Australian Government
Australian Transport Safety Bureau

Canopy-related landing accident involving Lancair Legacy, VH-ALP

Geraldton Airport, Western Australia | 18 September 2013

Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
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Source: Cover photo supplied by Geraldton Airport

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Addendum

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Safety summary

What happened

On 18 September 2013, the pilot of an amateur-built Lancair Legacy aircraft, registered VH-ALP, was taking off from runway 32 at Geraldton Airport, Western Australia. Late in the take-off roll the canopy came open – the pilot continued the take-off and manoeuvred at low level for a landing. During the approach the aircraft undershot the runway, touched down across a road then collided with the airport perimeter fence and caught fire. The aircraft was destroyed and the pilot sustained injuries that were later fatal.

Taxiing for take-off

Source: Geraldton Airport

What the ATSB found

The ATSB found that the pilot conducted the take-off with the canopy down but inadvertently unlatched. As the aircraft accelerated the aerodynamic loads on the canopy increased and resulted in it suddenly lifting up to a partially open position. The pilot did not reject the take-off and during the subsequent manoeuvring for landing, likely encountered control, performance and forward visibility difficulties associated with the open canopy. This adversely affected the pilot's capacity to conduct a normal approach.

Safety message

The ATSB advises owners, operators and pilots of aircraft with canopies to review the adequacy of their existing measures that are intended to ensure canopies are securely latched before flight (such as pre-take-off checks and warning systems), and the actions in case of inadvertent canopy opening during take-off.

Where possible in abnormal situations, pilots should take time to assess the nature of the abnormality to rectify the situation or mitigate the effects.

Contents

The occurrence

On 18 September 2013, the pilot of an amateur-built Lancair Legacy aircraft, registered VH-ALP, was intending to conduct a private/business flight from Geraldton to Newman, Western Australia. At 1545 Western Standard Time[1] the pilot was taxiing at Geraldton Airport for runway 32, an 884 m sealed strip. The canopy was down and the air conditioner was probably on (Figure 1). Local weather was overcast cloud down to as low as 2,500 ft above ground level with rain showers in the area. The surface wind was from the south-west at around 10 kt.

Figure 1: Airport camera image of the aircraft during taxi

Source: Geraldton Airport (edited by ATSB)

The pilot began the take-off roll with substantial engine power and the aircraft was observed to accelerate normally to about halfway along the runway. At this point, smoke from the main wheels indicated that the brakes were applied momentarily, and at about the same time the forward-hinged canopy opened about 15 to 30 cm. No change to engine power was evident and the take-off roll continued.

The aircraft lifted off with runway to spare and climbed to about 100–150 ft above ground level. The pilot then banked the aircraft to the left and during the turn the canopy opened further so that it was at an estimated angle of 30°. Various people on the ground saw the aircraft flying low and fast with the canopy open.

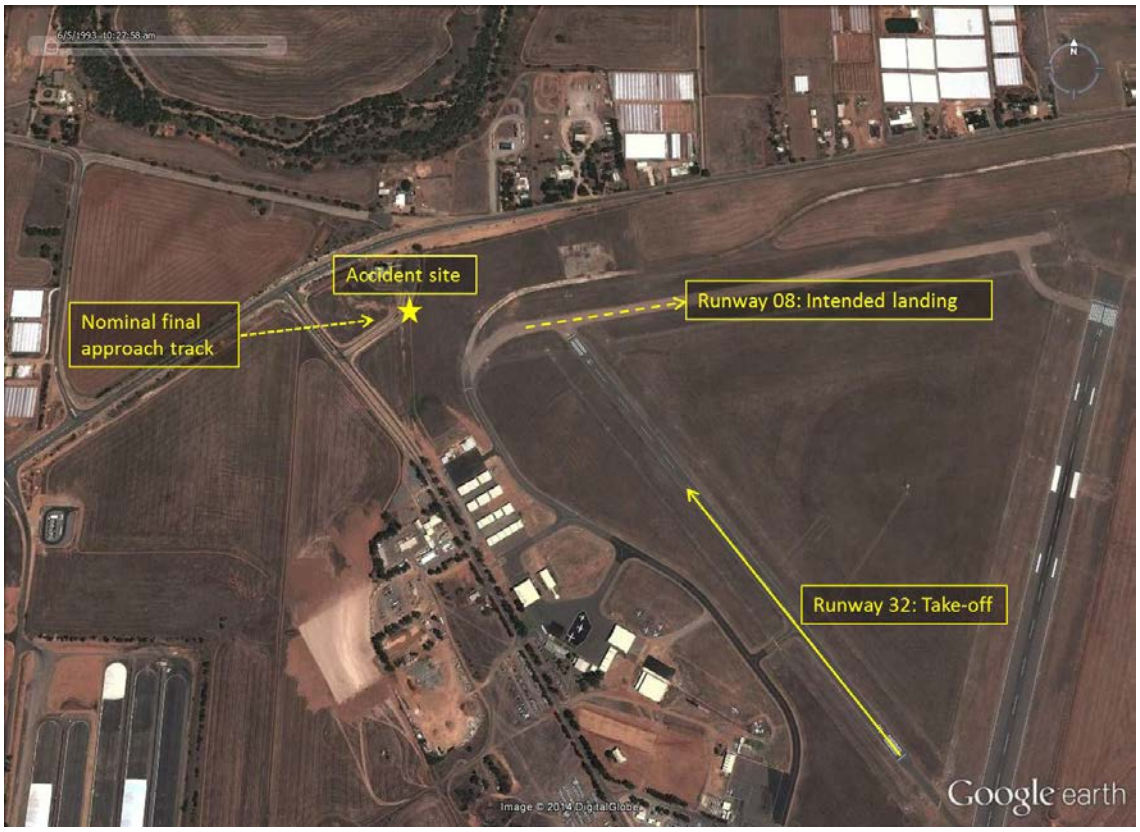
The pilot appeared to be manoeuvring for a landing on runway 08 but the aircraft undershot the approach and the wheels hit a road kerb short of the airport perimeter (Figure 2). The aircraft then collided with the perimeter fence and became entangled as it overturned. Shortly after, an intense fire engulfed the aircraft.

Bystanders tried to extinguish the fire with handheld fire extinguishers and a water truck from a nearby worksite but were unable to have immediate effect. The pilot was rescued from the wreckage and treated for burns, but later succumbed to his injuries.

[1] Western Standard Time was Coordinated Universal Time (UTC) +8 hours.

No airport fire and rescue service was provided at Geraldton Airport and under the extant regulations there was no requirement for such a service.

Figure 2: Geraldton Airport



Source: Google Earth (annotated by ATSB)

Context

Aircraft information

The Legacy was designed by Lancair International in the United States as a high-performance aircraft with a composite (carbon fibre or fibreglass) fuselage and wing skins. Lancair International produced kits as the basis for individuals to build their own aircraft.

The aircraft involved in this occurrence was built in the United States by the first owner who completed the build in 2002. The owner obtained a certificate of airworthiness and operated the aircraft in the United States for 250 hours.

In 2010 the owner-builder sold the aircraft to a company associated with the pilot involved in this occurrence. The aircraft was disassembled and shipped to Australia where it was reassembled by the builder and inspected by an authorised person. A special certificate of airworthiness was issued in August 2010 to allow operation in Australia in the experimental airworthiness designation. The new owner operated the aircraft for about 300 hours until the occurrence.

The aircraft was being maintained by a CASA-approved maintenance organisation, which referenced Schedule 5 of the *Civil Aviation Regulations 1988* and a generic inspection schedule produced by the kit manufacturer. Both schedules contained items relating to inspection of the canopy and associated hardware.

The last periodic inspection was carried out in November 2012 at 508 hours total time in service. The canopy inspection items were annotated as completed and no defects were noted. A maintenance release was issued at the time and, though it was not found in the wreckage, it was probably still valid. The most recent maintenance was on the day of accident when a broken rod end on the right inboard main landing gear door was replaced. There were no reports of any canopy problems.

Canopy information

The Legacy was designed with a canopy as the means of occupant entry and exit. It comprised a plexiglass windscreen moulded in an aerodynamic shape and secured in a composite frame. The frame was made to fit closely to the contours of the fuselage when the canopy was down, with little visible difference between the latched and unlatched positions.

At the front of the canopy, two hinges connected the canopy to the fuselage and allowed rotation through an arc of 50° from the down position (Figure 3). Gas struts connected to the hinges provided mechanical assistance to open the canopy but due to the geometry of the design had no effect when the canopy was down.

Figure 3: Exemplar Lancair Legacy with fully open canopy – latching pawls in circled area

Source: ATSB

With the canopy sitting in the down position, the pilot was able to mechanically latch it by operating a handle located between the seat backs (Figure 4). When the handle was in the upper OPEN position the latching pawls mounted in the fuselage were retracted. When the handle was moved to the lower CLOSED position, the mechanism extended the pawls forward to engage with the canopy frame. In that latched position, the actuating mechanism was designed to be positively over-centre and resisted any movement. This action was supplemented by a spring that provided resistance to movement of the canopy handle from the closed or open position, whichever was selected.

The ATSB examined an intact Lancair Legacy as an exemplar and found that the canopy latching mechanism of that aircraft was rigged according to the kit manufacturer's instructions. When the canopy handle was placed in the OPEN or CLOSED position it was spring-loaded to maintain the selected position. Some force was required to move the handle up from the closed position.

Figure 4: Exemplar Lancair Legacy canopy latching handle in closed (latched) position

Source: ATSB

While the Lancair Legacy kit did not include any canopy position warning system, the owner-builder of the exemplar aircraft had elected to fit such a system. This incorporated a switch actuated by the canopy in the closed (latched) position and a switch actuated by the operating handle in the latched position. Non-actuation of either switch activated a door warning light on the instrument panel. Notably, the aircraft involved in this occurrence was not equipped with any canopy position warning system and nor was it required to be.

The Lancair Legacy pilot's operating handbook contained emergency procedures for an unlatched canopy in flight. If a latch became disengaged from the locked position the published advice was to, '… slow the aircraft to approximately 85 kt and attempt to relock. If unable to lock, land as soon as practical.'

As was typical for Lancair Legacy aircraft, the builder of VH-ALP had fitted an inflatable canopy seal. When activated with the canopy down (latched or unlatched), the inflatable seal had a tendency to hold the canopy in place.

Accident site and wreckage information

The aircraft touched down across the road on an easterly heading, about 10 m outside the airport perimeter fence and 200 m from the threshold of runway 08 (Figure 5). The aircraft then collided with the perimeter fence and overturned. Fire broke out during the accident sequence and consumed most of the aircraft.

Figure 5: View along accident trail towards wreckage

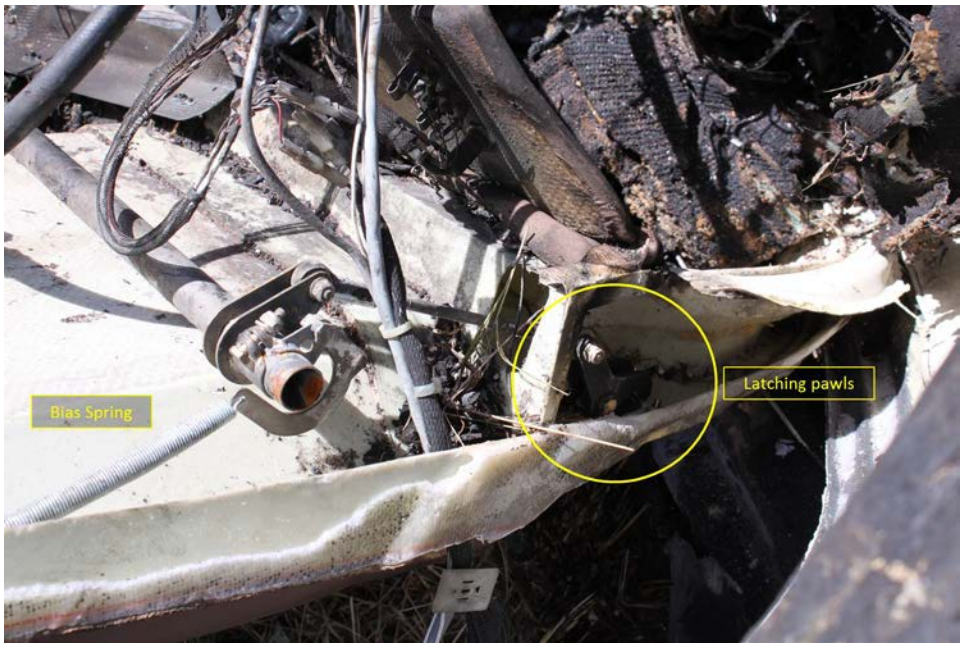
Source: ATSB

The ATSB examined the wreckage and found the landing gear in the extended position and the wing flap selector in the UP setting. Fire damage precluded a determination of the physical position of the wing flaps. The aircraft's wing-mounted speed brakes were retracted.

The canopy was found in a partially open position and securely attached to the fuselage by the forward hinges. A large amount of plexiglass was missing from the canopy and a number of fragments were found in the debris field. On the rear of the canopy, the latching engagement components were relatively intact and showed no indication of damage other than that wrought by the fire.

In the fuselage behind the seats the structure had disintegrated and disrupted the arrangement of the canopy latching mechanism. That precluded the derivation of any useful information about the canopy handle position and mechanism rigging. The latching mechanism was examined and found to have all of the rods connected with bias spring still attached (Figure 6). Some of the pawls were distorted by intense heat but were otherwise complete.

Figure 6: Canopy latching mechanism on pilot's side of aircraft, showing latching pawls and bias spring



Source: ATSB

Other canopy-related occurrences

A search of the ATSB database yielded 30 reported occurrences involving canopy anomalies in the 10-year period prior to this accident. That search did not identify any occurrences involving Lancair aircraft. Of the 30 occurrences, eight involved the canopy opening and/or detaching during take-off. No injuries were reported in those eight occurrences – in all but one the pilots rejected the take-off.

In response to a request from the ATSB, the United States National Transportation Safety Board (NTSB) advised of three occurrences involving open-canopy flight in Lancair Legacy aircraft, as outlined below.

On 13 April 2008, the aircraft's canopy was observed to be open during the take-off climb. The aircraft aerodynamically stalled and collided with terrain, fatally injuring the pilot. Examination of the available wreckage did not reveal any evidence of pre-impact failures or malfunctions. The NTSB found that the pilot's distraction with the canopy contributed to the accident.

On 18 October 2008, after departure, the aircraft was unusually low then entered a left turn. Items from the cockpit fell to the ground. The turn continued until the aircraft impacted the ground, fatally injuring the pilot. Examination of the available wreckage did not reveal any evidence of pre-impact failures or malfunctions. The aircraft by design did not have a cockpit indication of canopy security. The NTSB found that the pilot failed to secure the canopy prior to take-off, resulting in his inability to control the aircraft. There were also physiological factors.

On 30 January 2009, during the take-off, the canopy opened. Not certain that he could stop on the remaining runway, the pilot continued the take-off and climbed to a safe altitude. While attempting to return to the airport and simultaneously fighting the canopy oscillation, the pilot lost control of the aircraft on approach and impacted terrain, but was not injured. The NTSB found that the pilot's failure to ensure the canopy was fully locked prior to take-off and the canopy oscillations in flight contributed to the accident.

Safety analysis

Introduction

The aircraft collided with terrain during an approach to land while in an abnormal configuration. This analysis will examine the factors contributing to flight with the canopy open and the influence of the open canopy on development of the accident.

Canopy abnormality

It was apparent that the canopy came open during the latter part of the take-off roll. For this to occur there needed to be a strong upward force on the canopy as well as ineffective latching at the rear of the forward-hinged canopy.

The forces on the canopy during the early stages of the take-off roll would have had a downward effect as a result of airflow from the propeller and the weight of the canopy. However, as airspeed increased, the shape of the canopy would generate proportionally more aerodynamic lift that would eventually exceed the downward effects and raise the canopy to an equilibrium position. On this occasion it opened before lift-off and stayed open such that the rear of the canopy was displaced 15 to 30 cm above the corresponding part of the fuselage. Given the canopy opening was observed to be sudden, it is possible that the inflatable air seal held the canopy until it popped open.

The ineffective latching required for the canopy opening could have been the result of a latching mechanism malfunction (undetected by the pilot) or simply non-engagement of the mechanism. Although the latching mechanism and supporting structure was disrupted in the accident, the unbroken mechanical continuity, in-situ bias spring, and undamaged condition of the pawls (except fire-related) were evidence of pre-accident functionality.

If the aircraft had a functioning canopy latching system it follows that the operating handle was in the open position when the canopy opened. Based on the photos showing the aircraft taxiing before the accident and compared with a previous flight (Figure 7), the canopy was down but not latched during the taxi and in the circumstances was likely not latched before take-off. Given the unlikelihood of the pilot manipulating the canopy handle during the take-off roll, the pilot must have conducted the take-off with the canopy down but inadvertently unlatched. Then late in the take-off roll, under the influence of lift generated by the airflow as the aircraft accelerated, the canopy suddenly popped open.

Figure 7: Contrasting canopy positions

Taxiing pre-accident | **Taxiing 14 May 2013**

Source: Geraldton Airport (edited and annotated by ATSB)

In this aircraft type there was little visible and likely little audible variation between the down and the closed-latched canopy positions. This would be especially so if the inflatable seal had been

activated. In addition, the canopy latch handle was not in the pilot's normal field of vision and there was no canopy status warning device fitted. As a result, there was an absence of salient cues so the pilot was reliant on remembering to latch the canopy and/or conducting a pre-take-off check to confirm canopy security.

It is not known how the pilot missed latching the canopy. However, human memory can be unreliable and checklist items can easily be overlooked. It is possible that the pilot was distracted or experienced self-imposed time pressure to depart with sufficient time to complete the flight in daylight. Operators of aircraft with canopies and doors that don't give an obvious physical indication of being unlatched and that affect flight characteristics when open should consider all available means to reduce the risk of aircraft operation with those components unsecured.

Take-off and landing with aircraft abnormality

From the momentary brake application when the canopy came open it appears that the pilot's initial reaction, perhaps instinctive, was to reject the take-off. However, engine power was not reduced as necessary for a rejected take-off. This incomplete procedure might have been due to the pilot attempting to close and latch the canopy and/or the pilot might have judged the runway distance remaining to be insufficient to allow for a safe stop.

The decision to stop or go when an aircraft is close to lifting off can be a difficult one. There are a number of considerations that might need to be assessed at the time including the nature of any abnormality, aircraft momentum, aircraft braking effectiveness, runway remaining, and prospective aircraft performance/controllability. And these factors will be considered in the particular context of a pilots' mindset about the importance of the flight and a natural inclination to avoid damage to their aircraft.

With limited time available to process all of the available information and with the available runway length rapidly diminishing, the pilot decided to continue with the take-off. This committed the pilot to conducting a circuit and landing with a partially open canopy. With the benefit of hindsight, it would have been better for the pilot to have rejected the take-off and accepted the possibility of aircraft damage and personal injury, but at relatively lower aircraft energy levels. This is supported by the ATSB occurrence data for open/detached canopies during take-off in which nil injuries were sustained during the previous seven such rejected take-offs.

The pilot turned soon after take-off to conduct a low-level circuit onto the closest available runway, apparently wanting to get onto the ground as soon as possible. While that would be an understandable reaction, the pilot had limited opportunity to understand the behaviour of the aircraft with the canopy open at different speeds and flap settings. There was also little time for the pilot to plan an approach to mitigate the effects of the open canopy. It is not known if the pilot tried to close the canopy once airborne, but depending on the airspeed, any attempt was likely to be difficult. Where possible in abnormal situations, pilots should take time to assess the nature of the abnormality to rectify the situation or mitigate the effects.

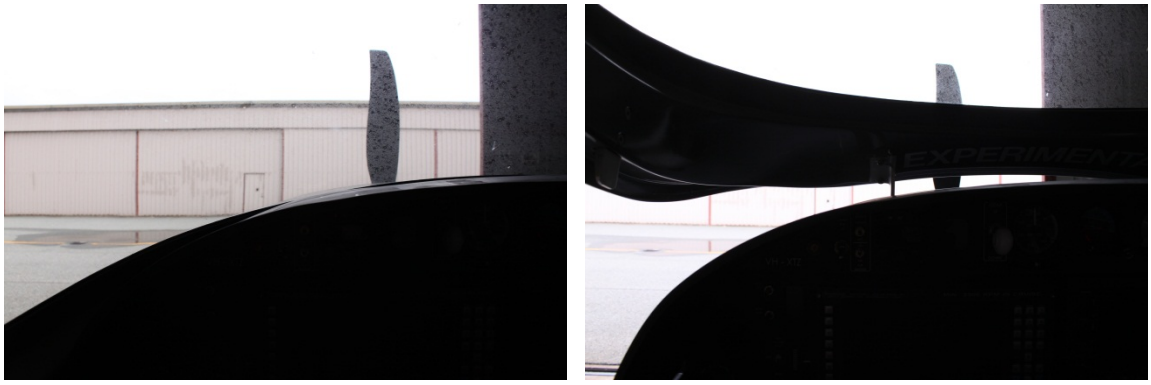
It is highly likely that the pilot was experiencing difficulty in controlling the aircraft as he approached for a landing. The open canopy was probably disrupting the airflow over the tail with an adverse effect on pitch (nose up/down) stability and controllability and without flap the pilot might have had difficulty stabilising the airspeed. Added to the control difficulties was the effect that the open canopy would have been having on the performance of the aircraft in the form of reduced effective lift and increased drag from the canopy. There was no abrupt height loss or significant change in aircraft attitude reported by witnesses, so an aerodynamic stall was not considered to be a factor.

Whatever the control and performance issues, the open canopy would have been obstructing the pilot's forward visibility. The ATSB placed the canopy of the exemplar Legacy in different positions and found that the most obstructive position was the 20°-open position (Figure 8). While the exact position of the canopy during the approach could not be determined, witness accounts were

generally consistent in estimating the angle as 30°. This might have been closer to 20° given the rake on the forward part of the canopy might have created a visual illusion that over-accentuated the opening angle.

Figure 8: Exemplar Lancair Legacy – representative views from pilot's seat

Canopy down **Canopy open 20°**



Source: ATSB

With the canopy partially open the pilot was also contending with substantial airflow coming into the cockpit. Being unaccustomed to such conditions, it is likely that the pilot was disconcerted and distracted.

There were no canopy-related occurrences involving Lancair aircraft reported to the ATSB in the 10 years prior to this accident. While that demonstrates the frequency of such events is low, the serious consequences of this occurrence and the three accidents in the United States indicate the difficulty involved and highlight the importance of prevention.

As a result of likely control, performance and forward visibility difficulties, the pilot was unable to prevent the aircraft undershooting the approach, touching down across a road and colliding with the airport perimeter fence with consequent serious damage to the aircraft and a fire that inflicted injuries that were fatal to the pilot.

Findings

From the evidence available, the following findings are made with respect to the canopy-related landing accident involving a Lancair Legacy, registered VH-ALP, which occurred at Geraldton Airport, Western Australia on 18 September 2013. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- The pilot conducted the take-off with the canopy down but inadvertently unlatched, and late in the take-off roll the canopy suddenly lifted up to be partially open.
- With the canopy partially open, the pilot continued the take-off then turned to conduct a low-level circuit and approach to land.
- As a result of likely control, performance and forward visibility difficulties, the pilot was unable to prevent the aircraft undershooting the approach, touching down across a road and colliding with the airport perimeter fence with consequent serious damage to the aircraft and a fire that inflicted injuries that were fatal to the pilot.

Other factor that increased risk

- In an aircraft with a canopy that showed little difference between the down and the closed-latched position, and likely produced significant aerodynamic effects when open in flight, there was no system to reduce the risk of take-off with the canopy unlatched.

Safety issues and actions

The Australian Transport Safety Bureau (ATSB) did not identify any organisational or systemic issues that might adversely affect the future safety of aircraft operations. However, shortly after the occurrence, on 1 October 2013, the ATSB issued a web update that advised of the essential circumstances of the accident and communicated the following safety message about canopy latching.

The ATSB advises owners, operators and pilots of aircraft with canopies to review the adequacy of their existing measures that are intended to ensure canopies are securely latched before flight (such as pre-take-off checks and warning systems), and the actions in case of inadvertent canopy opening during take-off.

In response to the draft report, Lancair International advised that 'the latching system, when properly employed has no history of failure or service issues, causing any mishap, incident or accident. Given these facts, Lancair will take no action to change the latching mechanism. Warning lights, buzzers, and shakers are widely employed in aircraft to warn the pilot of unsafe conditions. These devices are not always successful, and the burden of proper aircraft system management ultimately lies with the pilot.'

General details

Occurrence details

Date and time:	18 September 2013 – 1550 WST	
Occurrence category:	Accident	
Primary occurrence type:	Canopy-related landing accident	
Location:	Geraldton Airport, Western Australia	
	Latitude: 28° 47.26' S	Longitude: 114° 41.86' E

Pilot details

Licence details:	Private Pilot (Aeroplane) Licence, issued in 1989
Endorsements:	Manual Propeller Pitch Control; Retractable Undercarriage; Single Engine Aeroplanes less than 5,700 kg Maximum Take-off Weight
Ratings:	Night VFR issued in 1990
Medical Certificate:	Class 2, valid to September 2014
Aeronautical experience:	Approximately 1,630 hours total; 300 hours Lancair Legacy
Last flight review:	September 2012

Aircraft details

Kit manufacturer:	Lancair International	
Builder:	First owner (United States)	
Registration:	VH-ALP	
Operator:	Current owner	
Serial number:	L2K-142	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 (Fatal)	Passengers – 0
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- witnesses
- the operator of Geraldton Airport
- Western Australia Police
- Lancair Legacy owner-builders
- Lancair International
- the United States National Transportation Safety Board (NTSB)
- the Civil Aviation Safety Authority (CASA).

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 Geraldton Airport, Lancair International, NTSB, and CASA. Submissions were received from some of the parties to the investigation. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB 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 factors related to the transport safety matter being investigated.

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.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

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