Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Aviation Occurrence Investigation – AO-2007-005
Final

Procedures related event
Townsville Airport, QLD
4 May 2007
N7088S
Raytheon Aircraft Company 390

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Abstract

On the night of 3 May 2007, a Raytheon Aircraft Company 390, registered N7088S, was enroute to Townsville Airport, Qld on the final leg of a private instrument flight rules (IFR) flight from Avalon, Vic via Sydney, NSW and Brisbane, Qld. The aircraft carried four passengers and a pilot. At about 0049 EST on 4 May, the pilot landed the aircraft on runway 01 while it was closed due to works in progress. There was no damage to the aircraft or injuries to personnel.

On 29 April 2007, a notice to airmen (NOTAM) had been issued which required that pilots requiring the use of runway 01 provide 30 minutes prior notice to the works safety officer (WSO) on duty at the airport. The pilot of N7088S later reported that although he had reviewed the list of NOTAMs for the airport prior to the flight, he did not recall noting the runway closure and did not notify the WSO of his planned arrival. The WSO had been notified of the planned arrival of another aircraft and had selected the runway lighting ON in anticipation of its arrival. At the time of the occurrence, the instrument landing system approach aid for runway 01 was available and the airport's pilot activated lighting and airfield frequency response unit were unavailable.

For a period of several minutes while on approach and final, the pilot was not contactable by radio on either the Brisbane Centre frequency or the Townsville common traffic advisory frequency. During this time the duty supervisor at Brisbane Centre notified the WSO of the approaching aircraft. Workers on the runway noticed the approaching aircraft and vacated the runway before the aircraft landed.

The investigation identified several safety factors that contributed to the occurrence, including pre-flight planning, radio selection and operation, ground works management, and air traffic control. The airport operator, the pilot, and Airservices Australia initiated a number of safety actions in response to some of the issues identified.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external bodies.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

FACTUAL INFORMATION

History of the flight

On the night of 3 May 2007, a Raytheon Aircraft Company 390, registered N7088S, was enroute to Townsville Airport, Qld on the final leg of a private instrument flight rules (IFR) flight from Avalon, Vic. via Sydney, NSW and Brisbane, Qld. The aircraft carried four passengers and a pilot. At about 0049 Eastern Standard Time[1] on 4 May, the pilot landed the aircraft on runway 01, while the runway was closed due to works in progress. There was no damage to the aircraft or injuries to personnel.

On 29 April 2007, a notice to airmen[2] (NOTAM) had been issued for Townsville, which required that pilots requiring the use of runway 01 provide 30 minutes prior notice to the works safety officer (WSO) on duty at the airport. The WSO had been notified of the planned arrival of another aircraft and had left the runway lighting on in anticipation of its arrival. The instrument landing system (ILS)[3] for runway 01 was also available but the pilot activated lighting (PAL)[4] and the aerodrome frequency response unit (AFRU)[5] were unavailable at Townsville at the time of the occurrence.

The pilot of N7088S later reported that although he had reviewed the list of NOTAMs for the airport prior to the flight, he did not recall noting the runway closure and did not notify the WSO of his planned arrival.

Sequence of events

At 0000 on 4 May 2007, the Brisbane enroute controller cleared the pilot to track direct to navigation point SATCO for an instrument landing system (ILS) approach to Townsville Runway 01. At 0029, the controller cleared the pilot to descend and to leave controlled airspace. At 0036, the controller advised the pilot that there was no IFR traffic and instructed him to report again when on the ground at Townsville Airport.

At about 0038, when the aircraft was about 40 nautical miles from the runway, the pilot called the controller on the Brisbane radio frequency asking whether the runway lights were on at Townsville Airport. The controller replied that the airport

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1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time, as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

2 NOTAM: Notice to airmen concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard. A published service, such as a runway, is normally considered to be available unless a NOTAM is issued that specifically states that it is not available.

3 ILS: Instrument landing system, a radio guided precision approach system.

4 PAL: Pilot activated lighting, a form of airport lighting that is activated for a limited time by transmission on a particular frequency.

5 AFRU: Aerodrome frequency response unit, an automated radio response system.

used PAL. The pilot told the controller that according to the Townsville automatic terminal information service[6] (ATIS), PAL was unavailable. The pilot later recalled that he thought the ATIS stated: 'PAL lighting not available 01 (pause) runway 19 not available'. In a response to a draft report issued by the Australian Transport Safety Bureau (ATSB), the pilot later reported that he 'listened to the ATIS several times and wrote down what was said, and then rechecked this several times.'

The controller monitored the Townsville ATIS, which stated that PAL was not available and that runway 01/19 was not available. The controller asked the Brisbane supervisor to confirm whether PAL was available. The supervisor told the controller that when PAL was not available, the lights would normally be left on. The controller then told the pilot that his supervisor would be checking on the lighting and would telephone the local 'firies' (aerodrome rescue and fire fighting staff at the airport) to check if the lights were on, and that if they were not on then they should be coming on shortly. The pilot then requested and obtained the PAL frequency[7] from the controller, stating that he was going to attempt to activate the PAL anyway.

As Townsville Airport was a CTAF (R)[8] airport, pilots were required to transmit notification of their intentions on the CTAF when operating around or on the airport. The pilot of N7088S advised that after attempting to activate the PAL, he transmitted his position and intentions on the CTAF. The pilot reported that he did not hear the AFRU in response to his CTAF transmission, but assumed that this was because the AFRU was not active. He also did not expect a response due to the usual low traffic levels in the area during the night. Recordings of transmissions on the CTAF did not contain any transmissions from the pilot of N7088S[9]. The WSO later reported that he had been monitoring the CTAF and had not heard any transmissions from the pilot of N7088S at any time.

At 0045, the controller attempted to contact the pilot on the Brisbane frequency, but no response from the pilot was heard or recorded. The controller attempted to contact the pilot on the Brisbane frequency six more times over the next 3 minutes, with no response. The last three of these transmissions also included advice of works in progress on the runway at Townsville.

At 0047, the supervisor at Brisbane Centre telephoned the WSO at Townsville and advised him of the approaching aircraft. The WSO saw the landing lights of the aircraft approaching and made two unsuccessful attempts to contact the pilot on the CTAF. The WSO later reported that he had not heard any response on the frequency. No transmissions were recorded from the pilot on either the Brisbane frequency or CTAF during this period. The WSO's CTAF transmissions were recorded. The CTAF was not available to the controller for broadcasting or monitoring.

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6 ATIS: Automatic Terminal Information Service, a continuous broadcast of recorded information in terminal areas. Refer to Appendix A.

7 When the PAL was available, the Townsville Airport PAL could be activated either by a particular sequence of radio transmissions on the CTAF, or by a sequence on a separate PAL frequency.

8 CTAF: Common Traffic Advisory Frequency, a frequency used by aircrew in terminal areas to broadcast positional information. CTAF (R) denotes a mandatory notification area.

9 Recordings of transmissions on the CTAF and Brisbane frequencies were available to the investigation. Recordings of transmissions on ATIS and PAL frequencies were not available.

At around the same time, the workers on the runway became aware of the aircraft and began vacating the runway. The pilot reported seeing a vehicle with a flashing red light crossing the runway threshold or undershoot area when the aircraft was about 5 miles from the runway. He later reported that he had continued the landing after noticing the vehicle because he had assumed that it was a vehicle used by emergency services personnel who were there to turn the lights on for him. The WSO reported that during the landing, the aircraft flew over a works vehicle that was travelling across the runway threshold.

The aircraft landed on runway 01 at about 0049, by which time workers and equipment had been cleared from the runway, with the exception of some temporary lighting near taxiway Delta. The WSO observed the aircraft touch down slightly short of that lighting and then taxi through a line of temporary red lights that were placed so as to close off part of the taxiway and runway to pilots of aircraft taxiing from the other direction.

At 0050, the pilot contacted the controller on the Brisbane frequency to cancel SARWATCH[10]. The time between this transmission and the previous aircraft transmission on the Brisbane frequency was eight minutes and 35 seconds. The controller asked the pilot if he had heard any of the controller's recent transmissions and the pilot replied that he had not. The controller then advised the pilot that there had been a NOTAM issued regarding works on the runway, and that the runway was closed. The pilot replied that he had not been aware of this. The pilot later reported that the active runway lights had confirmed his impression that the runway was available.

Pilot information

Type of licence	ATPL
Medical certificate	VALID
Flying experience (total hours)	12,200
Total hours on the type	120
Night flying hours	950
Hours flown in the last 24 hours	4.5

The pilot reported that he had submitted his flight plan from home in the morning. At this time, he had obtained and printed a listing of relevant NOTAMs from the Airservices Australia website. He reported that he had brought this list with him.

On the morning prior to the occurrence, the pilot had flown as a passenger on a commercial flight that left Brisbane at 1039 and arrived at Avalon at 1256. While at Avalon, he assisted in the refuelling of N7088S. The pilot reported that this was conducted outdoors in cold, rainy, and windy weather for about an hour. He reported that the exposure probably affected his ability to read and understand the NOTAMs.

Bureau of Meteorology weather observations at Avalon Airport on 3 May 2008 recorded temperatures between 13.7 and 21.4 °C, and 0.6mm of total rainfall. The wind speed at 3pm was 35 km/h, and the temperature at 3pm was 14.7 °C.

10 SARWATCH: Search and rescue alert system.

The pilot also reported that there were a large number of NOTAMs on his printed list, and that the NOTAM informing of the runway closure had been printed half on one page and half on the next. He reported that this made it difficult to interpret. In addition, in response to the draft report, he advised that:

> The original plan for the flight had an arrival time inside tower hours, so not only was the NOTAM partly on the bottom of one page and partly on the top of the next, but I crossed it out as being not applicable, as the WEF[11] time was after the planned ETA[12].

The pilot departed Avalon at about 1730, flying alone in N7088S to Sydney. While at Sydney, he ate a hot meal, then picked up two passengers and flew to Brisbane.

The pilot estimated that they arrived at Brisbane at about 2030. The aircraft was refuelled at Brisbane after a delay of approximately 2.5 hours, waiting for the fuel vehicle. During this time, the pilot checked the weather at Townsville via the internet. The pilot reported that he used the original printed NOTAMs as he did not have access to a printer during the trip. The pilot picked up two more passengers and the aircraft departed Brisbane at approximately 2300.

The pilot estimated that he had flown N7088S for approximately 4.5 hours during the day.

The investigation was not able to obtain information as to the activities of the pilot in the days prior to the occurrence. The pilot reported 'nothing out of the ordinary going on; and I had a good sleep'.

The pilot reported that he was not taking any medication in the week leading up to the occurrence. He reported that he had about 40 years flying experience and that he was employed by the aircraft owners as a corporate pilot.

Effects of fatigue

Fatigue in aviation is a recognised problem that has been associated with many air safety occurrences[13].

The negative effects of fatigue on human performance are wide-ranging. For example, it can affect flight crew performance in areas such as reaction time, attention, memory, and decision making.

An increase in reaction time can lead to timing errors, less smooth control, and the need for stronger stimuli to gain the pilot's attention. A decrease in attention can result in mistakes in task sequences, preoccupation with particular tasks, and a reduced audiovisual scan. Diminished memory can lead to inaccurate recall of operational events, forgetting to carry out peripheral tasks, and reversion to established routines[14].

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11 WEF: with effect from. WEF time was the time that a NOTAM became effective.

12 ETA: estimated time of arrival.

13 Caldwell JA & Caldwell JL (2003). *Fatigue in aviation: A guide to staying awake at the stick.* Hants, UK: Ashgate.

14 Graeber RC (1988). Aircrew fatigue and circadian rhythmicity. In EL Wiener and DC Nagel (Eds.) *Human Factors in Aviation.* San Diego: Academic Press.

Fatigue can have a detrimental effect on decision making by increasing the time it takes for a pilot to take in and interpret information. Hence, their ability to accurately perceive the situation they face, and take appropriate and timely action, can be diminished[15].

When fatigued, a pilot's performance is likely to become increasingly inconsistent. Another insidious aspect of fatigue is that the pilot is likely to be unaware of the extent to which their performance has been negatively affected.

Historically, aircrew flight and duty times have been subject to regulation in order to minimise the possibility that safety could be compromised by the effects of fatigue.

Regulations and procedures

Civil Aviation Order 48

In Australia, the regulations relating to aircrew flight and duty times vary for different categories of operation.

Charter flights are subject to the requirements of Civil Aviation Order (CAO) 48.1 regarding crew rostering. This includes, in part:

> 1.3 An operator shall not roster a pilot for a tour of duty in excess of 11 hours.

Additionally, Subsection 1.5 of CAO 48.1 states that:

> 1.5 A tour of duty already commenced in accordance with paragraph 1.3 of this subsection may be extended to 12 hours.

CAO 48.0 contains general flight time limitations, including the following instruction:

> 1.4 Notwithstanding anything contained in these Orders, a flight crew member shall not fly, and an operator shall not require that person to fly if either the flight crew member is suffering from, or, considering the circumstances of the particular flight to be undertaken, is likely to suffer from, fatigue or illness which may affect judgement or performance to the extent that safety may be impaired.

Flight classification

Civil Aviation Regulation 206 classifies charter operations as those being for the purposes of the carriage of passengers or cargo for hire or reward to or from any place, other than carriage in accordance with fixed schedules or certain limited and experimental categories.

The incident flight of N7088S was not classified as a charter operation so the pilot was not required to comply with CAO 48.1.

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15 Costa G (1999). Fatigue and biological rhythms. In DJ Garland, JA Wise, & VD Hopkin (Eds), *Handbook of Aviation Human Factors*. Mahwah, NJ: LEA.

On 7 September 2001, as a result of another investigation, the ATSB issued the following recommendation:

> **Safety Recommendation R20010195**
>
> The Australian Safety Transport Bureau recommends that the Civil Aviation Safety Authority consider proposing an increase in the operations' classification, and/or the minimum safety standards required, for organisations that transport their own employees and similar personnel (for example contractors, personnel from related organisations, or prisoners, but not fare-paying passengers) on a regular basis. This recommendation applies to all such operations, regardless of the take-off weight of the aircraft involved.

CASA responded:

> **Response dated 4 February 2002**
>
> … CASA is presently reviewing the standards contained within the existing Civil Aviation Regulations (CARs) and Civil Aviation Orders (CAOs) with regard to the Classification of Aircraft Operations. The input and recommendations contained within Air Safety Recommendation R20010195 will be taken into consideration and addressed as part of this project.
>
> The outcome of the review will determine which category employees (and similar personnel such as contractors) are placed and the standards that will apply to their transportation in aircraft. I trust that this review will satisfactorily address the issues raised in this Air Safety Recommendation.
>
> **Response dated 14 November 2002**
>
> ... CASA proposes releasing an NPRM early next year to consult with the aviation industry with a view to amend CAR 206 to give effect to changes which would see recommendation R20010195 being adopted.
>
> **Response dated 21 December 2004**
>
> A Notice of Proposed Rule Making (NPRM) proposing amendments to Civil Aviation Regulation (CAR) 206 was issued in March 2003. Responses to this NPRM and the associated review of the Classification of Operations confirmed that the proposed amendment to CAR 206, which would accommodate this recommendation would be problematic. Consequently, CASA has decided to proceed only with the other amendments to CAR 206. The associated NFRM is currently with the Department of Transport and Regional Services for clearance prior to Ministerial approval.
>
> However, under the new Civil Aviation Safety Regulations, Corporate Operations will be classified as Aerial work and will be regulated under CASR Part 132. The carriage of patients and other personnel (other than air transport operations) will be regarded as Aerial Work under a subpart of Part 136 to be titled Emergency and Medical Services Operations. It is proposed that 'Emergency Services Flights' will cover aerial fire-fighting, law enforcement, and search and rescue operations. while 'Medical Services Flights' will cover air ambulance flights, health services flights, and emergency medical services flights. The development of these regulations is proceeding in consultation with industry.

The ATSB has classified the response ‘Monitor’.

Civil Aviation Regulation 239

Civil Aviation Regulation 239 (Planning of flight by pilot in command) stated that:

> (1) Before beginning a flight, the pilot in command shall study all available information appropriate to the intended operation, and, in the cases of flights away from the vicinity of an aerodrome and all I.F.R. flights, shall make a careful study of:
>
> (a) current weather reports and forecasts for the route to be followed and at aerodromes to be used;
>
> (b) the airways facilities available on the route to be followed and the condition of those facilities;
>
> (c) the condition of aerodromes to be used and their suitability for the aircraft to be used; and
>
> (d) the air traffic control rules and procedures appertaining to the particular flight;
>
> and the pilot shall plan the flight in relation to the information obtained.

Aeronautical Information Publication

The Aeronautical Information Publication (AIP) sets out pilot actions and related Air Traffic Services activity in civil and military controlled airspace. The Enroute part of the AIP stated, in part, that:

> 63.2 A pilot of an IFR flight must report when changing to the CTAF when the ATS[16] frequency will not, or cannot, be monitored. This report must include the aerodrome location and frequency.

The General part of the AIP stated that:

> 2.1.1 Pilots are responsible for requesting information necessary to make operational decisions.

The General part also stated that:

> 1.2.8 When preflight briefing is obtained more than one hour prior to ETD[17], pilots should obtain an update before each departure to ensure that the latest information available can be used for the flight. The update should be obtained by NAIPS[18] pilot access, telephone, or, when this is impracticable, by radio.

Radio communication

The aircraft was fitted with two radios. Radio frequencies were selected using a keypad on the console, and then entered into standby for a particular radio by

16 ATS: Air Traffic Services

17 ETD: Estimated time of departure

18 NAIPS: National Aeronautical Information Processing System, a multi-function, computerised aeronautical information system.

pressing a button next to the displayed frequencies for that radio. The active and standby frequencies could then be swapped using another button.

The active radio was selected with a rotary knob type switch. When the switch was in the left position, radio 1 would be selected for both transmission and reception. Similarly, radio 2 could be selected by turning the knob to the right. In addition, the knob had a push-pull switch action that would mute the non-selected radio when the knob was pushed in. When the knob was pulled out, the pilot could listen to both radios, but only transmit on the selected radio.

The pilot reported that he had previously experienced intermittent failures of radio 2. On occasion, he would not get any response when attempting to use this radio, but after reverting to radio 1, he could successfully transmit and receive. The pilot was unsure whether the problem involved transmission, reception, or both. The pilot reported that the radio was checked for correct operation during scheduled maintenance approximately a week after this occurrence and no fault was found. The pilot reported that he had not experienced any failure of radio 1.

The pilot reported that he would normally use radio 1 to communicate with air traffic control, and use radio 2 for other purposes such as monitoring the ATIS and CTAF. He reported that he checked the selected frequencies on both radios immediately after the occurrence and again the next day. He recalled that radio 1 was set to the Brisbane Centre frequency, and radio 2 was set to the Townsville CTAF. There were no transmissions from the pilot on the Brisbane frequency that were intended for CTAF.

Townsville Airport

Townsville Airport was a combined military and civil airport consisting of two runways. The main runway was oriented 01/19, and the second runway was oriented 07/25. The airport and surrounding airspace were controlled by air traffic control during the day and uncontrolled CTAF(R) procedures were used after 2200 each night.

Conduct of airport works

Method of works plan

The Townsville Airport works were conducted under method of works plan (MOWP) YBTL0206 Issue 1, Amendment 1, dated 13 June 2006. The MOWP had been developed in consultation with a number of interested parties, including the Airside Coordinator, the Aviation and Engineering Manager at Townsville Airport, and airlines operating out of the airport. The MOWP had been approved by the Aviation and Engineering Manager.

The MOWP specified several stages of works, and specified which tasks were to be undertaken at each stage of the works. On the shift commencing at 2130 on 3 May 2007, the workers were implementing Stage 2 of the plan. This stage involved asphalt overlay, grooving and replacement of airfield lighting on runway 01/19.

The runway had been closed from 2130 to 0530 during implementation of Stage 2 of the MOWP, which had been undertaken at night to avoid impinging on

scheduled flight operations. The runway was scheduled to be closed at this time during the night of 3 May.

Due to the location of workers and equipment on and near runway 01/19 during Stage 2 of the works, the MOWP directed full length closure of runway 01/19 and taxiways north of taxiway Delta. This was to be accomplished by the issue of a NOTAM in the following form:

A) TOWNSVILLE (AD)
B) DATE/TIME OF COMMENCEMENT OF WORKS
C) DATE/TIME OF COMPLETION OF WORKS
D) DAILY DURATION OF WORKS
E) REF MOWP YBTL/02/06 STAGE 2
RWY 01/19 NOT AVBL DUE WIP
TEMPO TWY LGT ACROSS RWY 01/19 BTN TWY DELTA 2 AND TWY DELTA 3 FOR TAX TO RWY 07/25
PAL+AFRU (FREQ 118.3) NOT AVBL
RWY 07/25 AND OTHER AD LGT ON
TWY ALPHA N OF TWY FOXTROT NOT AVBL

The MOWP included the following section:

> Should operators have requirement for movements with aircraft that are unable to operate with the NOTAM restrictions, they must advise the Project Coordinator. The request will be assessed on the basis that all other options have been exhausted and the occurrence is unscheduled and unavoidable. The decision to permit the operation lies with the Project Coordinator (PC).

The plan did not include provisions for allowing intermittent use of the runway during the runway closure period.

The process for developing a MOWP was outlined in the Townsville Airport Aerodrome Manual. The manual included a procedure for submitting a NOTAM, which included a step for the Duty Safety Officer to 'check accuracy of issued NOTAM'.

The WSO supervised the airport works, including associated contract workers and equipment. The workers were split into a number of separate work units and did not have a means for radio communication between units or between the WSO and each unit.

Notice to airmen (NOTAM)

The relevant NOTAM in effect on the night of 3 May 2007 was as follows:

C0228/07 REVIEW C0227/07
RWY 01/19 NOT AVBL DUE WIP
EXC FOR APPROVED ACFT WITH 30 MIN PN TO WORKS SAFETY OFFICER TEL 0418 771 999
TEMPO TWY LGT ACROSS RWY 01/19 BTN TWY DELTA-2 AND TWY DELTA-3
FOR TAX TO RWY 07/25
PILOT ACT LGT PLUS AFRU(AD FREQ RESPONSE UNIT) (FREQ 118.3) NOT AVBL
RWY 07/25 AND OTHER AD LGT ON
TWY ALPHA N OF TWY FOXTROT NOT AVBL
REF METHOD OF WORK PLAN YBTL 02/06 STAGE 2

FROM 04 291130 TO 05 181930
DAILY 1130/1930

The NOTAM included a statement that the runway was closed, and also included a provision for pilots of approved aircraft to use the runway with at least 30 minutes prior notice provided to the WSO on duty at the airport.

The WSO reported that the 30 minute requirement was to allow sufficient time to clear the runway of workers and equipment, and to allow time to switch the runway lights on.

Serviceability NOTAMs were written and submitted by the Duty Safety Officer, using the MOWP as a guide, the day before they were due to become active. Each day, the Duty Safety Officer would check that the active NOTAMs were in accordance with those that were submitted.

These NOTAMs were available to pilots for flight planning purposes via NAIPS over the internet, or by telephone or radio.

Automatic terminal information service (ATIS)

The Townsville Airport ATIS radio message was recorded on the flight information service's automatic voice recording (AVR) system when it was monitored by the Brisbane controller. The recording was clear and understandable, and was as follows:

TOWNSVILLE TERMINAL INFORMATION ZULU
TOWER CLOSED UNTIL 1930 ZULU
CTAF BROADCAST INTENTIONS ON 118.3
RUNWAY 01/19 NOT AVAILABLE AS PER NOTAM
PAL AND AFRU NOT AVAILABLE
WIND CALM.
QNH 1015 HECTOPASCALS
TEMPERATURE 19
DEW POINT 18
CLOUD CLEAR BELOW 12 THOUSAND FEET
RAINFALL LAST TEN MINUTES NIL
HUMIDITY 95 PERCENT
WET BULB TEMPERATURE 18
VISIBILITY 10 KILOMETRES

There was a change in the tone and volume of the recorded ATIS voice between the words 'RUNWAY 01' and '19'.

Other airport operations

During the night, runway 07/25 remained open. The MOWP allowed for aircraft activity on this runway without hindrance to or from the workers on the ground and a number of aircraft used the runway during the night. In addition, the workers halted their activity at about 2235 to allow several approved aircraft to use runway 01. Work recommenced at around 2312.

Runway lighting and ILS

The PAL had been deactivated so that work could be carried out on the runway lighting. The PAL and AFRU could not be switched off independently, so the AFRU was also deactivated. The runway lights were under manual control from a switch at the airport. The MOWP did not specifically state that the runway lights or ILS were to be turned off while runway works were in progress. The operations standards manager at Townsville reported that it was airport policy to have the runway lights off while people and equipment were on the runway and that all works safety officers were trained in this procedure. There was no similar policy regarding deactivation of the ILS during periods of runway works.

Workers on the airport had previously experienced some difficulties with the runway lighting and that occasionally the lights would fail when they were switched on. On the night of the occurrence, the WSO had been notified of another aircraft that was expected to arrive later in the night and he decided to leave the lights on in order to minimise the risk of them not operating when they were required. The WSO was unsure of the time that the approved aircraft was expected to arrive and was unaware that N7088S had also planned to land at Townsville. He also reported that there would not have been enough time within the 30 minute notification period to switch the lights on as well as ensuring that workers and equipment vacated the runway in sufficient time.

The ILS was under manual control from a switch at the airport, but it was owned and controlled by Airservices Australia. The duty officers at the airport did not have access to it. In order to switch the ILS on or off, a technician needed to be called out.

Manual of Standards

The Civil Aviation Safety Authority (CASA) Manual of Standards (MOS) Part 139 set out the standards and operating procedures for airports such as Townsville Airport. Chapter 9 of the MOS contained standards associated with visual aids provided by airport lighting. Section 9.18 (Lighting Associated with Closed and Unserviceable Areas) stated, in part, that:

> 9.18.1.1 When a runway or taxiway, or portion thereof is closed, all aerodrome lighting thereon is to be extinguished. The lighting is to be electrically isolated or disabled, to prevent inadvertent activation of the lights.

The MOS did not require an ILS to be switched off when the associated runway was closed.

Air Traffic Services

Prior to commencing duty at a work station, controllers were required to review a specific set of applicable operational information, including the NOTAMs that were current, or would become current during the controller's shift. The process for accessing these NOTAMs at Brisbane Centre was via a printed computer report.

The Brisbane Centre local instructions[19] included a procedure for correctly printing the report, including steps for ensuring that all pages were printed.

On the night of 3 May, these steps were not followed and the final two pages of this report were not reproduced. As a result, the NOTAM list available to the controller was truncated and the NOTAM applicable to the closure of the Townsville runway was not printed. The controller and supervisor were not aware that any NOTAM information was missing from the report.

The controller reported that he was not aware that the runway was closed until just before he attempted to warn the aircraft of the runway closure. He also reported that although he listened to the ATIS, he was focusing on the status of the PAL and had not detected the runway closure advice.

Manual of Air Traffic Services

The Manual of Air Traffic Services (MATS) contained instructions for the provision of air traffic services to aircraft. Part 5 of the MATS listed the types of information that were to be provided as part of a Flight Information Service (FIS)[20], including pertinent changes in condition of airports and associated facilities. Section 5.1.1.5 of the MATS stated:

> Pilots are responsible for requesting information necessary to make operational decisions.

Section 5.1.1.3 of the MATS stated:

> Officers may, at times, experience situations not specifically covered whereby the safety of an aircraft may be considered to be in doubt. Nothing in these instructions shall preclude officers from exercising their best judgement and initiative to assist pilots.

19 Local instructions: A set of instructions specific to the provider of Air Traffic Services in a specific airspace region.

20 FIS: Flight information service, a service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

ANALYSIS

Pilot's decision to land

Flight planning

The notice to airmen (NOTAM) and the automatic terminal information service (ATIS) systems are the primary methods by which long and short-term changes in operational information are disseminated to pilots. Pilots are required to review relevant NOTAM and ATIS content to assess their potential effect on their flights, as they may be the only means available by which some types of information can be obtained.

There is no evidence to suggest that the pilot would not have contacted the works safety officer (WSO) in accordance with the issued NOTAM prior to the flight, or alternatively would have planned a flight into Townsville, had he been aware that the runway would be closed. The NOTAM was the only source of information readily available to the pilot prior to the flight relating to the availability of services at Townsville, so the review of this information in the flight planning process was an important step in managing the safety of the flight.

The investigation could not conclusively establish why the pilot was not aware of the contents of the NOTAM that advised of the runway closure. It is highly likely that the content of the relevant NOTAM was either overlooked or not read. The pilot had the required list of NOTAMs available and the NOTAM content was unambiguous. The pilot had several opportunities to review the list throughout the day, such as on receipt of the list, during the commercial flight from Brisbane to Avalon, prior to fuelling at Avalon, at Sydney, or while awaiting fuel at Brisbane.

In addition, if the pilot had obtained and reviewed an updated briefing immediately prior to leaving Sydney or Brisbane, he may have noticed the relevant NOTAM content and would have been able to adapt the flight plan accordingly.

Under the circumstances, the longer the pilot delayed the NOTAM review, the more likely it was that he would forget to review them. Also, the pilot's exposure to cold, wet, and windy conditions at Avalon and the duration of the period of duty, into late evening, may have affected his ability to remember that he had not reviewed the NOTAMs.

It was also important to update the briefing information and flight plan prior to each departure. As each leg was successively delayed, the actual flight times were increasingly different from the original flight plan. As a result, the applicability of some briefing information had, or could have, changed. Updated briefing information could have been obtained by internet, telephone, or radio prior to each leg. This would have enabled the pilot to check which NOTAMs were applicable to the revised flight times if he had previously discounted them (crossed them off).

Interpretation of ATIS

The pilot listened to the Townsville ATIS during his descent and his recollection was that he heard the phrase 'Pilot activated lighting not available 01 (pause) runway 19 not available'. The relevant statements in the recorded ATIS were:

RUNWAY 01/19 NOT AVAILABLE AS PER NOTAM
PAL AND AFRU NOT AVAILABLE

The pilot's recollection of the sequence and content of the ATIS information suggested that he may have heard the statement about the runway but misinterpreted the meaning.

Availability of cues on approach

Without knowledge of the relevant contents of the NOTAM and ATIS, the pilot had some cues that would have supported his assumption that the runway was available.

Those cues included:

- the Brisbane controller's advice for the pilot to track to the reporting point 'for an ILS (instrument landing system) approach to runway 01'
- the Brisbane controller's advice to expect that the runway lights would be turned on
- the fact that the ILS was operating and the pilot was able to carry out an approach using the ILS
- the fact that the pilot could see the runway 01 runway lighting.

There were no other cues or warnings to the pilot that challenged his assumption that the runway was available for use. He did not hear the Brisbane controller or the WSO's attempts to call him on the radio. He was also able to rationalise the presence of a vehicle on and near the runway as the expected rescue and fire-fighting personal ensuring that the lights were operating. As a result, the pilot was not aware that the runway was closed and this led to his decision to land on the runway.

Fatigue

Fatigue can have an adverse effect on many aspects of human performance, including attention, planning and decision making, and situational awareness.[21] For example, in this occurrence, consideration was given as to whether the pilot's attention to the Townsville ATIS, or his decision-making during the Brisbane to Townsville flight sector, could have been influenced by the effects of fatigue.

The pilot first began activities related to his duty for the day at least 14 hours before the time of the occurrence. During that time, he had flown approximately 4.5 hours as a single pilot during flight sectors from Avalon to Sydney, from Sydney to Brisbane and from Brisbane to Townsville, plus ancillary duties related to aircraft refuellings at Avalon and Brisbane.

The extent, if any, to which the pilot was experiencing fatigue at the time of the occurrence would also depend on how well rested he was when he started duty that morning. This, in turn, would depend on the length and time of day of the pilot's duty and rest periods over the previous days, and the amount and quality of sleep

21 Caldwell JA & Caldwell JL (2003). *Fatigue in aviation: A guide to staying awake at the stick.* Hants, UK: Ashgate.

that he had obtained. However, not all of this information was available to the investigation.

Although the available evidence suggests there was the potential for the pilot's performance to have been influenced by fatigue, there was insufficient evidence available to make a probable finding in this area.

The pilot was operating the aircraft as an employee of the aircraft owners for corporate purposes. However, the flight was not a charter operation under Civil Aviation Regulation (CAR) 206. As such the pilot was not required to adhere to the rostering requirements of Civil Aviation Order (CAO) 48.1, which limits the amount of permissible flying hours and duty times conducted by commercial and charter pilots. Private and business pilots do not need to comply with the requirements of CAO 48.0. However, that does not preclude pilots of private or business flights voluntarily limiting flying and duty times to reduce the incidence and effect of fatigue.

Radio communication

The pilot was reportedly unable to hear any transmissions on the Brisbane centre frequency for a period of time between acknowledging the PAL frequency that the Brisbane controller provided, and after landing. However, there was no evidence to suggest that this was the result of a technical failure of radio 1.

Earlier, the pilot had listened to the ATIS using radio 2. He reported that his normal procedure for doing this was to enter the frequency into the radio, pull the selection switch in order to listen to radio 2, and afterwards push the switch back in to mute radio 2.

It is probable that the pilot switched to radio 2 in order to transmit on the PAL frequency without pulling the selection switch. This would have muted any transmissions on radio 1, so the pilot was unable to hear the Brisbane controller during this period. After landing, the pilot probably switched back to radio 1 in order to transmit to Brisbane. This would have selected radio 1 audio, allowing him to hear the Brisbane controller.

The probable sequence of radio switching in the aircraft, based on recorded audio and pilot interviews, is at Figure 1.

The pilot had 120 hours flying time on the aircraft type and was familiar with the operation of the radios.

The Aeronautical Information Publication (AIP) stated that pilots must report when changing to the CTAF when the Air Traffic Services (ATS) frequency will not, or cannot, be monitored. Although the pilot of N7088S did not report to the Brisbane controller when he changed frequencies, there was no evidence to suggest that he was aware that he would not then be monitoring the ATS frequency.

The pilot reported that he had made the required broadcasts on the CTAF while on approach. The CTAF recordings did not contain any transmissions from the pilot, and the WSO reported that he did not hear the pilot transmit on that frequency. The pilot reported that he did not hear any transmissions from the WSO prior to landing.

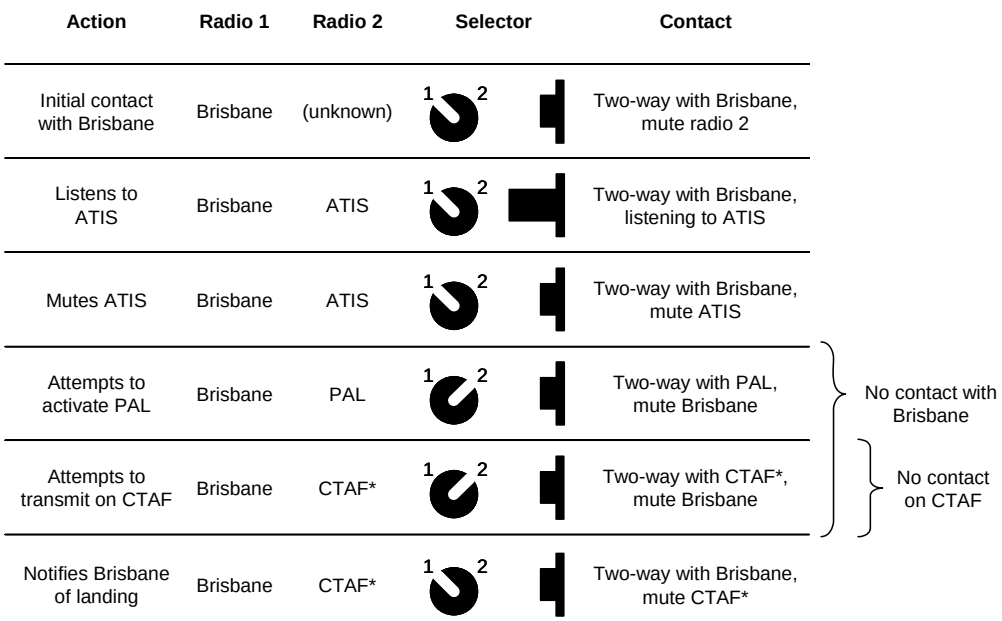
The pilot was not expecting any response to his CTAF radio broadcasts due to the low volume of traffic in the area at that time of night and he was also not expecting

an AFRU response on the CTAF due to his awareness that the AFRU was not available.

The pilot also reported that he had used radio 2 to transmit and listen on the CTAF, and that he had previously experienced intermittent failures of this radio. The pilot was able to use this radio on other frequencies prior to the attempt to use it on the CTAF. The pilot reported that the radio was working the next day and had been set to the correct CTAF.

The investigation had no reason to believe that the pilot had heard and disregarded the WSO's transmissions on the CTAF. Therefore, it seems highly likely that the aircraft radio was not operating on the CTAF. The investigation could not establish whether this was a result of a transient failure of the radio, or an error in radio selection or operation. However, based on the fact that the radio did operate after the event, it is more likely that the pilot made an error in selection when operating the radios.

Figure 1: Probable radio selection sequence



* Investigation could not establish whether the CTAF was actually selected on radio 2.

Conduct of airport works

Intermittent runway operations

The issued NOTAM included a provision for intermittent runway operations during the period when the runway would be closed. A 30 minute notification period was provided to enable the WSO to vacate personnel and equipment from the runway prior to an aircraft using the runway.

This runway activity and the associated NOTAM were not in accordance with the Method of Works Plan (MOWP), and were not subject to the level of safety analysis and approval that was required by the airport operating procedures. As a

result, the level of risk introduced by the change from MOWP procedures had not been fully evaluated.

Runway lights

It was airport policy, in accordance with the Manual of Standards (MOS), to have the runway lights off while personnel and equipment were on the runway. However, several factors contributed to the WSO's decision to leave the runway lights on while the runway was closed. The WSO was expecting another aircraft but did not know its expected time of arrival, and previous experience with runway lighting failures caused him to be concerned that the lights might not operate if they were switched OFF and then ON again. Consequently, the WSO did not comply with the airport policy.

There were a number of defences to prevent a pilot attempting to land on a closed runway, such as the ATIS and NOTAMS from a pre-flight briefing. However, the presence of runway lights at night would be a primary indicator to a pilot that a runway was available for operations. Having them lit when the associated runway was not available greatly increased the risk that a pilot would attempt to land on it in the event that one or more of the other defences failed.

Air Traffic Services

The Manual of Air Traffic Services (MATS) did not require controllers to provide information about runway availability unless requested to do so by the pilot. However, they are required to exercise their best judgement and initiative to assist pilots when the safety of an aircraft is in doubt.

The local instructions required controllers to review the NOTAMs affecting their areas of responsibility via the shift commencement NOTAM briefing list. However, the controller's pre-shift briefing did not include the entire list of NOTAMs since it had not been printed in accordance with the documented procedure.

In addition, although the controller listened to the ATIS, he had focused on the status of the PAL and did not immediately detect the advice that the runway was not available. This probably affected the controller's awareness of the status of the runway at Townsville and he would not have been aware of any reason to doubt the safety of the aircraft during this period.

Once the controller and supervisor became aware that the runway was not available, they attempted to contact the aircraft and the WSO. The controller was unable to transmit a safety alert on the CTAF as there was no facility to do so. However, this probably would not have prevented the event as the pilot was not contactable on the CTAF.

FINDINGS

From the evidence available, the following findings are made with respect to the incident involving a Raytheon Aircraft Company 390 at Townsville Airport on 4 May 2007 and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- During pre-flight planning the pilot did not read, or did not correctly interpret, the notice to airmen (NOTAM) notifying that the runway would not be available without prior notice.
- The pilot did not correctly interpret part of the automatic terminal information service recording that stated that the runway was not available.
- The Brisbane controller was not aware that the runway was not available as the operating position briefing was not printed in accordance with the local instructions and did not include a complete list of relevant NOTAMs.
- When the pilot selected the aircraft's radio 2, it is highly likely that he muted radio 1 and so was not operating on the Brisbane control frequency for a period of time.
- The aircraft's radio 2 was not operating on the common traffic advisory frequency (CTAF).
- The works safety officer could not contact the pilot on the CTAF to advise of non-availability of the runway.
- The pilot was not aware that the aircraft's radio 2 was not operating on the CTAF.
- The runway operations during the closure period and the associated NOTAM were not in accordance with the Method of Works Plan (MOWP).
- The Works Safety Officer left the runway lights on when workers and equipment were on the runway.
- The pilot landed the aircraft on the closed runway.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Action sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Airport operator

The airport operator advised that it:

- has changed procedures so that all airport related notices to airmen (NOTAM) must be approved by the operations standards manager
- uses the circumstances of this incident as part of safety officer training to reinforce policy and procedures for control of lighting during works
- will liaise with Airservices Australia for provision of an ILS remote control switch that can be operated by its safety officers and Townsville air traffic control.

Airservices Australia

Airservices Australia advised that:

- Brisbane local instructions were reviewed and changed to ensure that the printed list of NOTAMs was not truncated. Subsequently, ‘the system used at that time has since been decommissioned and briefing material is now sourced directly from NAIPS which enables downloads to process much faster. Subsequent testing has shown that it is practically impossible to open the print dialogue button before the information has fully downloaded.’

Pilot

The pilot advised that ‘the following steps have been taken to address issues that I initially identified as a result of this incident’:

- a number of warm, water proof jackets are kept in the aircraft at all times
- all planning is done on the basis that fuel is not available at major airports during peak RPT hours
- NOTAMs are kept in original condition, and not ‘crossed off’ as not applicable for the flight.