to LTOP by controllers has not been universal.

Organisational pressure on the Sydney air traffic controllers has been significant and has been centred on the competing demands of increasing the number of air traffic movements within the airspace of the Sydney Terminal Area against the demands of reducing aircraft noise over the Sydney community. Parallel runway operations are more efficient in moving traffic than the other noise sharing modes of LTOP largely due to shorter runway occupancy times required for processing traffic, particularly when there are dedicated arrivals and departures

runways. However, the noise sharing modes of LTOP are more community-friendly. One method to gain performance improvements with LTOP is with controllers' increased familiarity with the modes. Increased familiarity with the modes will increase both controller efficiency in directing aircraft traffic, and controllers' confidence in operating with and between each mode. Such familiarity can only be developed by constant practice and training by motivated controllers.

Whenever a new skill is taught or a change is introduced, training should be provided followed by a period of stability to allow controllers to consolidate. The period of consolidation will vary between individuals. The most effortless human performance level to achieve on a consistent basis, is the skill based behaviour or performance level. If controllers are denied a period of consolidation to develop these skill based performance levels, by exposure to constant change, they will resort to rule based or knowledge based behaviours. Rule based or knowledge based behaviours have increased cognitive demands, which inhibit effective decision-making and increase the potential for error.

The volume and complexity of the changes occurring in the Sydney TCU may have exceeded the capacity of many of the controllers to assimilate such change. Whereas, a safety case may have considered a change to be an acceptable risk in isolation, a holistic approach to system capacity for change has not yet been addressed. The constant pressure for change has overwhelmed a number of controllers who, in turn, have resigned themselves to quiet acquiescence. Alternatively, some controllers believe that there will be some occasions when they will not be able to cope with a problem, and others believe that they will have to manage the situation 'as best they can' at the time. It is therefore important that Airservices Australia take a more considered approach to forthcoming changes in order to ensure that all controllers are adequately prepared at both the initial and ongoing phases of the change process and that the cumulative effects of change are being adequately assessed and addressed.

Hopkin[3] purports that for high morale, management must be well informed and sensitive to controllers' needs at work. Moreover, management should be willing and able to communicate effectively with the workforce on all matters of mutual concern. Morale will ebb away if controllers are blamed for delays that were not their fault, particularly when their forewarnings were ignored. Hopkin goes on to state, 'Constant disparagement of a profession whose members are doing their best does no good for its morale'.

Most controllers acknowledge that morale is low, and most of the feedback on their performance is negative. They believe that the community holds them partly responsible for the noise problem, and that attempts to share the noise through the LTOP reduce the efficiency of air traffic management. This increases the negative feedback from management and the industry. Some of the recent air safety incidents described in this report resulted from attempts to minimise climb and speed restrictions imposed on airlines. Also, controllers may have been seeking some positive feedback from aircrews by providing them with less restrictive route structures.

The transition to TAAATS will require total commitment for its introduction and subsequent successful operation by the controllers involved. Because of controllers' reservations about whether TAAATS is a suitable Terminal Area tool and their concerns about the human-machine interface issues associated with its operation, there appears to be limited commitment to the introduction of TAAATS into Sydney. Its seamless introduction is considered unlikely. Careful management of this transition is therefore critical.

[3] Hopkin, V.D., *Human Factors in Air Traffic Control*, 1995, p360-363

If TAAATS training continues as rostered overtime, the physiological pressure of achieving such a demanding work and training output may prove unsustainable. The cumulative effect of working overtime and extra duties increases the potential for fatigue. This can lead to a controller taking a day's sick leave that, in turn, further compounds the problem. Fatigue was a contributing factor in two of the air safety incidents.

2.2 TEAMS

Ratner's concept of teams has not been wholly applied in the Sydney TCU. The current roster being worked by Sydney TCU controllers, the resource implication of having a number of experienced controllers essentially working full-time on a variety of projects, and the additional resource implication of TAAATS training, are just some of the reasons cited to explain why both Sydney TCU controllers and local managers do not believe that controllers can currently operate primarily as 'walk-in-walk-out' teams.

The investigation revealed concerns about the quality of training provided to team leaders in order for them to carry out their responsibilities as supervisors and check controllers adequately and consistently. Joint training for team leaders and their teams has not been carried out in accordance with S&QM policy. This has resulted in a poor understanding by a number of controllers of the 'teams' concept and has the potential to impact on safety when the team is not operating as a total and supportive unit. Whilst a number of team leaders were unclear about their role and responsibilities, these matters are clearly stated in the S&QM Safety Management manual. This may again highlight deficiencies in initial and ongoing training of team leaders.

Concerns are held about issues of standardisation that can, in part, be linked to inadequate training and refresher training of team leaders. A more concerted effort is required by stream specialists and local managers to ensure that cross-team standardisation is achieved in order to eliminate current uncertainties about operating procedures that appear to be arising when controllers' are temporarily placed into another team's shift.

The disproportionate amount of administrative tasks that are expected to be carried out by team leaders in the Sydney TCU has the potential to impact on safety. The requirement to be responsible for a variety of administrative tasks does not appear to be allowing sufficient time for the team leaders to remain both current and confident on all their required endorsements and on all the operating modes. In turn, team leaders appear to have insufficient time to carry out adequately supervisory and check responsibilities to a consistent standard.

The effect of taking a number of very experienced controllers out of the team environment for the development of ongoing and imminent projects, is that it has reduced the depth of knowledge within the teams and taken away some of the benefits that these role models and mentors have on the overall effectiveness of the team. This, in turn, has rostering implications, which further compound the resource issue.

If Airservices Australia believes that the benefits of the 'teams' concept outweigh those of any previous method of utilising human resources, then there must be total commitment to the concept and it must be adequately resourced. BASI is not suggesting that more staff will be required to operate teams within the Sydney TCU but that current resources, and the commitment to projects and project timelines, must be rationalised in order to allow the teams to undertake their primary task of safely and efficiently controlling aircraft traffic effectively.

2.3 ROSTERS

There was a general consensus among both controllers and management in the Sydney TCU that the current roster was inadequate. In particular, it was felt to cause an undue amount of stress and fatigue. Whilst on the surface, the issue of rosters may appear to be simply an industrial issue, recent incidents have highlighted the impact that it has also had on safety with at least three of these incidents citing fatigue as a contributing factor.

Fatigue is insidious and potentially very dangerous for critical operations such as air traffic control. Losing as little as two hours sleep from that normally obtained can result in fatigue and a subsequent degradation in performance and alertness. Over days, continual sleep loss will accrue into a cumulative sleep debt. Although analysis of the roster did not reveal any extreme deficiencies, the effects of perceived ongoing pressure and resulting stress appear to have compounded the effects of fatigue in a number of Sydney TCU controllers. However, the strong perception of controllers that the shift pattern produces fatigue should not be ignored. Indeed, given the safety implications of a decrease in controllers' work performance due to fatigue, this is an area that should investigated as a priority.

The results of studies on fatigue and performance are complex but generally they show effects related to attention, the timing of tasks, and short-term memory. All of these abilities are crucial to the performance of safe and efficient air traffic control. Tasks requiring sustained attention and rapid reaction times are particularly sensitive to the effects of fatigue. Indeed, tests involving these skills are routinely used to measure sleepiness. The sensitivity of vigilance tasks to sleep loss can be partly due to 'microsleeps', momentary 'blocks' or 'lapses' where the individual suffers from intermittent loss of awareness and a failure to react to external stimuli. Cognitive slowing related to fatigue can be a particular problem in work that is not 'self paced' but driven by external factors, such as is typically the case in air traffic control. In general, while it is possible for a fatigued controller to sustain normal levels of performance for brief periods of time, deterioration in performance will occur more quickly and will be more severe in comparison to a well rested controller.

There may be difficulties in having a roster that is desirable from a safety point of view accepted by either controllers or management. The normal recommendation is for a rotating shift schedule that delays the sleep/wake cycle rather than one that advances it. Human physiology can adjust more easily to a longer than normal 'day' (for example a day shift, followed by an evening shift, and then a night shift) than it can to a shortened day that requires an individual to try to sleep before they actually feel tired. In general, however, delaying rotations lengthen the work week, while advancing rotations compress the work week. Hence controllers may prefer an advancing schedule that maximises continuous periods away from work, even though to achieve this they may have to work a difficult shift roster that disrupts their sleep patterns and leads to a decrease in work performance due to fatigue. Management, in turn, may resist introducing a roster that requires a greater number of controllers at a time when there are other significant demands on staff resources.

Because of the conflicting requirements demanded of a 'good' roster, it is desirable that an independent external consultant in fatigue management be contracted to devise a shift schedule based primarily on safety, but which also recognises the non-work commitments of controllers and the resource constraints of management.

2.4 SEPARATION ASSURANCE

Recommendation 17 of the Ratner review refers to separation assurance, and states:

'Place greater emphasis on traffic planning and conflict avoidance as opposed to conflict resolution, adopt a criterion for correct application of separation standards that requires separation to be ensured by planning, execution, and monitoring rather than simply achieved in each case. Reflect this criterion in training, supervision, evaluation and incident reporting'.

Whilst structured airspace has largely removed the need for controllers to apply the skills of conflict resolution frequently, four issues have been highlighted by recent incidents:

(1) controllers are continuing, for a variety of reasons, to take aircraft off predetermined routes and therefore outside structured airspace, thus increasing the complexity of their task and introducing an added element of risk;

(2) controllers are at times relying on aircraft performance to resolve potential conflicts;

(3) some controllers are not monitoring their tasks closely and are not recognising the development of potential conflict in a timely fashion; and

(4) some controllers are selecting less safe courses of action for the resolution of potential conflict.

As the traffic density increases, there will be an increased need to maintain aircraft on predetermined routes for arrivals and departures in order to maintain an acceptable balance between efficiency and safety. Initiatives such as 'Slots' and 'metred-flow' will play a greater role in being able to achieve these efficiencies. Controllers will need to be more disciplined in their approach to traffic management and will need to come to terms with this new order. Controllers who continue to take aircraft 'off the rails' are exposing the system to a higher level of risk for little, if any, gains in efficiency. Notwithstanding the foregoing, a high priority must continue to be placed on the need for ongoing training in the techniques of conflict resolution in order for controllers to be able to recognise and manage a traffic conflict when it arises.

Humans are notoriously poor at monitoring tasks. One of the negative outcomes of structured airspace is that the controller has taken on a greater role in monitoring traffic rather than actively managing it. For this reason, some of the analysis of the safety cases has been rather simplistic as it does not appear to have factored in this human shortcoming and has not considered well the underlying concept that humans are error-prone. Some of the specific separation assurance issues that have been highlighted by recent incidents have exposed concerns that where areas of potential conflict have been created as a result of the geometry of the SIDs and STARs, the integrity of the system rests entirely on the controller. That the 'controller will manage his traffic', 'will recognise potential conflict' and 'will be familiar with the modes', in order to effectively reduce the level of risk of an identified hazard to an acceptable level, are not considered to be acceptable mitigating strategies in the light of known human performance limitations.

Where refresher and other awareness training have been cited as appropriate strategies to achieve familiarity with modes and some of the potential 'traps', then there must be a commitment at all levels to undertake such training on an ongoing basis in order to maintain the integrity of safety cases.

Airservices Australia should undertake to review the more problematic separation assurance issues identified by recent occurrences and this investigation and prompt action must be taken where necessary.

2.5 THE CIVIL AVIATION SAFETY AUTHORITY

This investigation highlighted a degree of uncertainty and perhaps confusion about the roles of and relationship between CASA and Airservices Australia. This same issue had previously been highlighted following an investigation of an incident involving SODPROPs and the subsequent independent review of the SODPROPS safety case. The opinion that appears to be held by some CASA officers is that the role of CASA is limited to 'auditing the process' that Airservices has in place to manage it's own safety, and that it does not extend to setting standards that an air service provider must achieve and maintain. Managers within Airservices Australia also hold differing opinions about their expectations of CASA's role in overseeing Airservices' activities.

Similar to the observations made following the SODPROPs safety case review, there appears to be a degree of professional reluctance for CASA to provide clear guidance on what is expected of Airservices as an air service provider. This responsibility appears to be largely devolved to Airservices to determine internally. Whilst the investigation gained a general sense that concerns were held by CASA about the safety implications of the rate and complexity of change that the Sydney TCU controllers were being subject to, there also appeared to be a degree of reluctance to be more positive in bringing this concern to the attention of Airservices and in directing that quick and positive action be taken to redress the problem. If it is accepted that the CASA role is primarily to audit the safety processes of Airservices Australia, this role should encompass continuing active oversight and follow-up. Notwithstanding, CASA was cognisant of the fact that the Sydney TCU had been subject to the pressure of a number of recent reviews and, arguably, indicated that yet another deputation by another agency may have only served to exacerbate the problem for the Sydney TCU controllers and managers at that time.

2.6 AIRSERVICES AUSTRALIA SAFETY AND QUALITY MANAGEMENT (S&QM)

The role and responsibility of S&QM does not appear to be clearly understood by Sydney TCU controllers and managers and there is some evidence to suggest that some of the responsibilities of S&QM have not been carried out in accordance with Airservices' safety management policy. Whilst the views of Sydney TCU controllers and Sydney TCU managers may well be perceptions rather than reality, it is nevertheless a matter that needs to be resolved. The day-to-day safety management decisions may legitimately be the responsibility of 'line' managers and team leaders. However, S&QM staff have an oversight responsibility including one of standardisation and the follow-up of recommendations. This may be an area that S&QM could place more emphasis upon, in order for Airservices Australia to achieve the maximum safety benefit that the S&QM Branch has the potential to deliver.

There is also evidence to suggest that recent concerted efforts by S&QM to take a proactive approach to safety have been thwarted at local management level. Such an apparent adversarial relationship does nothing to achieve improvements in air safety.

2.7 OPERATORS

While operators are somewhat concerned about the reductions in efficiencies of operation of the Sydney Terminal Area airspace, they nevertheless consider safety as their highest priority. The fuel required for extra track miles for particular SIDs is less of a concern to operators than the number of artificially created low-level crossover points of the current SIDs and STARs.

Whilst it is accepted that it is not possible to eliminate all crossover points, some of these are seen as unnecessary and impose a higher risk of collision where several outbound and inbound routes crossover both laterally and vertically in a confined area.

Whilst some flexibility needs to be maintained to achieve maximum efficiencies in the use of the runways at Sydney, it is highly desirable for controllers to provide flight crews with timely advice of the runway for landing. Approach briefings are an extremely important part of a flight crew's routine and can at times be very complex and lengthy. Approach briefings also require the flight crews to brief for a possible missed approach. The requirements of the missed approaches at Sydney are quite complex and differ according to the runway for landing. It is therefore critical that the correct approach, landing and missed approach procedures are clear in flight crews' minds well before the final approach and landing phases of flight. As many flight crews are not informed of the intended runway for landing until the flight is within 30 NM of Sydney, approach briefings are often being carried out within the airspace of the Sydney Terminal Area during the flight's descent phase. As this is recognised as a high workload environment, the possibility of distraction because of other activities, and the subsequent inability to attend adequately to briefings and pre-landing checklists , is increased. This has the effect of reducing the overall situational awareness of the operating crew and introduces an element of uncertainty and added risk to the operation.

A recent landing accident at Amsterdam involving a Boeing 757 has highlighted the risk of continued operations on runways with crosswinds of up to 25 kts. Whilst this level of crosswind is within the structural capacity of the aircraft and the capability of the flight crews, it has reduced the margin for error when aircraft are required to land on close-set parallel or short runways, when safer options are available. In addition, an increased level of complexity is added to the airspace environment when flight crews operationally require a landing on an into-wind runway while crosswind operations are in progress, thus compromising structured airspace concepts.

Operators have general concerns about the efficiency of operations at Sydney compared to other centres around Australia. Whilst this is largely an economic issue, the potential to impact on safety occurs when crews have been frustrated by late changes of runway, perceived unnecessary and often low-level holding, extended periods of operation at low altitude following departure, and perceived inefficiencies in the processing of traffic for landing. Some of this frustration has the potential to manifest itself in such things as distractions from tasks, missed checks and 'coarser' handling of aircraft.

2.8 'SAFETY HEALTH' OF THE SYDNEY TCU

Not all the safety issues identified during the course of this systemic investigation could be directly linked to the factors that contributed to the recent incidents in the airspace of the Sydney Terminal Area. However, current research on human factors highlights those factors that predispose people to be more prone to make errors and mistakes. The presence and strength of these factors can be estimated, and this can be used as an indirect measure of the 'safety health' of the system or organisation. The greater the presence of factors which increase the likelihood of making an error or mistake, the poorer the organisation's 'safety health'. The notion of an organisation's 'safety health' reflects that there is similarly no single measure, but only a constellation of measures of many factors. It also suggests that the 'safety health' of an organisation provides a measure of its intrinsic resistance to accident-producing factors.

A safety program referred to as MESH (Managing Engineering Safety Health) utilises the concepts of 'safety health' and was originally developed for the aviation engineering industry. MESH is a set of diagnostic instruments for making visible, within a particular organisation,

the local and organisational factors most likely to contribute to human factors problems. These factors are equally applicable to the Sydney TCU environment and will be briefly considered in this conclusion.

Local factors are aspects of the job and workplace that might influence how likely a person is to make an error or mistake. In broad terms, aspects of the following local factors are considered to be of concern in the Sydney TCU environment:

(1) skills, knowledge and experience;

(2) morale;

(4) pressure;

(5) fatigue;

(4) teamwork; and

(5) third party support.

All of these aspects have been referred to in detail in earlier sections of this report.

Organisational factors are aspects of the company and organisation that might influence the presence and/or severity of local factors and that, in turn, influence how likely a person is to make an error or mistake. In broad terms, aspects of the following organisational factors are considered to be of concern in the Sydney TCU environment:

(1) people management;

(2) training and selection;

(3) commercial and operational pressures;

(4) planning and scheduling; and

(6) communication.

All of these aspects have been referred to in detail in earlier sections of this report.

These aspects need to be addressed at both a local and organisational level in order to improve the overall 'safety health' of the Sydney TCU and, in turn, reduce the potential for errors to occur in the traffic management of the airspace of the Sydney Terminal Area.

3.0 FINDINGS

The following is a summary of the findings of the investigation team.

- Controllers have been exposed to significant and ongoing change over the last four years.
- The human performance limitations of individual controllers have not been considered adequately in the change management equation.
- Safety cases have been developed for all modes of LTOP and other procedural changes. However, the cumulative effect of the changes occurring within the Sydney Terminal Area environment do not appear to have been adequately considered.
- The recent air safety occurrences in the airspace of the Sydney Terminal Area have been manifestations of human performance limitations.
- The 'teams' concept has not been appropriately resourced or implemented within the Sydney TCU.
- The integrity of safety cases may have been compromised because strategies to mitigate identified hazards have not been implemented adequately.
- Those involved in the development and analysis of safety cases did not possess adequate expertise to enable meaningful human factors analysis of identified hazards.
- The current Sydney TCU roster is perceived by Sydney TCU operational staff to be the source of considerable stress and fatigue.
- A separation assurance issue involving the MARUB ONE standard instrument departure track, was identified as a result of one of the recent occurrences, however, this issue has not yet been resolved.
- The role of S&QM does not seem to be clearly understood or appreciated by those employed in the Sydney TCU. In addition, there is information to suggest that S&QM has not been carrying out some of its responsibilities. There is also information to suggest that attempts by S&QM to carry out its' intended role have been thwarted at a local level.
- Understanding of the relationship between Airservices Australia and the Civil Aviation Safety Authority varies considerably between individuals and there appear to be different views held about the roles and responsibilities of the two agencies.
- Flight crews have been exposed to high workloads within the airspace of the Sydney Terminal Area due to the late nomination of the landing runway.
- The current policy of operating the short runways at Sydney with up to 25 kts of crosswind has reduced safety margins for arriving and departing aircraft and has increased the complexity of the surrounding airspace when some aircraft operationally require an alternative runway for arrival or departure.

4.0 RECOMMENDATIONS

The Bureau of Air Safety Investigation recommends that:

R980156

Airservices Australia review its change management procedures and the program for change leading up to the Olympics. The review should ensure that safety is not compromised to meet project schedules or perceived community imperatives.

R980157

Airservices Australia review the application of the 'teams' concept within the Sydney Terminal Control Unit to ensure that teams are resourced appropriately and that there is an ongoing commitment to the provision of adequate training in order to achieve a high level of controller proficiency and standardisation.

R980158

Airservices Australia ensure that adequate refresher training is undertaken by controllers in order to provide for high levels of controller proficiency and standardisation and so that the integrity of safety cases, in which refresher training is deemed to be a mitigating strategy for identified hazards, is maintained.

R980159

Airservices Australia reassess the human factor hazard analysis for both Stage One and Stage Two of the LTOP safety cases so that the mitigating strategies applied to identified hazards adequately allow for the fundamental limitations of human performance. In reassessing this hazard analysis, BASI recommends that Airservices Australia seek the assistance of human performance expertise.

R980160

Airservices Australia consider restructuring the current roster operating in the Sydney TCU to ensure that contemporary fatigue management research is translated into meaningful duty hour regulations. In any restructure of the roster, BASI recommends that Airservices Australia expand its absentee management program to include individuals who expose themselves to the risks of fatigue by participating in excessive amounts of overtime and/or emergency duty.

R980161

Airservices Australia review the relationship between the Sydney Safety and Quality Management Branch and the Sydney Terminal Control Unit with a view to developing procedures to improve the effectiveness of the safety management system, thus contributing to the overall 'safety health' of Sydney TCU operations.

R980162

The Civil Aviation Safety Authority and Airservices Australia review their current relationship in order that both agencies have a clear and uniform understanding and expectations of each other's roles and responsibilities.

R980163

Airservices Australia consider providing early advice of the landing runway to the flight crews of inbound aircraft so that required cockpit procedures may be completed before flights enter the airspace of the Sydney Terminal Area.

R980164

Airservices Australia, in conjunction with the Civil Aviation Safety Authority, reconsider the current policy of routinely operating the short runways at Sydney with up to 25 kts crosswind when other runway options are available.

ATTACHMENT ONE

INVESTIGATION INTO SYSTEMIC FACTORS UNDERLYING AIR SAFETY OCCURRENCES IN THE SYDNEY TERMINAL AREA AIRSPACE

TERMS OF REFERENCE

INTRODUCTION

1. Over the period 22 May 1998 to 12 June 1998, there were three breakdown of separation occurrences in the Sydney Terminal Area airspace. Each of these occurrences was categorised as a serious incident and involved high capacity aircraft conducting scheduled fare paying passenger operations. Staff from the Bureau of Air Safety Investigation (BASI) have initiated an on-site investigation of one of these occurrences and office investigations of the other two. The interim information gained from these investigations suggests systemic safety deficiencies relative to airspace configurations, separation assurance and changes in runway configuration. Significant factors in each occurrence highlight the limitations of human performance in the provision of air traffic control services.

2. The Bureau of Air Safety Investigation proposes to conduct an investigation into the potential systemic factors underlying these recent air safety occurrences in the Sydney Terminal Area airspace.

SCOPE

3. The investigation team is to address whether the safety impact of the implementation of operational changes at Sydney has been fully analysed. In particular, the following areas are to be examined:

- investigate human performance limitations in multi-faceted operations,
- investigate traffic segregation procedures in the TMA,
- investigate controller preparation and training for changes to procedures,
- investigate the application of separation assurance procedures and culture,
- investigate coordination procedures,
- investigate airspace constraints imposed by the changes, and
- investigate possible workload issues due to additional training.

OBJECTIVES

4. The objectives of the investigation are to:

- determine whether there are underlying organisational factors impacting the safe management of traffic in the TMA,
- identify safety deficiencies,
- examine ways to minimise the impact of identified deficiencies, and
- where considered appropriate, make remedial recommendations.

ORGANISATIONAL CONSIDERATIONS

5. The team will comprise three air safety investigators, one each from the Operations, Air Traffic Services and Human Performance specialisations. The review team will work closely with Airservices Australia and Civil Aviation Safety Authority officers.

TIMING

6. The investigation team is to prepare a draft report for consideration by the Director, BASI, by 31 July 1998.

Note: In the introduction contained within the terms of reference, a reference is made to the conduct of one on-site investigation and two office investigations into the three breakdown of separation occurrences. The body of the report refers to the conduct of two on-site investigations and one office investigation. In the period between the release of the terms of reference to the relevant action agencies and the conduct of the systemic investigation, a further on-site investigation was conducted into one of the occurrences.

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