Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation
AO-2010-008
Final

Turbulence event
Canberra Aerodrome, ACT
31 January 2010
VH-ERP
Grumman Traveller AA-5

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Abstract

On 31 January 2010, an American Aircraft Corporation Grumman Traveller AA-5 aircraft, registered VH-ERP, was being operated on a visual flight rules private flight from Temora, New South Wales to Canberra, Australian Capital Territory. At about 1630 Eastern Daylight-saving Time, on late final approach to runway 12 at Canberra Aerodrome, and at an altitude of about 150 ft above ground level, the aircraft experienced severe turbulence that resulted in a brief loss of control. The pilot recovered control and landed on runway 12.

The investigation determined that it was probable that the severe turbulence was generated by a combination of the wind conditions on the day and the position of the two buildings located about 220 m and 290 m upwind from runway 12. In addition, there were no standard criteria for assessing the potential local wind effect of aerodrome building developments on aviation operations, and no national building codes for aerodrome developments that address the phenomena of building-induced turbulence.

The aerodrome operator had commissioned pre-construction wind impact assessments of the two buildings to the north of runway 12. These reports concluded that the buildings would not result in adverse wind effects on aircraft operations. This conclusion was based in part on the assessment that use of runway 12 was unlikely in northerly wind conditions. However, operations to that runway remained possible in those conditions without any alert to affected pilots about possible risk. By contrast the Canberra Aerodrome information in the En Route Supplement Australia alerted pilots of the possibility of severe turbulence during touchdown on runway 35 in strong westerly winds.

Subsequent to this occurrence, the Department of Infrastructure, Transport, Regional Development and Local Government established the National Airports Safety Advisory Group (NASAG). NASAG's role is to examine airport planning issues, including the potential local wind effects of buildings on aircraft operations, and to develop a set of universal guidelines and policy material for application at state and local levels. In addition, Airservices Australia is progressing the installation of wind shear detection technologies at several aerodromes. There is the potential that one of those installations could be at Canberra Aerodrome.

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 identify

cation 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 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 31 January 2010, an American Aircraft Corporation Grumman Traveller AA-5 aircraft, registered VH-ERP (ERP), was being operated under the visual flight rules on a private flight from Temora, New South Wales to Canberra Aerodrome, Australian Capital Territory (ACT).

Runway 35 was in use for the aircraft's arrival at Canberra Aerodrome, and the wind was from 020° magnetic[1] (M) at 10 kts. As there were other aircraft ahead of ERP in the sequence to use runway 35, and air traffic control considered runway 12 as being suitable, the aerodrome controller offered the pilot the option of landing on runway 12 (Figure 1). The pilot accepted runway 12 as the crosswind component[2] of around 10 kts was within the aircraft's operating limitations.

The pilot reported that, at about 1630 EDT[3], just past the runway 12 threshold markings on approach to runway 12 and at an altitude of about 150 ft above ground level (AGL), the aircraft encountered severe turbulence[4], which resulted in an uncommanded roll to the right of about 60° from the horizontal. The pilot's rapid input of full left aileron[5] restored control and the aircraft landed on runway 12, slightly past the marked touchdown zone.

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1 Degrees Magnetic (M) uses the traditional compass indicating local horizontal direction of the Earth's magnetic field.

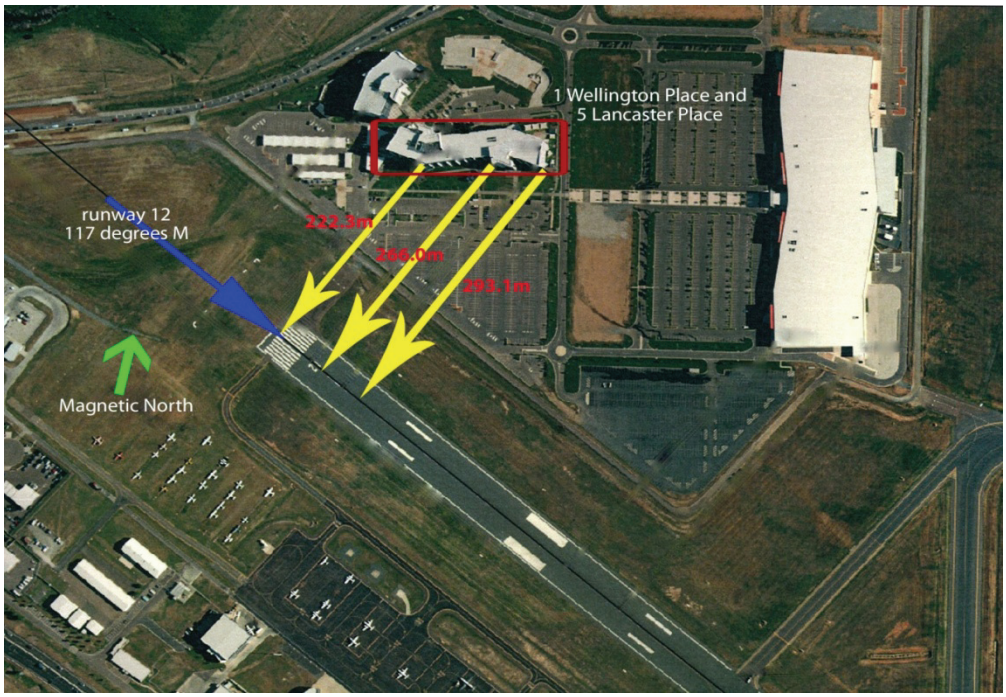
2 The surface wind component at right angles to the runway 12 centreline.

3 The 24-hour clock is used in this report to describe the local time of day, Eastern Daylight-saving Time (EDT), as particular events occurred. Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.

4 Turbulence occurs when airflow becomes chaotic and apparently random rather than smooth and laminar. It occurs as eddies of varying size and intensity travel as vortices in the general airflow before dissipating due to friction.

5 An aircraft control surface, traditionally hinged to the outer wing, forming part of the trailing edge of the wing, providing control about the longitudinal axis.

Figure 1: Aerial view of runway 12 and Majura Park



Personnel information

The experienced owner/pilot had regularly operated to runway 12 at Canberra Aerodrome prior to 2008, and recommenced operations at the aerodrome a few days prior to the occurrence.

Meteorological information

The conditions at the aerodrome were suitable for visual flight. Automatic terminal information service (ATIS)[6] 'Juliet' was current for the arrival and accessed by the pilot. Information Juliet indicated a wind from 020° M at 10 kts, and an ambient temperature of 30 °C. There was no indication in the ATIS of any turbulence affecting the aerodrome at that time, including as a result of thermal activity associated with the ambient temperature.

Automatic terminal information service Kilo was recorded 15 minutes after the occurrence, with no change to the wind conditions or duty runway.

Aerodrome information

Canberra Aerodrome was leased to the aerodrome operator by the Commonwealth in May 1998 and was located in the Majura Valley, about 8 km east of Canberra city. The main runway, runway 17/35 was 3,283 m long and aligned approximately north-to-south. Runway 12/30 was 1,679 m long and aligned south-east to north-west. The magnetic heading of runway 12 was 117° M.

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[6] A continuous broadcast of recorded non-control information in selected terminal areas. Successive ATIS recordings are identified by the next letter of the phonetic alphabet.

The En Route Supplement Australia (ERSA) runway usage data for runway 12 indicated regular light aircraft movements to that runway. Aircraft movement statistics for the 6-month period from 1 August 2009 to 31 January 2010 inclusive indicated that there were 779 aircraft movements to or from runway 12 during that time.

Buildings near the runway 12 threshold

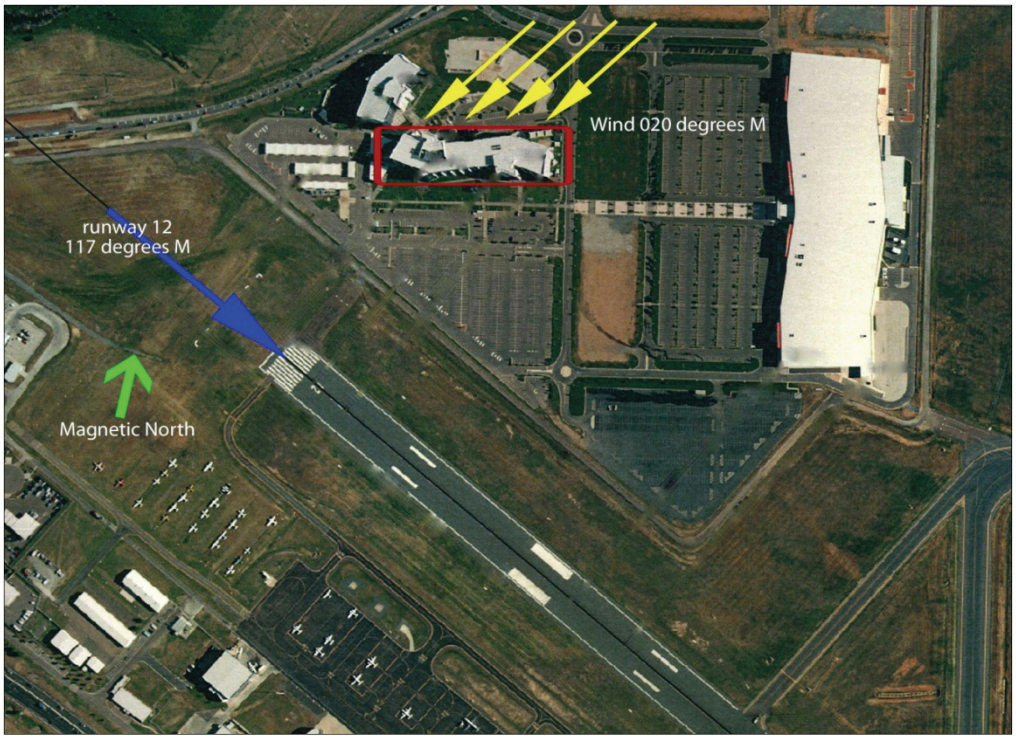
The two buildings adjacent and to the north of the runway 12 threshold were of five storeys, and were completed in April 2008 (Figures 2 and 3).

Figure 2: The Majura Park precinct

Figure 3: Ground-based view of the adjacent buildings from the southern side of runway 12

The buildings were 20 to 25 m in height and located between 222.3 m and 293.1 m from the approach and threshold areas of runway 12 (Figure 1). The position of the buildings was such that a large surface area faced directly into any north to north-north-easterly winds, interrupting the wind flow over the approach and landing areas of runway 12 (Figure 4).

Figure 4: Wind flow direction diagram



Effect of obstructions on wind flow and aviation operations

The Bureau of Meteorology (BoM) *Manual of Aviation Meteorology (2nd Edition)* provides meteorological information that meets the needs of pilots, air traffic controllers, flight planners, and those interested in meteorology from an aviation perspective. The manual states that any obstruction to the wind flow at the time, including by buildings and trees would produce disturbed air, manifested as wind shear[7] and mechanical turbulence[8].

An examination of the conditions during the occurrence, and their possible effect on the aircraft's approach and landing on runway 12 was requested from the BoM. In its report, the BoM advised that barriers to wind flow have the potential to induce downstream turbulent conditions that can be particularly hazardous to low-flying aircraft. Turbulence induces in-flight bumpiness without necessarily influencing an aircraft's flight path significantly, unless of extreme intensity. The intensity of any turbulence is specified by the BoM according to the perceived effect upon aircraft and occupants, and is classified as being 'light', 'moderate', 'severe' or 'extreme'.

While light to moderate turbulence may make flight uncomfortable, severe turbulence could cause an aircraft to roll and pitch violently and may lead to a loss of control.

The combination of surface winds and obstacles to the wind flow that are situated upwind of an approach or departure path, such as large buildings, low hills or close-planted stands of tall trees, can create localised areas of low-level windshear.[9] The effect of those upwind obstacles on the wind flow depends on a number of factors, the most important being the speed of the wind and its orientation relative to the obstacle, and the size of the obstacle in relation to the runway dimensions.

The most commonly encountered windshear and turbulence of this type, particularly at smaller aerodromes, is that caused by buildings in the vicinity of a runway. The height of any buildings is regulated in proportion to their distance from the edge of the relevant runway strip to ensure that they do not constitute an obstacle to aircraft during takeoff and landing (see the subsequent discussion titled *Requirements for leased federal aerodromes*). The lateral dimensions of aerodrome buildings tend to be large and, for commercial and many other reasons the buildings may be grouped together in the same area. This means that while aerodrome buildings (including commercial buildings, passenger terminals, hangars and multi-storey car parks) are of comparatively low height, they present a wide and solid barrier to the surface wind flow.

In such circumstances, the wind flow is diverted around and over the buildings causing the surface wind to vary along the runway (Figure 5). Horizontal windshear, which is normally very localised, shallow and turbulent, is of particular concern to light aircraft but has also been known to affect larger aircraft. In the case of low-flying aircraft, any significant eddies and gusts experienced during takeoff and landing may place an aircraft in a dangerous and possibly irrecoverable situation.

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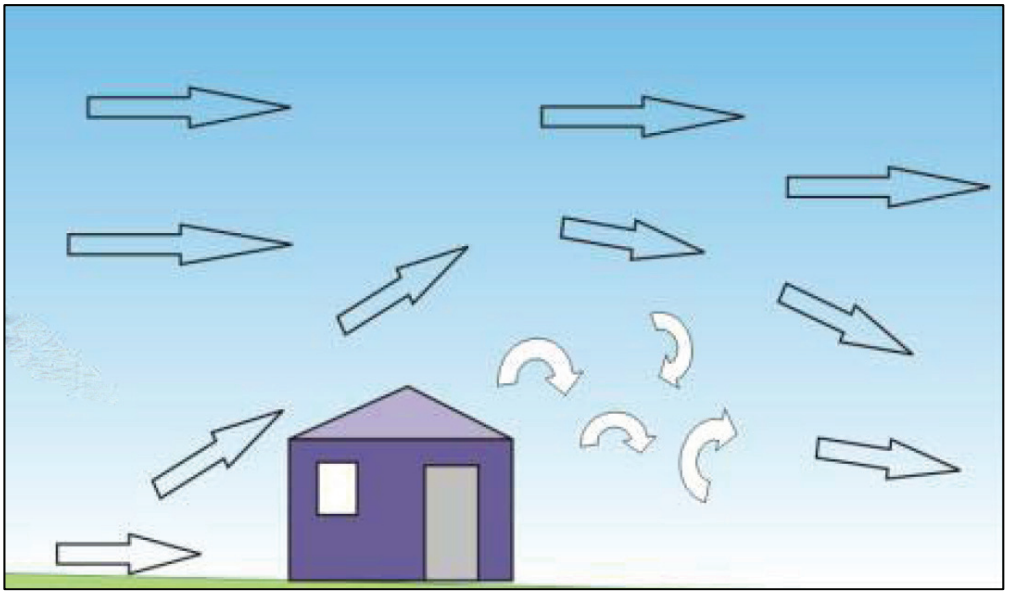
[7] A sudden change of wind velocity in either the horizontal or vertical planes of the atmosphere, or a mixture of both.

[8] Disrupted air flow caused by frictional interference.

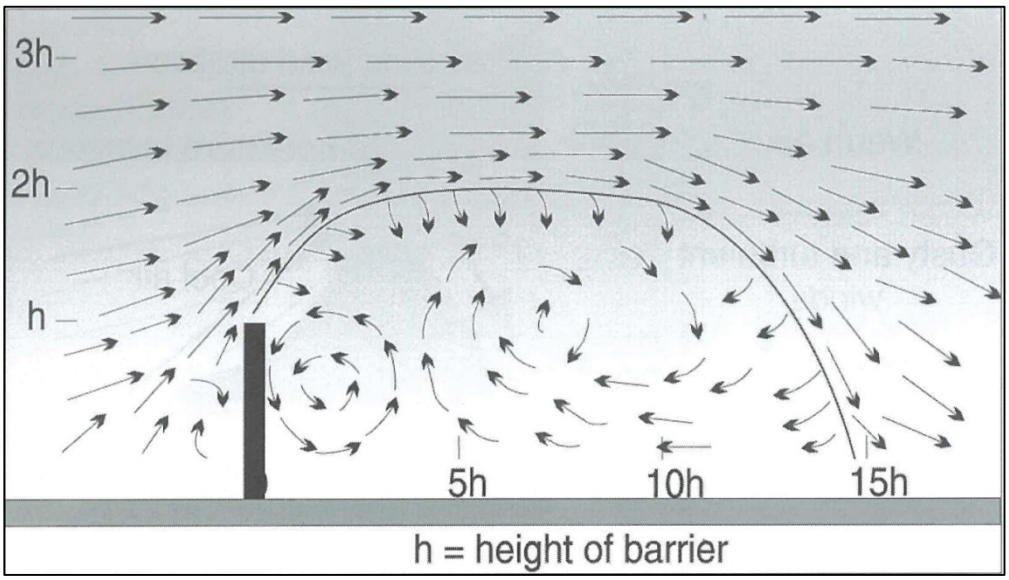
[9] ICAO (2005). *Manual on Low-level Wind Shear* (1st ed.) (Doc 9817-AN/449). Montreal, Canada. International Civil Aviation Organization.

Figure 5: Wind flow disturbance



In its report into the conditions that affected the aircraft's arrival, the BoM estimated that for smaller impermeable barriers, such as trees and buildings, it has been estimated that turbulence occurs up to about twice the height of the barrier vertically, and an equivalent distance downwind of up to 15 times the height of the barrier (Figure 6).

Figure 6: Airflow near a solid (impermeable) crosswind barrier[10]



[10] Not to scale.

Wind impact assessment criteria for aerodrome developments

At the time of the occurrence, Australian Standard: AS/NZS 1170.2 *Structural design actions – Part 2: wind actions*, proposed a number of wind-related requirements for use in the structural design of buildings but did not address building-generated wind turbulence. There was no wind-engineering criterion for use in the assessment of the potential wind-related impact on adjacent aircraft operations of upstream developments.

Majura Park buildings wind impact studies

In 2007, the aerodrome operator commissioned two independent wind impact studies in respect of the planned developments in Majura Park. There was no legislated requirement for those studies, which were instigated to understand the potential effect of the development, including the five storey buildings north of the threshold of runway 12. Both assessments were desktop studies and were based on the criterion that building turbulence could occur an equivalent distance downwind of up to 10 times the height of the building. The studies noted that under that criterion, the buildings were close to being located at a critical distance from runway 12, but that it was unlikely that the runway would be used in northerly wind conditions, and that '...north and north-east sector winds...are relatively moderate'. Overall, the studies concluded that aircraft operations should not be affected.

The aerodrome operator provided the results of the wind impact studies to Airservices Australia, the Civil Aviation Safety Authority (CASA) and the then Department of Infrastructure, Transport, Regional Development and Local Government (DITRDLG) – subsequently re-named the Department of Infrastructure and Transport (DoIT)).

Organisational and management information

Requirements for leased federal aerodromes

Australia's federal aerodromes were privatised between 1997 and 2003 by selling long-term leases over the affected sites to private sector operators. Leased aerodromes were regulated under the Commonwealth *Airports Act 1996* (the Airports Act). Planning and development on federal aerodromes is regulated under Commonwealth law, and not subject to state/territory or local government planning and building laws.

DITRDLG advised the Australian Government on the policy and regulatory framework affecting Australian aerodromes and the aviation industry, and managed the administration of the Government's interests in privatised aerodromes under the Airports Act.

Part 12 of the Airports Act, together with the Airports (Protection of Airspace) Regulations 1996, established the framework for the protection of airspace at and around Canberra and other federal aerodromes via the production of current and future Obstacle Limitation Surface (OLS) and Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) surfaces. The PANS-OPS established

minimum clearances between aircraft approach and departure paths that were not to be infringed in any circumstances.[11]

The Majura Park buildings were located outside of the defined OLS and PANS-OPS surface respectively.

The requirements of aerodromes that were used in air transport operations were prescribed in Civil Aviation Safety Regulation (CASR) Part 139 – *Aerodromes*, and the supporting Manual of Standards (MOS). CASR Part 139 stipulated that the construction of any facilities at or in the vicinity of an aerodrome should minimise the effect on aircraft operations of reflection, glare and external lighting. In addition, CASR Part 139.365 specified that any proposed structure that exceeded 110 m AGL must be referred to CASA for assessment, and could be subject to conditions of approval.

The consideration of the potential impact of aerodrome building developments on the local wind affecting aircraft operations was not stated in Part 139. During CASA's regular aerodrome auditing program, there was no published requirement for CASA to review the wind/turbulence-related impact of building developments on aircraft operations.

Building development approval process

An Airport Building Controller (ABC) was appointed by DITRDLG tender at each leased federal airport. The ABC was responsible for ensuring that activities at leased airports met the appropriate building and engineering standards.

In addition, the ABC administered and advised airport operators on building control issues, as contained in the Airports (Building Control) Regulations 1996. There was no reference in those regulations to wind impact considerations; however, in 2003 DITRDLG issued an advisory notice to all ABCs stating that the potential for building-induced wind shear and turbulence was to be considered for all new aerodrome building developments.

The Airports Act defined Canberra Aerodrome as a 'core regulated airport'. As a result, all privatised development applications for the aerodrome were to be consistent with the aerodrome's master plan, which was itself required to be revised and updated every 5 years. Where significant development was contemplated, a major development plan (MDP) was necessary. MDPs were subject to a 90-day public consultation period.

The development of Majura Park was in all of the Canberra Aerodrome master plans that had been approved since the aerodrome's privatisation. That included the most recent 2009 master plan, which was approved by the then Minister for DITRDLG in August 2009.

No MDPs were required in respect of the two five storey buildings in the Majura Precinct (Figure 1).

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[11] A more complete explanation of the application of PANS-Ops to aerodrome development and obstacle clearances is available at Hhttp://www.atsb.gov.au/media/1370134/ai2008038.pdfH

Aerodrome safety management systems

Under CASR 139.250, all Certified Aerodromes[12] were required to have a Safety Management System (SMS) in place that complied with the supporting MOS. MOS Part 139– highlighted the importance of ongoing hazard identification and reporting as an essential component of a successful SMS. Guidance material published by CASA further stated that an aerodrome operator's SMS should include a formal risk assessment program that identifies the hazards at their aerodrome. CASA has indicated that the potential for building-induced turbulence from new and existing developments was a hazard that could be expected to be addressed by a certified aerodrome operator's SMS.

Canberra Aerodrome was a certified aerodrome and had an SMS in place that encompassed hazard, incident and accident reporting, and included regular safety committee meetings. Those meetings were attended by a number of operators and aviation agencies. No wind-related hazards or incidents relating to building-induced turbulence were reported at the safety committee meetings or recorded in the aerodrome operator's SMS since its commencement in January 2007.

Australian Government National Aviation Policy White Paper

On 16 December 2009, the Australian Government published *The National Aviation Policy White Paper*. In that paper, the Government stated:

> ...the Government's position is that the primary purpose of the federal leased airports is aviation. The Government accepts that the federal airports will continue to identify opportunities for non-aeronautical land use and commercial developments on airport sites. However these alternative uses should not be allowed to compromise or constrain the ability of an airport to undertake its core aviation business. A non-aeronautical development will only be consistent with the airport planning framework where it places no unnecessary restriction on aviation at the airport.

and that:

> Better integration of on- and off-airport planning regimes will enhance transparency and give the community, developers and all stakeholders' greater understanding of airport development plans and related approval processes.

That could be expected to include clearer guidance to reduce the risk of inappropriate aerodrome development.

At the time of the release of this report, there were no criteria in Australia for assessing the wind impact of aerodrome building developments on aircraft operations, or national building codes that addressed the risk of building-induced turbulence at Australian aerodromes.

International considerations

The hazardous nature of low-level wind shear is considered by the International Civil Aviation Organization (ICAO) to be one of the major technical problems facing aviation. In response, ICAO developed the Manual of Low-level Wind

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[12] Aerodromes for which the operators have been granted a certificate by CASA under CASR 139.050.

Shear, the aim of which was, in part to work towards the development of international Standards and Recommended Practices for observing, reporting and forecasting wind shear. The Manual did not include any standards in respect of the assessment of potential wind impact from aerodrome building developments.

Despite the lack of international standards and practices, at Schiphol Airport in the Netherlands, any assessment of the potential risks posed by new buildings encroaching on the aerodrome included the need for wind impact modelling for all new developments. Those assessments applied a downwind distance criterion of 35 times the height of the proposed structure.

Operations near aerodromes

The Civil Aviation Regulation 92 *Use of Aerodromes* stated that:

> (1) A person must not land an aircraft on, or engage in conduct that causes an aircraft to take off from, a place that does not satisfy one or more of the following requirements:
>
> (a) the place is an aerodrome established under the Air Navigation Regulations;
>
> (b) the use of the place as an aerodrome is authorised by a certificate granted, or registration, under Part 139 of CASR;
>
> (c) the place is an aerodrome for which an arrangement under section 20 of the Act is in force and the use of the aerodrome by aircraft engaged in civil air navigation is authorised by CASA under that section;
>
> (d) the place (not being a place referred to in paragraph (a), (b) or (c)) is suitable for use as an aerodrome for the purposes of the landing and taking off of aircraft; and
>
> having regard to all the circumstances of the proposed landing or take off (including the prevailing weather conditions), the aircraft can land at, or take off from, the place in safety.

This places responsibility on a pilot to consider aircraft performance in the prevailing conditions in order to ensure that the aerodrome is suitable for the pilot's operation.

Additional information

Industry forums

There were a number of forums through which the aviation industry could raise and discuss related issues, including reporting issues directly to an aerodrome operator. Those forums included the Regional Airspace and Procedures Advisory Committees (RAPACs) and the Australian Aviation Associations Forum (AAAF).

Regional Airspace and Procedures Advisory Committee meetings

The RAPACs were primarily state-based forums for discussing airspace matters and related procedures, more specifically in each RAPAC's area of concern. Membership was open to all significant airspace users through their major industry associations/organisations or independently.

Concerns relative to the construction of the Majura Park development were raised by the local industry convenor at ACT RAPAC meetings in 2005. Those concerns related to the potential for turbulence during landing on runway 12, particularly during the summer months.

At the ACT RAPAC meeting of 29 March 2007, the convenor suggested that there needed to be a national audit on the effect of airport developments on aircraft operations, as a number of aircraft were reporting problems. Those problems were reported to include turbulence generated by new airport developments. The meeting was advised by the aerodrome operator that it was expected government agencies such as CASA and Airservices Australia (Airservices) would be part of the process, and would comment on the likely effects of any development prior to construction.

The March 2007 ACT RAPAC meeting minutes recorded that:

> No conclusion was reached regarding the issue raised by [the convenor].

Australian Aviation Associations Forum

The AAAF involved aviation groups representing sectors of the industry ranging from agricultural and recreational pilots, to engineers and airlines. As a result of this occurrence, the AAAF endorsed the view that all new on-airport buildings should be subject to an 'aerodynamic impact' study before any building approval was given.

Previous occurrences

The *Transport Safety Investigation Regulations 2003* detailed the type of aviation event that should be reported to the Australian Transport Safety Bureau (ATSB). In respect of aircraft operations other than air transport operations (such as might use runway 12 at Canberra aerodrome), those types of events included:

> ...an occurrence that results in difficulty controlling the aircraft, including any of the following occurrences:
>
> - a weather phenomenon...

A search of the ATSB occurrence database found eight turbulence-related occurrences since 2002 that involved aircraft operating to or from Canberra Aerodrome. The aerodrome development to the west of the threshold of runway 35 was in-place during that period and the Majura Park developments to the north of runway 12 were in-place from late 2007 to early 2008. Of those occurrences, one involved an aircraft operating to runway 12 on 13 December 2009, when the pilot reported that:[13]

> A moment after landing a 27 knot gust from the left picked the left wing up over a metre higher. This caused the aircraft to pivot on right and nose gear causing the right propeller to strike the surface.

Apart from the above pilot report, none of the remaining reports had sufficient detail on the wind speed and direction at the time to determine whether or not building-induced turbulence was a factor. The occurrences included military and civilian operations, including regular public transport and training aircraft.

In addition, in early 2009 a local flight-training operator reviewed its standard operating procedures as a consequence of several similar turbulence incidents experienced by their instructors and trainee pilots. As a result of that review, the operator imposed the following limitations on operations to runway 12:

- no solo flights were to be undertaken when the crosswind exceeded 8 kts
- a modified landing profile was to be used in which pilots were to land further along the runway, beyond the touchdown zone and the area identified by the operator as being affected by building-induced turbulence and wind shear.

In 2002, ATSB investigation 200205179 examined a turbulence event during landing by a Boeing 737-476 aircraft on runway 35 at Canberra Aerodrome.[14] The report stated in part that:

> At about 6 ft radio altitude, the aircraft suddenly rolled left to a left wing low attitude of about 6 degrees, and the pilot in command rapidly applied right control wheel input to arrest the roll to the left. The aircraft landed about one second later in a slightly right wing low attitude. The landing was completed without further incident, and there were no reported injuries to any of the 34 occupants of the aircraft. The pilot in command subsequently reported that the turbulence encountered during the landing flare appeared to have resulted from a hangar located adjacent to, and to the west of, the touchdown zone of runway 35.

The report found that it was probable that the prevailing wind conditions at the time resulted in turbulent downwind eddies from the hangar. The aerodrome operator requested Airservices to include a caution note in the Canberra Aerodrome information in ERSA. That entry remained in ERSA at the time of this occurrence.

There was no similar turbulence caution in ERSA for operations to/from runway 12.

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[13] The pilot reported that the wind at the time was 090° M at 27 kts.

[14] Available on the ATSB website at Hwww.atsb.gov.au

ANALYSIS

Wind impact assessment criteria

The aerodrome operator conducted two wind assessments prior to the development to the north of runway 12 at Canberra Aerodrome to assess the potential wind-related impact of the construction. Those assessments discounted the likelihood of operations to runway 12 with northerly winds, so that no risk to such operations from that development was identified.

There are a large number of variables that determine the wind-impact of a development, including building shielding and profile, terrain, vegetation and other developments. This may require the coordination of on- and off-aerodrome development activity at some locations, as developments outside the vicinity of an aerodrome may cause wind flow disturbances to aircraft operations, either directly or through changed wind actions at on-aerodrome buildings and facilities. The specific location and orientation of development activity, in relation to critical points on the runway, also requires consideration.

Without specific wind-impact criteria for application to the consideration of aerodrome development, attempts by aerodrome operators to assess the possible impact of building-induced turbulence will be inconsistent. Wind-impact criteria would, if available also serve as a benchmark for understanding the potential impact of future developments at different locations. The increased availability of such guidance was foreshadowed by the Government in its National Aviation Policy White Paper (White Paper).

Aerodrome development oversight

The safety of aviation activities is a critical consideration in the development and continued operation of aerodromes and the Government's White Paper recognises the primacy of aircraft operations. Building-induced turbulence has been identified as a probable contributing safety factor in a number of incidents involving both military and civil operations since 2002.

The determination that runway 12 at Canberra Aerodrome was, at its closest point to the planned development, close to the wind assessments' critical turbulence distance of 250 m could normally be expected to result in the development of appropriate risk controls. As already indicated, the consultant wind assessments that were commissioned by the aerodrome operator assumed that aircraft would not operate to runway 12 in northerly winds, so that risk controls were not considered for application in those conditions. As with the response to the previously-identified possibility of wind-induced turbulence affecting the threshold of runway 35 during westerly winds, the notification to pilots of the possibility of turbulence when using runway 12 in northerly winds could represent an appropriate risk control in the light of the occurrence under investigation.

The position of the buildings to the north of runway 12, with a large surface area facing directly into the north to north-north-easterly winds, created a large wind barrier adjacent to the critical approach and landing areas of the runway. Application of the Bureau of Meteorology building turbulence criteria to the

buildings to the north of runway 12 indicated that any turbulence generated may have extended up to about 164 ft above ground level and 375 m towards the runway. The location of the buildings between 222.3 m and 293.1 m from the runway centreline meant that the approach, threshold and touchdown areas of runway 12 were at risk of northerly wind-induced turbulence.

The investigation considered the possibility of thermal activity as a contributing factor to the turbulence event. However, the previously reported similar occurrences on runway 12 in northerly wind conditions, the pilot's familiarity with operations to that runway and the nature of the turbulence experienced, and the airfield information at the time indicated that it was highly unlikely that thermal activity was a contributing factor.

The investigation concluded that the north-north-easterly wind at the time of the occurrence, and the development to the north of runway 12 probably combined to produce building-induced turbulence on approach to the runway.

Industry awareness

Aerodrome operators, aerodrome controllers (ADC) and pilots require an ongoing awareness of the wind impact risks associated with intervening terrain, vegetation and buildings in the vicinity of an aerodrome. The wind direction, orientation of the runway and nature of the nearby terrain and surrounding obstacles are critical aspects in the nomination by ADCs, and acceptance for use by pilots of a particular runway.

Similarly, aerodrome operators need to beware of and address the potential wind impact on aircraft operations when considering improvements to their aerodrome. The application of the hazard identification and risk management components of the affected aerodrome's safety management system to all new and existing building developments and other aerodrome enhancements, would represent a valid tool in that consideration. The design and construction of on- and off-aerodrome developments to eliminate wind-related hazards offers the most reliable risk control.

FINDINGS

From the evidence available, the following findings are made with respect to the turbulence event involving Grumman Traveller AA-5 aircraft, registered VH-ERP, that occurred at Canberra Aerodrome, Australian Capital Territory on 31 January 2010, and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- Two buildings were constructed north of the runway 12 threshold at a height and position that could generate turbulence affecting the approach, threshold and touchdown areas of the runway under some wind conditions. *[Minor safety issue]*
- The north-north-easterly wind at the time of the occurrence, and the development to the north of runway 12 probably combined to produce building-induced turbulence on approach to the runway.
- The consideration of the potential wind impact of the two buildings to the north of runway 12 assumed that aircraft would not operate to runway 12 in northerly winds, so that risk controls were not considered for application in those conditions. *[Minor safety issue]*
- There were no criteria for assessing the potential wind impact of aerodrome building developments on aircraft operations. *[Significant safety issue]*

Other key findings

- The pilot's experience and familiarity with the aircraft assisted with the recovery of control and safe landing.

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.

Department of Infrastructure, Transport, Regional Development and Local Government

Australian aerodrome planning and guidance criteria

Significant safety issue

There were no criteria for assessing the potential wind impact of aerodrome building developments on aircraft operations.

Action taken by the Department of Infrastructure, Transport, Regional Development and Local Government

The Department of Infrastructure, Transport, Regional Development and Local Government (subsequently re-named the Department of Infrastructure and Transport (DoIT)) has established the National Airports Safety Advisory Group (NASAG). In respect of the composition and work of that group, DoIT has advised that:

> NASAG is made up of senior officials from the Planning Departments of States and Territories, the Australian Local Government Association, senior officials from some Transport Departments, Airservices Australia, CASA and DoIT. NASAG was established to provide advice to Governments on the establishment of a national safeguarding framework.

and that:

> Following agreement by NASAG, the Department, in close consultation with CASA, has engaged an independent firm with expertise in wind engineering to develop guidance material for airports and off-airport planning authorities on the potential windshear and mechanical turbulence effects of new constructions near runways. This work will include:
>
> (a) a review of relevant ICAO guidance material and existing research and approaches to assess world's leading practice;
>
> (b) the establishment of criterion/ criteria which would trigger a detailed assessment of

the potential for building-generated turbulence and windshear to affect the safety of operations at airports;

(c) guidance on the design and positioning of structures in relation to runways to minimise effects on aircraft operations; and

(d) guidance on other options to mitigate building generated turbulence and windshear for existing structures where safety risks are identified.

This work is expected to be completed by the first quarter of 2011.

ATSB assessment of action

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

Canberra Airport Pty Ltd

Buildings dimensions and location

Minor safety issue

Two buildings were constructed north of the runway 12 threshold at a height and position that could generate turbulence affecting the approach, threshold and touchdown areas of the runway under some wind conditions.

Limited consideration of potential wind impact

Minor safety issue

The consideration of the potential wind impact of the two buildings to the north of runway 12 assumed that aircraft would not operate to runway 12 in northerly winds, so that risk controls were not considered for application in those conditions.

Action taken by Canberra Airport Pty Ltd

In response to this occurrence, Canberra Airport Pty Ltd has advised that it proposes:

- the continued commissioning of wind impact studies for future developments; and
- that Canberra Airport will discuss with operators at the Airport the use of runway 12, whether there have been any other turbulent events, and assess their views on what action should be taken, if any, to maintain safety in the use of the runway.

ATSB assessment of action

The ATSB acknowledges the action taken by Canberra Airport to addresses these safety issues. However, there is the potential for the inclusion of an entry in the En Route Supplement Australia, similar to that affecting aircraft operations to runway 35 at Canberra during strong westerly winds, to alert pilots of the possibility of turbulence during operations on runway 12 in north-easterly winds.

It may be that, after the planned discussions between Canberra Airport Pty Ltd and the operators at the airport, such action might be considered an appropriate safety response to that risk.

Airservices Australia

Minor safety issue

The consideration of the potential wind impact of the two buildings to the north of runway 12 assumed that aircraft would not operate to runway 12 in northerly winds, so that risk controls were not considered for application in those conditions.

Action taken by Airservices Australia

In response to this occurrence, Airservices Australia (Airservices) advised:

> Current procedures state, upon receipt of a pilot report and/or a forecast of moderate, strong or sever wind shear, alert all arriving and departing aircraft by ATIS broadcast, and directed transmission where the aircraft is not in receipt of the ATIS information. When aware of the presence of significant wind shear, nominate a more favourable runway, if available, and provide the appropriate flight information. Given that no previous reports had been received, before the occurrence, Airservices was unable to provide this consideration and implement the alerting system.
>
> Finally, as no standards exist for assessing the potential wind impact of aerodrome building developments in conjunction with the actual wind direction and speed, Airservices is not in a position to accurately predict where and when mechanical turbulence will be experienced on approach to Runway 12.

and that:

> On a broader note, and not directly related to this particular incident Airservices is now progressing the installation of wind shear detection technologies at several key airports. One of the candidate airports is Canberra. The acquisition of the most suitable technology and the scheduling of installation are still being determined.

ATSB assessment of action

The ATSB acknowledges that Airservices is presently reliant on pilot reports of windshear and associated turbulence, and the likely future advantages of the installation of wind shear detection equipment at a number of Australian aerodromes. However, there is the potential for the inclusion of an entry in the En Route Supplement Australia, similar to that affecting aircraft operations to runway 35 at Canberra during strong westerly winds, to alert pilots of the possibility of turbulence on landing on runway 12 in north-easterly winds. Such action would forewarn pilots of that risk, prior to it having effect and then being reported to Airservices for inclusion in a subsequent automatic terminal information service broadcast.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of information

The sources of information during the investigation included:

- the pilot of VH-ERP (ERP)
- Canberra Airport Pty Ltd
- a flight training school that operated at Canberra Aerodrome
- the Regional Aviation Association of Australia
- the Department of Infrastructure, Transport, Regional Development and Local Government (DITRDLG – subsequently re-named the Department of Infrastructure and Transport (DoIT))
- the Directorate of Defence Aviation and Air Force Safety (DDAAFS)
- the Civil Aviation Safety Authority (CASA)
- Airservices Australia (Airservices)
- the Bureau of Meteorology (BoM)
- the wind-impact consultants that examined the potential effect of the planned development to the north of the threshold of runway 12
- the National Aerospace Laboratory (Netherlands).

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, 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 pilot of ERP, the aerodrome operator, the two wind-impact consultants, DDAAFS, Airservices, BoM, CASA and DoIT.

Submissions were received from the pilot of ERP, the aerodrome operator, Airservices, CASA, DoIT and BoM. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Turbulence event - Canberra Aerodrome, ACT
31 January 2010
VH-ERP, Grumman Traveller AA-5