Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation – AO-2009-007
Final

Collision on ground
Townsville Aerodrome, Queensland
11 February 2009
VH-SBW
Bombardier DHC-8-315

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Abstract

On 11 February 2009 at about 1922 Eastern Standard Time, a Bombardier Inc DHC-8-315 commenced the take-off roll on runway 01 at Townsville Aerodrome for Cairns, Queensland. During the takeoff, the pilot in command realised that the aircraft was aligned with the left runway edge. The aircraft was manoeuvred to the centre of the runway and the takeoff rejected. It was later determined that the aircraft's left mainwheel had damaged a runway edge light. There were no injuries to the 34 passengers or five crew members and no damage to the aircraft.

The investigation found a number of factors that may have led to the pilot in command not aligning the aircraft on the runway centreline for the takeoff. Those factors included misinterpreting the normal runway cues, time pressure to depart, the weather conditions at Townsville Aerodrome and the associated delays during the aircraft's arrival, landing and departure.

Following this occurrence, the operator amended their operational procedures to ensure aircraft were aligned on the centreline of the assigned runway. In addition, the Australian Transport Safety Bureau (ATSB) has released an Aviation Research and Analysis Report (AR-2009-033) that examined a number of domestic and international occurrences in which pilots commenced the takeoff while aligned with the runway edge lighting. In that examination, eight common factors were identified that increased the risk of a misaligned takeoff or landing occurrence, including: the distraction or divided attention of the flight crew; a confusing runway layout; the presence of a displaced threshold or the conduct of an intersection departure; poor visibility or weather; air traffic control clearance(s) issued during runway entry; no runway centreline lighting; flight crew fatigue; and recessed runway edge lighting.

The ATSB has developed a Pilot Information Card that will alert pilots of the increased risk of a misaligned takeoff as a result of those factors, which will be distributed to relevant parts of the industry and will be available from the ATSB on request.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

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 identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, 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 initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

FACTUAL INFORMATION

History of the flight

On Wednesday 11 February 2009 at about 1922 Eastern Standard Time,[1] a Bombardier Inc DHC-8-315 (DHC8) aircraft, registered VH-SBW was lined up for takeoff on runway 01 at Townsville Aerodrome for a scheduled passenger flight to Cairns, Queensland. Soon after commencing the take-off roll, the flight crew realised that the aircraft was not aligned with the runway centreline. The pilot in command (PIC) manoeuvred the aircraft towards the centre of the runway and rejected[2] the takeoff. The aircraft exited the runway and was returned to the runway 01 threshold for departure for Cairns.

The following morning, Townsville Aerodrome ground personnel found that a frangible runway edge light had been damaged. The flight crew later reported that they were not aware that the aircraft had struck a runway edge light during the takeoff. There were no injuries to the 34 passengers or five crew members and no damage to the aircraft.

Arrival at Townsville

At 1550 that day, the crew signed on for rostered duty at Cairns that included a regular public transport flight from Cairns to Townsville and return. The flight crew consisted of the PIC, who occupied the left seat, a copilot, who occupied the right seat and a trainee first officer, who occupied the observer seat. The copilot was the pilot flying (PF) for the first sector.[3] The cabin crew consisted of two flight attendants.

The crew compiled all of the relevant briefing material, including; the current weather information, the relevant notices to airmen, and the aircraft load summaries before preparing the flight plans. The fuel uplift from Cairns was planned to be sufficient for the flight to Townsville and return, negating the need to refuel at Townsville. The departure from Cairns was delayed due to the late arrival of a connecting flight.

The pilots stated that the flight to Townsville proceeded normally until they approached the descent point, where they observed thunderstorm activity in the Townsville area. The pilots also advised that the automatic terminal information service (ATIS)[4] indicated scattered[5] cloud with a base of 1,000 ft above ground level. The visibility was greater than 10 km.

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

2 A takeoff that is aborted after having been commenced.

3 The airline had a policy of sharing the flying duties equally between the PIC and the copilot. The PIC at all times exercised the responsibilities of the pilot in command; however, the copilot could manipulate the controls and make decisions under the supervision of the PIC.

4 A continuous broadcast of recorded, non-control information in selected high activity terminal areas.

The crew decided to carry out an area navigation (RNAV) global navigation satellite system (GNSS) instrument approach to runway 19 via northern initial approach fix BTLND.[6] The crew reported encountering moderate to severe turbulence during the approach and the flap limiting speed was exceeded when the crew selected flap 15°. The PIC reported being unaware of the flap overspeed at that time.

At the approach minima[7], the PIC became visual with the approach lighting, took control of the aircraft from the copilot and attempted to land. While manoeuvring the aircraft, the PIC decided that a safe landing was not possible and carried out a missed approach.[8]

Once the aircraft had climbed to an altitude of 6,000ft, the PIC returned the flying duties to the copilot. Under air traffic control (ATC) instruction, the aircraft was manoeuvred to the initial approach fix BTLNE and a number of holding patterns flown. During that period, the weather improved at Townsville and another DHC8 commenced an approach and landed. The crew then made a second instrument approach and landed.

On the ground at Townsville

As a result of the late departure from Cairns and the additional time to carry out the instrument approaches and holding at Townsville, the flight was behind schedule. While on the ground at Townsville, a number of events further delayed the return flight to Cairns, including:

- a failure of the ATC radar system during the thunderstorm activity
- an unplanned aircraft refuelling requirement, which added to the turnaround time and crew workload
- the refueller made an incorrect selection of the Refuel/Defuel switch on the aircraft's refuelling panel that was not detected until after the engines were started - corrective action required the crew to shut down the engines, open the refuelling panel at the rear of the right engine nacelle and turn the switch OFF, and then restart the engines
- a refuelling truck in an adjacent bay left insufficient clearance to enable a safe taxi out from the bay, and the PIC decided to feather the propellers to attract the attention of the ground staff and then wait for the fuel truck to clear the area before un-feathering the propellers and taxiing from the bay.

The PIC and copilot indicated that the events prior to landing and on the ground at Townsville were quite frustrating. The PIC commented to the copilot that, 'he had reached his limit' after feathering the propellers to allow for the movement of the refuelling truck from the adjacent bay. The PIC also noted that the ground

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5 Cloud amounts are reported in oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1 to 2 oktas, scattered = 3 to 4 oktas, broken = 5 to 7 oktas and overcast = 8 oktas.

6 One of a number of initial approach fixes at the commencement of the runway 19 GNSS approach.

7 The lower limit of weather during an approach(especially visibility) for a particular aircraft and type of flight operation.

8 A standard flight procedure that is flown after an aborted approach and go-around.

controller had tried to apologise for the delay on taxi, and that the copilot had been quite terse in response.

The observer pilot recalled that the atmosphere in the aircraft was quite tense during the taxi out at Townsville, as compared to his recollection of the departure from Cairns. The PIC indicated that the observer pilot might have misinterpreted the cockpit atmosphere.

The initial takeoff for Cairns

The meteorological conditions for the night takeoff included rain and reduced visibility. The crew noted that the weather that affected their approach and landing had now moved to the vicinity of their intended departure track. The crew reported that they were focused on the weather conditions in the area and on their intended track as they taxied for takeoff. The PIC recalled that although it was raining at the time, the rain was not heavy enough to require the use of the aircraft's windscreen wipers.

The PIC instructed the copilot to request line up[9], so that they could assess the information on the aircraft's weather radar. The controller issued the crew with a clearance to 'line up and wait.' As they entered the runway, the PIC instructed the copilot to select the weather radar tilt setting to 15° nose up and to select the range to 50 miles (93 km). The crew used the weather radar to assess the thunderstorm activity along the flight-planned track and visually assessed the weather in the vicinity and along their track (the runway heading was in the general direction of Cairns).

Analysis of information from the flight data recorder showed that the aircraft entered runway 01 via taxiway Alpha 1 (A1) and lined up on or near the left runway edge lighting. The copilot reported being focused on completing the line-up drills and checks as the PIC taxied the aircraft onto the runway. The observer pilot reported being focused on the 'actions of the copilot' and did not recall looking outside as the aircraft was being lined up. When the aircraft came to a stop after lining up, both the PIC and copilot reported being focussed on the weather radar.

Once the aircraft was cleared for takeoff by the aerodrome controller, the pilots completed the relevant checklist items and the PIC applied take-off power. The recorded flight data showed that the take-off engine torque (power) settings were initially 97.1% and 98.1% for the left and right engines, before reducing to 89.7% and 89.8% respectively 6 seconds later. The normal take-off torque for a DHC8 was 92.0% and the maximum take-off torque 105.6%. The aircraft operator's procedures required the PIC to set take-off power to within 10% below the required value and then for the copilot to make the final adjustments up to the required power settings. Once the PIC set the initial take-off power, the PIC's attention turned to monitoring the aircraft's path along the runway.

Later, the PIC advised that while applying take-off power, the aircraft's path was monitored confirming that what were believed to be the runway centreline lights were ahead. The PIC recalled thinking that 'something was wrong' but continued to set take-off power and to steer the aircraft. The PIC then realised that the aircraft

[9] Normally when pilots enter the runway, they are ready for immediate takeoff. During bad weather operations, it is a common practice to request line up on the runway to study the weather radar for storm activity that could affect the flight immediately after takeoff.

was not in the centre of the runway but to the left near the runway edge lighting. The aircraft was returned to the centreline and the PIC rejected the takeoff.

The PIC exited the runway and taxied back to the runway 01 threshold for another takeoff.

One of the flight attendants stated that during the takeoff, 'they felt a couple of bumps and then a thump – like hitting a pothole'. The attendant did not consider this abnormal, as it felt similar to other takeoffs on known rough runways in the operator's network. The other flight attendant, who was seated at the rear of the aircraft, felt the aircraft 'swerve during the take-off roll, like hitting a gust of wind'.

During the taxi back to the runway 01 holding point, the flight crew discussed the incident. The copilot reported that the PIC seemed to be physically shocked at what had happened and that the copilot repeatedly queried the PIC's fitness to continue. After some consideration by the PIC, the decision was taken to continue the flight. None of the flight crew reported hearing or feeling the aircraft hit the runway edge lighting.

The PIC made an announcement over the public address system to the passengers and flight attendants about the need for a second takeoff. As this announcement did not include any specific details of the rejected take-off, cabin crew were unaware of the reason for the rejected takeoff. They believed that the rejected takeoff was handled as per the aircraft operator's procedures; however, one cabin crewmember reported thinking that they would return to the parking bay to have the aircraft inspected.

Neither the PIC nor the copilot spoke to the cabin crew following the event to brief them on what had occurred or to ask them if they had noticed anything unusual during the rejected takeoff.

The departure for Cairns

The flight later departed Townsville without further incident.

At Cairns, the PIC informed the crew that an incident report would be submitted in relation to the rejected takeoff at Townsville. Later that evening, the copilot rang the PIC and voiced a number of concerns about the flap overspeed during the approach into Townsville. The PIC advised that until that telephone conversation with the copilot, the PIC had been unaware of that incident. The PIC then reported the overspeed to the operator's duty pilot and at the same time made mention of the rejected takeoff.

Based on the information included in the operator's occurrence report, the aircraft was inspected in respect of the flap overspeed but not for any other aircraft damage. That was consistent with the operating crew not having indicated that a collision with an object may have occurred.

On the day following the incident, the company safety department made further enquiries about the incident. It was then confirmed that the crew had lined up on the left edge runway for the departure from Townsville and that a collision with a runway edge light may have occurred.

The aerodrome operator was contacted and a subsequent inspection by Townsville Aerodrome ground safety staff confirmed that a single runway edge light was

damaged on the left side of runway 01. The aircraft was then re-inspected for possible damage with none evident.

Personnel information

PIC

The PIC joined the operator in 2003 as a copilot and completed command upgrade training in October 2008. The PIC's qualifications and experience are listed at Table 1.

On the 2 days prior to the occurrence, the PIC was on rostered days off and went to bed at 2230 the night before the occurrence. At 0300, the PIC was woken by a family member requiring attention. The PIC returned to bed, then arose at 0700 and had breakfast. The PIC reported being very busy prior to commencing duty and could not remember having anything further to eat that day.

Copilot

The copilot joined the operator in May 2008 and finished training in August that year. The copilot's qualifications and experience are listed at Table 1.

The copilot awoke at 0900 on the day of the occurrence, having gone to bed at 2130 the previous evening. On the day of the occurrence, the copilot remained at home and had lunch at about 1230. A number of small snacks were consumed prior to commencing duty.

Observer pilot

The observer pilot joined the operator in July 2008 and completed the operator's crew resource management (CRM) training requirements late that month. The cyclic entry simulator session was completed by the observer pilot in January 2009. The 5-month break in training was the result of extensive training commitments by the operator.

Once the initial training recommenced, the observer pilot was to undergo a series of line observation flights prior to commencing line flying. The occurrence flight was one of those observation flights.

The observer pilot's qualifications and experience are listed in Table 1.

Table 1: Summary of experience

Qualification / experience	PIC	Copilot	Observer pilot
Licence	ATPL(A)	ATPL(A)	CPL(A)
Instrument rating	Command multi-engine	Command multi-engine	Command multi-engine
Total aeronautical experience (hours)	9,080	2,400	371.5
Total command (hours)	5,564	1,580	100.1
Total command on DHC8 (hours)	187.4	Nil	Nil
Total on the DHC8 (hours)	3,639	538.4	Nil

CRM training

The operator provided training for all flight and cabin crew in a number of areas, including in CRM. The operator's training covered general principles of CRM and included:

- communication
- teamwork
- leadership
- decision making
- situational awareness
- threat and error management
- airmanship.

The operator's training records indicated that all of the flight crew had completed the operator's CRM training. That training comprised an introductory CRM course as part of the crew's induction training, followed by exposure to the above topics over a 3-year period.

The PIC's 6 years with the operator meant that the PIC would have received all of the operator's CRM training. The other flight crew members had less than 12 months experience with the operator and had not completed training in all of the operator's general CRM principles.

Meteorological Information

Aerodrome forecasts

The Bureau of Meteorology issued an aerodrome forecast (TAF) for Townsville at 1419 on 11 February 2009 that was valid from 1600 that day until 1600 on 12 February. That forecast encompassed the aircraft's arrival time at Townsville and indicated that, at the aircraft's expected arrival time:

- the wind direction would be 360° true (T) at 12 kts
- the visibility would be 10 km or greater, with light showers of rain
- there would be few clouds with a base of 1,400 ft, scattered cloud with a base of 2,500 ft and broken cloud base of 4,000 ft

In addition, temporary (TEMPO[10]) variations in the weather were forecast from 1530 to 1230, including changes in the:

- wind to variable in direction at 20 kts, gusting to 30 kts
- visibility, reducing at times to 1,000 m in thunderstorms and rain
- cloud, which would at times include broken cloud with a base of 1,000 ft and scattered with a base of 2,500 ft that was associated with the presence of cumulonimbus cloud.

Actual weather information

At 1845, ATIS information 'November' was issued, which gave the actual weather and aerodrome information for Townsville. Information 'November' advised pilot's to expect the following:

> ...instrument approach, runway 01 wet for arrivals and departures, wind from 220° (M) at 10 kts, visibility greater than 10 km reducing to 2,000 m in rain showers, cloud broken 500 ft, broken 1,500 ft, cumulonimbus cloud at 2,500 ft, temperature 24 ^{o}C, QNH 1008 hectopascal, start clearance required, ground and clearance delivery combined on 121.8 MHz.

At 1852, ATIS information 'Oscar' was issued with the only change to the previous information being that the wind direction had changed to 030° M.

At 1905, ATIS information 'Papa' was issued, with the only change to information 'Oscar' being that start clearance requirement had been removed.

Damage and site information

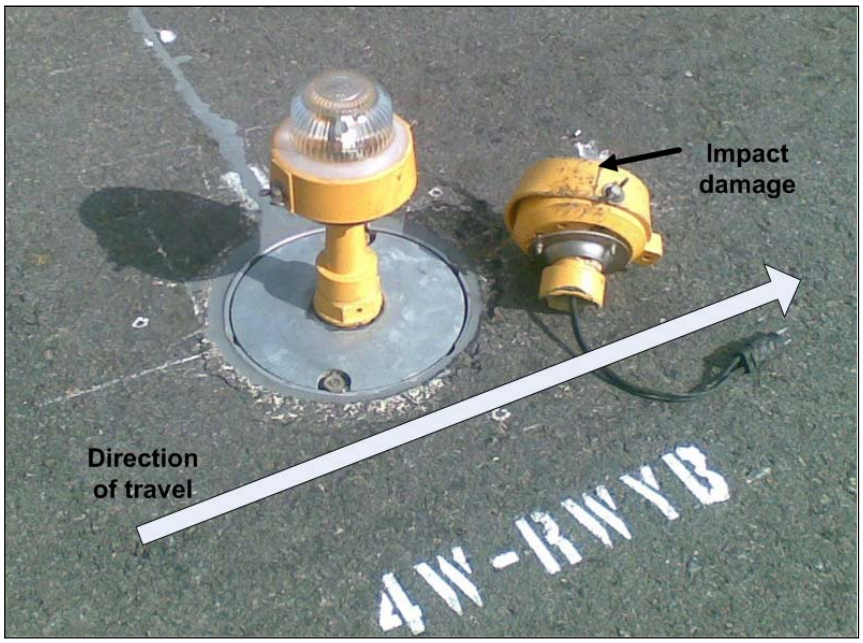
The damaged runway light was the first elevated light on the left of runway 01. Damage to the light consisted of a broken lens and a crushed upper casing. Witness marks on one side of the casing consisted of scrapings and, on the other side of the casing, tyre markings. The damage to the light was such that if the light was in its

[10] Used to indicate significant variations from the previously given mean conditions that is expected to last for periods of between 30 and 60 minutes in each instance.

correct position, the damage was parallel to and on the left runway edge side of the light fitting.

Figure 1 shows the damaged light next to an installed and serviceable unit.

Figure 1: Damaged runway light with replacement (scrape marks indicated on the damaged light)

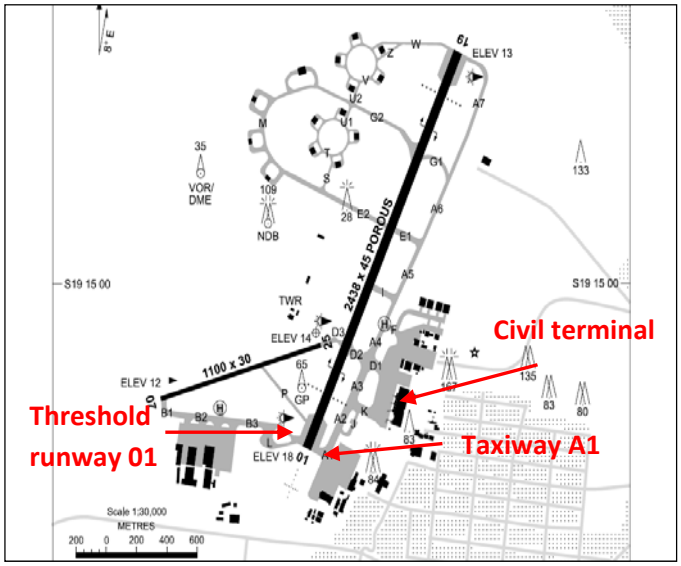


Aerodrome information

Townsville Aerodrome included the main, north to south-oriented runway 01/19 and the crossing runway 07/25 (Figure 2). Runway 01 was 8,000 ft (2,438 m) long and access from the civil terminal to the runway 01 threshold for takeoff was available via taxiway A1. Ordnance loading areas (OLA)[11] were situated either side of the runway 01 and 19 thresholds.

[11] Ordnance loading areas are areas beside the threshold of the runway where military operations deal with live ordnance in preparation for takeoff.

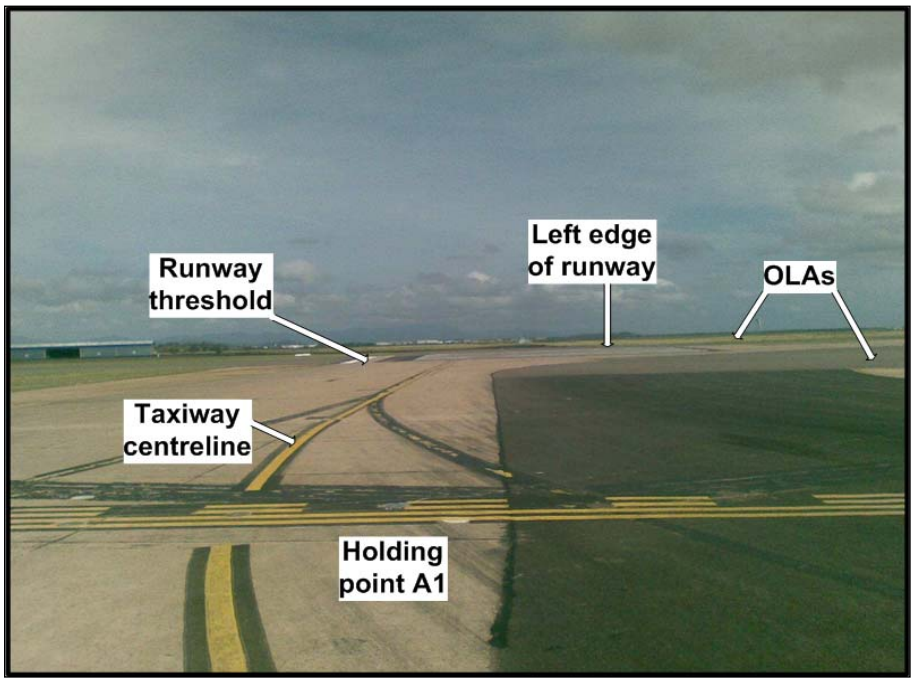
Figure 2: Townsville Aerodrome diagram



Aerodrome markings

Entry to runway 01 from taxiway A1 was marked by black and yellow lines that lead onto the runway (Figure 3). At the beginning of the runway, there was a series of black and white lines that formed the threshold marking. Those lines were spaced parallel to, and at equidistant intervals from the centre of the runway. That left a relatively larger black section in the centre of the runway threshold markings.

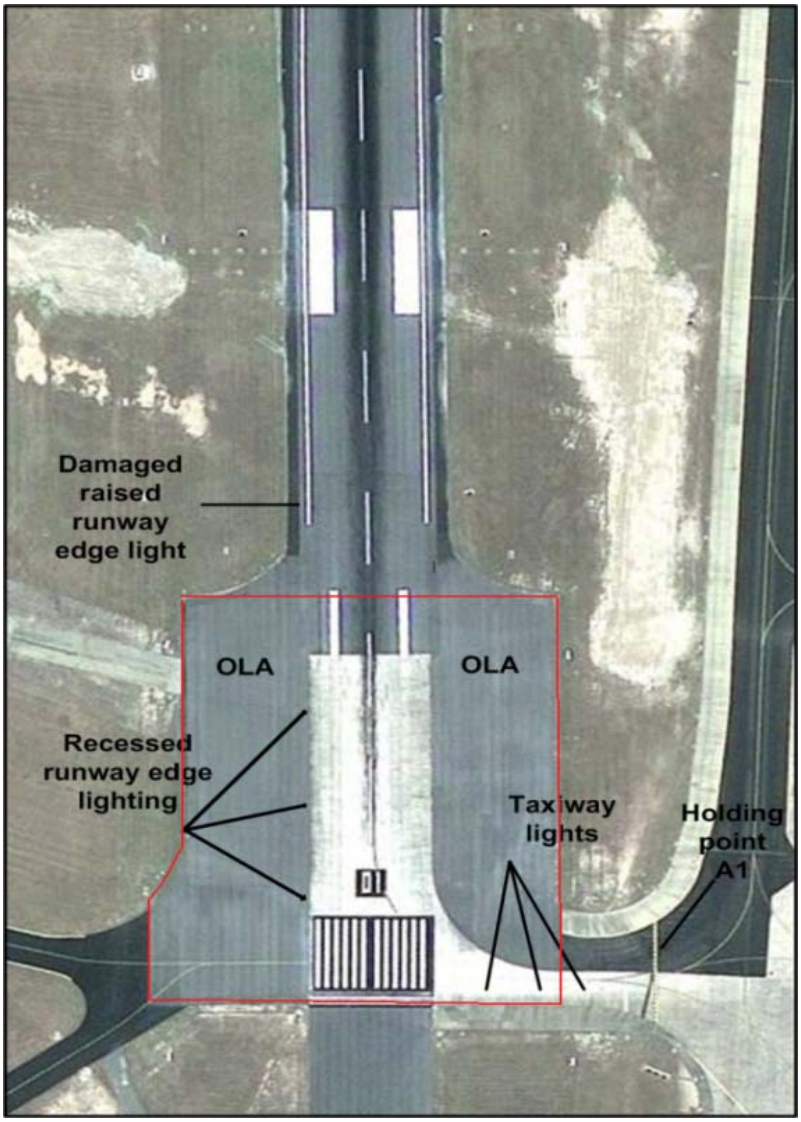
Figure 3: Taxiway A1 holding point and runway 01 entrance markings



The runway number was located further along the runway, comprising two numerals on either side of the centreline. The centreline markings commenced

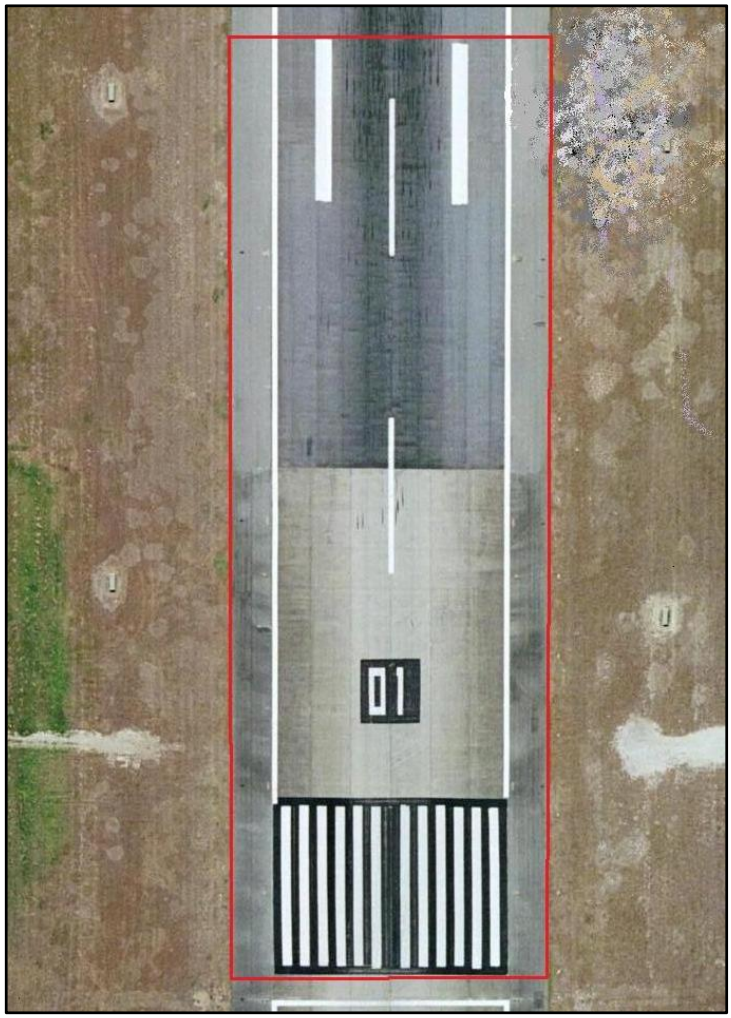
about 60 m from the runway threshold and comprised a series of dashed lines that continued the full length of the runway (Figure 4).

Figure 4: Aerial view of Townsville runway 01 (position of taxiway and runway edge lighting shown)



Civil use aerodromes do not have OLAs (Figure 5shows the Brisbane runway 01 take-off area). The surface areas between the commencement of runway 01 and the 500 ft markers at Townsville was 25,690 m², and at Brisbane 10,560 m² (Figures 4 and 5).

Figure 5: Aerial view of Brisbane runway 01



Aerodrome lighting

The lighting configuration at the junction of taxiway A1 with runway 01 included recessed green taxiway centreline lights, which commenced at the movement area and finished at the edge of the runway threshold. The holding point was annotated by three recessed orange lights (Figure 6). From the edge of the threshold to the centreline of runway 01, there were no lights to lead a pilot to the runway centreline and there was no runway centreline lighting. Instead, runway 01 employed runway edge lighting.

The runway edge lighting was spaced at 60 m intervals and the first three runway edge lights were recessed into the pavement, as both sides of the runway had OLAs that could be used by aircraft to access the runway. At the sides of these movement areas were a series of blue lights that signified the outer edges of the OLAs. The images in Figures 3 and 6 were taken from the holding point at taxiway A1 and show the view from that point during daylight and darkness.

Figure 6: Taxiway A1 holding point at night

A shows the Holding point lights, B taxiway centre line lights, C threshold lights, D runway edge lights

Recorded flight data

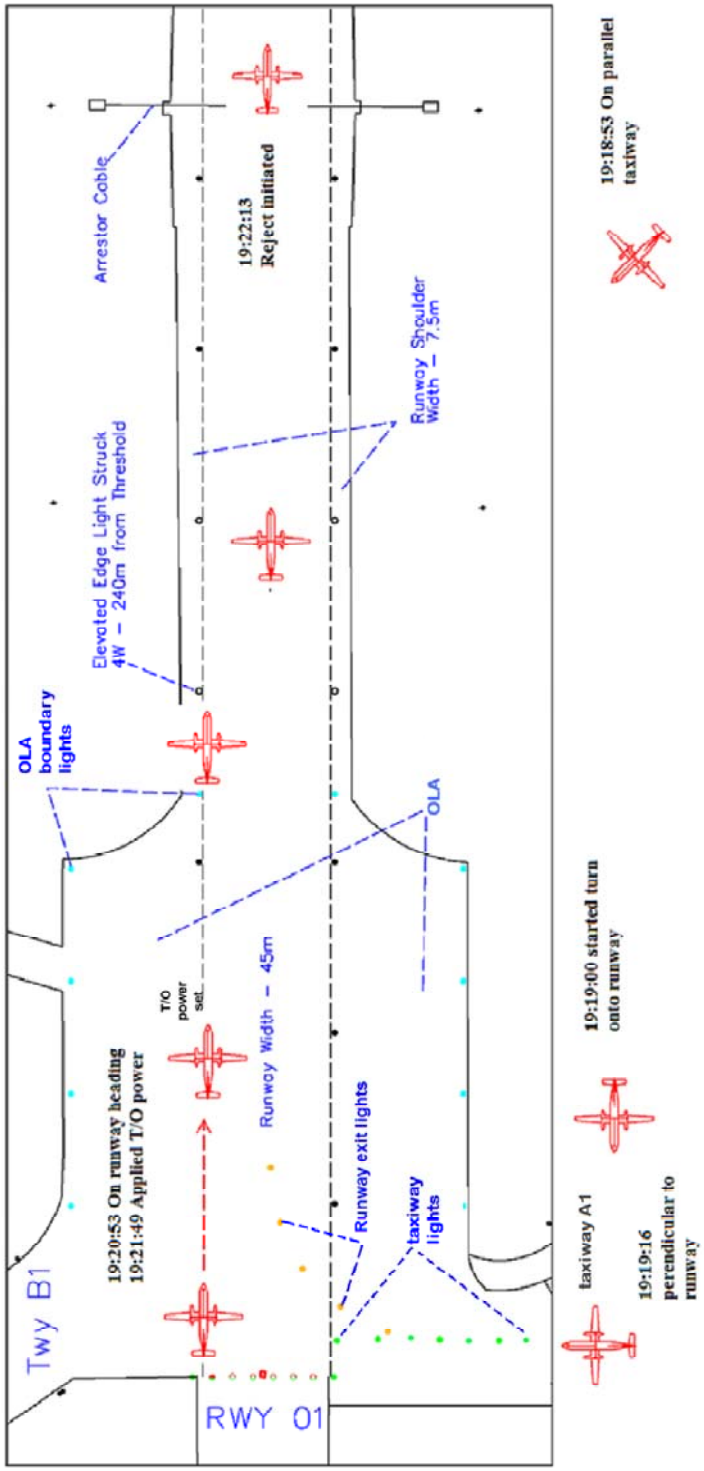
The aircraft was fitted with a digital flight data recorder (FDR) and a cockpit voice recorder (CVR). The CVR recorded on a continuous loop basis and the recorded cockpit audio for the rejected takeoff on the flight to Cairns was overwritten during subsequent flight operations.

The FDR, which contained over 25 hours of flight data was downloaded by the operator and the data provided to the Australian Transport Safety Bureau (ATSB). That data was examined and a sequence of relevant events was compiled. A timeline of events for the approaches into Townsville, the ground movements at Townsville, and for the rejected takeoff is included in Appendix A.

A representation of the aircraft's track during the rejected takeoff was derived from the FDR data and is shown in Figure 7 and 8.

Figure 7: Aircraft's track during the rejected takeoff

Figure 8: Take-off sequence until the flight crew rejected the takeoff



Organisational and management information

Operator's procedures for entering and lining up on the runway

The operators Flight Administration Manual set out in general terms the duties of the PIC and the copilot while taxiing onto a runway as follows:

> The PIC was to control and manoeuvre the aircraft safely with a secondary role to monitor the radio and aircraft systems and the co-pilot [sic] was to monitor the radio and aircraft systems with a secondary responsibility to monitor the aircraft's path

The observer pilot was to observe the conduct of the copilot's duties and to monitor the aircraft's path.

A number of procedures were required to be completed by the crew as they entered the runway in order to configure the aircraft for takeoff. However, there was no specific guidance or procedure to ensure aircraft were lined up on the centre of the runway.

Operator's refuelling procedures

The operator's refuelling procedures included the following:

> **Refuelling**
>
> **Flight Administration Manual**
>
> **5.7.12.2. Company Network Ports**
>
> Refuellers on the company network are trained and certified competent to be responsible for setting the required amount on the fuel bugs prior to refuelling and on completion, ensuring the Refuel/Defuel Master Switch is off, the Refuel/Defuel cap is fitted securely and access panel closed correctly. Delivery of the fuel docket completes this task. When refuelling is completed however, the Captain or First Officer must establish that the access panel is closed and the "*Refuelling On"* light is extinguished in the overhead annunciator panel.

The aircraft was not permitted to proceed if the 'refuelling on' light was illuminated. Before the refuelling panel could be accessed by a member of the flight crew, the engines had to be shut down.

Communication with passengers and crew during emergencies

The operator's procedures for communication between flight crew and cabin crew/passengers during emergencies included:

> **Flight crew communications with cabin crew and passengers**
>
> **Emergency Procedures – General**
>
> **1.4.3 Communication with Passengers**
>
> At the earliest opportunity passengers should be advised of any abnormality that is affecting or will affect the normal conduct of the flight. Small deviations from normal operation will be noticed by passengers, so Crew should act early to reassure passengers that any abnormality is being managed appropriately.
>
> Give a clear, succinct statement of the abnormality. Where it is considered unnecessary to give details of the problem, the expression "operational (or technical) problem with the ... " may be used. If the problem will be evident to the passengers, it should be referred to explicitly. If possible, reassure the passengers.
>
> **Abnormal Procedures – 5.2.7. Communication with Cabin Crew**
>
> As an integral part of the aircraft operating crew, Cabin Crew should be advised of any abnormality or circumstances that affect or may affect the safety or normal conduct of a flight.

Additional information

Distraction

Flight crew distraction continues to be a factor in a number of accidents and incidents and its effect is the subject of ongoing research. In 2005, the ATSB published Aviation Research Investigation Report B2004/0324 titled *Dangerous distraction: An examination of accidents and incidents involving pilot distraction in Australia between 1997 and 2004* that included the following:[12]

> **Definition of distraction**
>
> 'Distraction' is defined in the Macquarie dictionary as the act of distracting, drawing away or diverting, an action that divides attention In accordance with this, pilot distraction may be broadly defined as a process, condition or activity that takes a pilot's attention away from the task of flying. It may therefore be surmised that an effect of pilot distraction is the interruption of pilot control. Importantly though, this definition should also be conceptualised within the context of attention. Within the aviation environment, there are many secondary tasks that can divert the pilot's attention from a primary task. Some may be events or issues that must be attended to, whereas others may only be simple stimuli that require no immediate action. Even a momentary deflection from ongoing activities can have the potential to interrupt the primary task and adversely affect future performance.

[12] Available at http://www.atsb.gov.au/media/36244/distraction_report.pdf

Previous studies on pilot distraction

Dealing with distractions is a normal part of everyday flying. Pilots generally respond to distractions quickly and efficiently, interspersing novel events with habitual, well-practiced sequences of actions. As a result, the impact of distraction on performance and aviation safety generally goes unnoticed. However, a review of related empirical and scientific literature clearly indicates that pilots are vulnerable to distraction-related errors. Moreover, the literature reveals that the types of situations in which these errors arise are often complex and very diverse. In 1978, the NASA-Ames Research Centre examined more than 2000 Aviation Safety Reporting System (ASRS) reports involving incidents of distraction in air carrier operations. The findings indicated that even simple events and activities can result in pilot distraction. In addition, the findings showed that pilots were interrupted by distractions associated with (i) non-operational activities, such as public address announcements, paperwork, and social conversation, and (ii) operational tasks, such as completing checklists, air traffic control (ATC) communications, and radar monitoring

Sources of Pilot Distraction

In summary, a review of the literature found that there are only a few studies on pilot distraction. However, there were a number of key points that emerged from the literature: pilots are vulnerable to distraction; the sources of pilot distraction are diverse; distractions stem from a range of operational and non-operational tasks; and distractions can result in performance errors during both critical and non-critical phases of flight.

These findings are derived solely from studies conducted in the United States. There has been no extensive examination of aviation occurrences involving pilot distraction in Australia. Consequently, the extent of the problem in the Australian aviation industry has not been well understood.

Other occurrences

An examination of the ATSB occurrence database and other sources identified a number of similar misaligned takeoff occurrences in Australia and overseas. In Australia, there have been three occurrences between October 2007 and July 2009 where flight crew have lined up and commenced takeoff on the runway edge lighting, instead of on the runway centreline.

Of the international occurrences involving takeoffs from the edge of the runway, two were also reviewed by the investigation. Those occurrences were investigated by the United Kingdom Air Accidents Investigation Branch (UK AAIB) and the Transport Safety Board of Canada (TSB) respectively and are summarised below.

UK AAIB Bulletin: 10/2006

A summary of UK AAIB Bulletin 10/2006 follows:

> On the night of 20 January 2006, an ATR 42-300 aircraft, registered G-TAWE was being prepared for takeoff on a scheduled passenger service from Glasgow Aerodrome, U K. In preparation for takeoff, the captain initially lined up the aircraft in a position that he thought was just to the left of the runway centreline. The first officer then commented that he did not think that the 'perspective' looked quite right, so the captain taxied the aircraft to the left until it was lined up exactly over lights. The crew commenced the takeoff lined up with the left runway edge lights. However, almost immediately they were aware of increasingly loud 'bumps' from beneath the aircraft and abandoned the takeoff. Five runway edge lights were damaged.

The UK AAIB determined that the following issues contributed to the event:

> the crew were conducting an intersection departure from taxiway Quebec, which had no centreline lights as a lead-in to the runway
>
> the captain reported that there had been a heavy rain shower as the aircraft lined up on the runway and that this had distorted his vision
>
> the runway had a hard surface extending a further 23 m from each edge.

The UK Aeronautical Information Publication (AIP) contained a warning about mistaking the runway edge lights at Glascow for the centreline lights.

TSB Aviation Investigation Report AO6F0014

Transport Safety Board, Canada Aviation Investigation Report A06F0014 found that:

> On the night of 30 January 2006, an Airbus A319-114 aircraft, registered C-FYKR was being operated on a scheduled passenger service from Las Vegas, United States of America to Montreal, Canada. Shortly after commencing the takeoff, the flight crew realised that the aircraft was rolling along the runway shoulder instead of the runway centreline. Three runway edge lights were damaged.

The investigation identified various factors that contributed to the occurrence, including:

> • that the pilot flying was likely to have been relying on peripheral vision to taxi the aircraft because of the requirement to maintain separation with an aircraft departing ahead
>
> • the flight crew were conducting a rolling takeoff, which reduced the amount of time they had to conduct a visual check of their position
>
> • confusing aerodrome markings, especially taxiway lead-in lines that directed aircraft onto the runway edge lights, resulting in the misalignment of the aircraft at the beginning of the take-off roll.

United States Aviation Safety Reporting System

A review of the US Aviation Safety Reporting System (ASRS) database of occurrences in the US between January 1999 and August 2009 involving aircraft that had commenced the take-off roll while lined up on the runway edge lighting had one or more, of the following factors:

- night time operations
- the runway and taxiway environment included confusing runway entry markings or lighting, areas of additional runway pavement, an absence of runway centreline lighting, and recessed runway edge lighting.
- flight crew distraction (from within the cockpit) or inattention at the time of the occurrence
- the presence of bad weather or poor/reduced visibility
- the affected crew was conducting a displaced threshold or intersection departure
- air traffic control clearance was provided when the involved aircraft was entering the runway or still taxiing
- flight crews were fatigued.

ATSB Research Report AR-2009-033

The ATSB has recently issued a research report on misaligned takeoffs collated a number of misaligned takeoff reports. In that research, the most common factors that increased the risk of a misaligned takeoff were:

- The distraction or inattention of the flight crew. Flight crew distraction can occur when multiple stimuli or tasks make simultaneous demands for attention. In general, distraction results when a competing stimuli or task interferes with or diverts attention from the flight crew member's original task or focus. Such instances can include having to deal with an unusual event or problem and the out-of-sequence conduct of checklist items; for example, during the line-up phase.
- A confusing runway layout. The layout of taxiways and runways and the area around the runway entry and beyond the runway's edge were important determinants in flight crew confusion when lining up. Erroneous visual signals were possible from areas of additional pavement around the taxiway entry and runway threshold areas, and runways of greater width can cause pilots to believe they are on the runway centreline when they are actually aligned with the runway edge.
- The presence of a displaced threshold or the conduct of an intersection departure. A displaced threshold deprives the fight crew of important visual cues normally associated with the threshold, such as the runway number and 'piano keys'. The absence of runway centreline lighting could make it less obvious to a flight crew that they are aligned with the runway edge lighting. That is also the case with intersection departures, where the lack of any specific runway identification or threshold markings reduces the availability of visual cues for application by the pilot.
- Poor visibility or weather. Poor visibility can reduce the available visual cues during line up. In addition, any rain can, if heavy enough obscure the runway

markings during the crucial line-up phase. Any degradation or obstruction of the painted taxiway markings or runway lighting can have a similar effect.

- The timing of the issue of air traffic control clearances. In cases where the issue of air traffic control clearances was a factor in flight crew lining up on the runway edge lighting, those clearances were issued at a time where they distracted the flight crew from their original task or focus.
- A lack of runway centreline lighting. If a runway does not have centreline lighting, it may be less evident to a flight crew that they are (inadvertently) lined up on the runway edge lighting.
- Flight crew fatigue. Flight crew fatigue includes physical, mental and task-related elements and can be due to sleep deprivation, circadian disruption or excessive activity. When compared to well-rested people, sleep-deprived people think and act more slowly, have a higher mistake rate and experience difficulty with memory.
- Recessed runway edge lighting. Recessed lighting, particularly where aircraft enter a runway has been shown in US studies to be a factor in cases of incorrect line ups. When present, centreline runway lights are recessed to allow aircraft passage. Therefore, recessed runway edge lighting, particularly at a taxiway/runway intersection can incorrectly confirm for a flight crew that they have lined up on the runway centreline.

For further information on those events, see ATSB Research Report AR-2009-033 *Factors influencing misaligned take-off occurrences at night*, which is available for download at http://www.atsb.gov.au/media/1573990/ar2009033.pdf

ANALYSIS

A number of the factors in the development of this occurrence were consistent with the common factors in misaligned takeoffs that were identified in the Australian Transport Safety Bureau research report titled *Factors influencing misaligned take-off occurrences at night*, and by similar overseas investigations and research reports. Given the lack of evidence that the functionality of the aircraft and its systems, or that the air traffic control service or navigation facilities contributed to the event, this analysis will examine a number of the common factors in misaligned takeoffs as they applied to this occurrence. In addition, a number of crew resource management and operator issues will be discussed.

Events before departure

The delayed arrival at Townsville would have combined with the crew's pre and after start frustrations to elevate the crew's level of stress prior to the taxi for Cairns. The observations by the flight crew that they had reached their limit and of the tenseness on the flight deck, was consistent with the impact of that stress on their performance. The extent to which that may have distracted the crew during the subsequent taxi could not be determined.

More distracting during the taxi was the need to manage the adverse weather affecting their departure track. That preoccupation continued during the entry onto the runway, and was exacerbated when the pilot in command (PIC) directed the copilot to adjust the aircraft's weather radar. As a result, the copilot was unable to fulfil the secondary duty of monitoring the aircraft's path onto the runway. Given the observer pilot's priority of observing the copilot's duties, and report of not actually monitoring the aircraft's path at that time, the PIC was the only defence against a misaligned line up. Any consideration of the departure weather by the PIC at that time would have diverted the PIC's attention from lining up with the runway centreline.

Although the take-off power that was set by the PIC did not exceed the maximum value allowed, it was higher than required by the operator's procedures. That would appear to reinforce that the PIC was distracted or pre-occupied with other matters at that time.

Aerodrome facilities and conditions

The dark and wet conditions would have diminished the contrast between the taxiway and movement area line markings, increasing the flight crew's reliance on the aerodrome lighting for guidance.

The cessation of the recessed taxiway centreline lighting at the runway threshold would have combined with the relatively large size of the combined runway/ordnance loading areas (OLAs) to make it difficult for the flight crew to discern the runway edge. It would appear that the extent of the unlit runway/left OLA combined with the sequence of initially recessed runway edge lighting to convince the PIC, who at that stage was the only crew member monitoring the aircraft's path, that the aircraft was lined up with the runway centreline. Any

involvement of the PIC in the management of the weather radar would have increased the likelihood for that to have occurred.

The PIC's remark that 'he knew something was not right but not sure what' was consistent with an interrupted scan of the aircraft's path onto the runway, and with there being insufficient cues to alert him of the aircraft's position once lined up. The provision of operator procedures to assist crews to line up on the runway centreline, particularly in the case of low visibility, night operations would minimise the risk of misaligned takeoffs.

Flight crew performance

The action by the PIC to not advise the passengers and cabin crew of the reason for the rejected takeoff was inconsistent with the operator's requirements and meant that the PIC could not assure himself that the misaligned takeoff had been of no consequence. If the cabin crew had been advised of the reason for the rejected takeoff, they may have communicated its effect in the rear of the aircraft. Crew resource management encapsulates seeking and providing relevant information to allow the continued safe operation of the aircraft. A more 'team' approach to the consideration of the misaligned and then rejected takeoff would have ensured a full consideration of the implications for continued flight of the collision with the runway edge lights.

FINDINGS

From the evidence available, the following findings are made with respect to the collision with the runway light that occurred at Townsville Aerodrome, Queensland on 11 February 2009 and involved Bombardier Inc DHC-8-315 aircraft, registered VH-SBW and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The flight crew were distracted by the need to manage the weather conditions on their departure track.
- The runway line-up occurred at night and in reduced visibility, diminishing the contrast between the taxiway and ordnance loading area line markings and increasing the crew's reliance on the available runway lighting.
- The pilot in command did not line the aircraft up on the runway centreline.
- The copilot did not monitor the aircraft's taxi path

Other safety factors

- The pilot in command did not fully advise the passengers and cabin crew of the reason for the rejected takeoff.
- The operator did not have procedures to assist the crew to ensure that the aircraft was lined up on the runway centreline in preparation for takeoff. *[Minor safety issue]*
- The performance of the crew was likely to have been adversely affected by stress associated with prevailing weather conditions during the inbound flight, delays from weather and refuelling before departure and crew experience levels.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions 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.

Aircraft operator

Line-up procedures in preparation for takeoff

Minor safety issue

The operator did not have procedures to assist the crew to ensure that the aircraft was lined up on the runway centreline in preparation for takeoff.

Action taken by aircraft operator

The aircraft operator advised that as a result of this occurrence:

> The operator's Safety Systems Manager recommended:
>
> • that, due to the potential consequences of the event, all involved aircrew undergo retraining in the specific safety management subjects of Reporting Requirements, TEM, human factors, and CRM; and
>
> • that the Flight Crew additionally undergo simulator and line training.

and that:

> [The operator's] Operational procedures were amended, as follows:
>
> • incorporated a centre-line confirmation procedure by the First Officer prior to commencing the take-off roll;
>
> • expanded the policy contained in the company manuals for runway verification prior to take-off;
>
> • additional text was added to the Airport and Runway Data Manuals emphasising crew awareness of operational readiness platforms, and
>
> • circumstances where no centreline lighting exists; and
>
> • a training module was incorporated into a simulator cyclic session to focus the attention of crews on the importance of ensuring that the aircraft is on the centreline prior to take-off.

ATSB assessment of response/action

The ATSB is satisfied that the action taken by the operator adequately addresses the safety issue.

ATSB safety action

Following three misaligned take-off occurrences during the period from 2007 to 2009, the ATSB commenced a research investigation to examine each of the occurrences and a number of similar international occurrences to identify the factors associated with misaligned take-off and landing incidents.

On 30 June 2010, the ASTB issued Research Report AR-2009-033 titled *Factors influencing misaligned take-off occurrences at night*. That report is available for download at http://www.atsb.gov.au/media/1573990/ar2009033.pdf

APPENDIX A: REJECTED TAKEOFF TIMINGS

Time (EST)	Event
1748:25	Top of descent
1757:25	Passed 3,500 ft at about northern initial approach fix BTLND
1758:32	Flap overspeed
1801:40	Go-around commenced
1821:40	Passed 6,000 ft at initial approach fix BTLNE
1829:13	Landed
1832:19	Shut down
1905:09	Start engines
1908:13	Engine shut down
1914:37	Start engines
1918:10	Moved off the blocks
1918:53	On the parallel taxiway
1919:00	Commenced the turn onto runway 01
1919:16	Aircraft perpendicular to runway 01
1920:53	Aircraft aligned on runway heading
1921:49	Application of take-off power
1921:58	Engine No 2 torque setting (92%) for a 6-second period. 43 kts computed airspeed (CAS)
1921:59	No 1 engine torque setting (92%) for a 6-second period, 48 kts CAS.
1922:01	Max torque setting
1922:13	Rejected take-off initiated at 105 kts CAS
1922:44	Turn to exit runway 01 commenced

APPENDIX B: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- the flight crew of VH-SBW (SBW)
- Townsville air traffic control
- the operator of SBW
- the aerodrome operator.

References

Batelle Memorial Institute (1998), *An Overview of the Scientific Literature Concerning Fatigue, Sleep, and the Circadian Cycle*, FAA

Broadbent, D. E. (1953). *Perception and communication.* New York: Pergamon Press.

Mohler, S. R. (1966). Fatigue in aviation activities. *Aerospace Medicine*, 37, 722-732.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the flight crew and operator of SBW, the cabin crew of SBW, the Civil Aviation Safety Authority (CASA), the aerodrome operator and the aerodrome controller.

Submissions were received from the flight crew, the operator and CASA. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.