Australian Government
Australian Transport Safety Bureau

Collision with terrain involving Cessna T210N, VH-ZFW

near Inverell Airport, New South Wales | 4 July 2014

Investigation

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Addendum

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Safety summary

What happened

VH-ZFW

Source: John Newby

On 4 July 2014, the pilot/owner of a Cessna Aircraft Company T210N aircraft, registered VH-ZFW, and two passengers were conducting a private flight from Inverell Airport to Bankstown Airport, New South Wales.

Shortly after take-off, oil appeared on the windscreen and the pilot rejected the take-off with the intent of landing back on the runway. As the oil temporarily obscured the pilot's forward visibility, they looked to the left to assess their position along the runway. The pilot realised that they were a lot further along the runway than expected and that there was insufficient runway distance remaining to land safely. A go-around was commenced but the pilot reported that the engine did not respond. During the subsequent forced landing, the aircraft impacted a shrub beyond the end of the runway overrun and flipped, before coming to rest inverted.

The pilot and a passenger were hospitalised with serious injuries and the second passenger received minor injuries. The seriously-injured passenger later succumbed to their injuries. The aircraft was destroyed by the impact forces and a post-impact fuel-fed fire.

What the ATSB found

Examination of the aircraft found the engine oil filler cap detached from the oil filler tube but hanging by its chain. Further examination of the tube and cap determined that it was most likely the cap was not secure before the flight commenced. The Cessna T210N pilot's operating handbook advised pilots to check the engine oil level during a pre-flight inspection but not the security of the separate oil filler cap. The ATSB could not establish the extent to which a specific checklist item about oil filler cap security would have assisted in identifying the unsecured cap in this case, although it would probably have increased the likelihood of detection.

Witness observations and the pilot's assessment of the aircraft's position along the runway during the rejected take-off indicated that the take-off was longer than normal. The reason for this could not be determined.

Examination of the engine and turbocharger found no mechanical defect or failure that would have precluded normal operation. While it was possible that a temporary issue occurred, resulting in the reported lack of engine response during the go-around, this could not be established.

The ATSB also determined that the engine manufacturer's oil change interval had been exceeded by 3 months but it was very unlikely that this had any effect on the operation of the engine.

Safety message

This accident highlights that, prior to take-off, pilots should have in mind a go/no-go decision point along the runway by which time the aircraft should become airborne. If at that point the aircraft is not airborne, the pilot should reject the take-off. Having such a point assists pilot decision making during a critical phase of flight. This is particularly important when operating in conditions that may affect aircraft performance, such as tailwind conditions.

In addition, the ATSB highlights the importance of being aware of the daily inspection requirements when operating aircraft under a CASA maintenance schedule. In particular, how this may differ from the aircraft manufacturer's pre-flight inspection procedure.

Contents

The occurrence

On 4 July 2014, at about 1230 Eastern Standard Time,[1] the pilot/owner of Cessna Aircraft Company T210N aircraft, registered VH-ZFW (ZFW), and two passengers arrived at Inverell Airport to conduct a private flight to Bankstown Airport, New South Wales.

In preparation for the flight, the pilot removed the aircraft from the hangar and conducted a pre-flight inspection. The pilot could not initially recall adding engine oil to the engine during the inspection but later believed that was the case. Witnesses reported being aware of the pilot carrying out the pre-flight inspection but none observed the entire pre-flight, including whether the pilot added any engine oil. The two passengers remained some distance from the aircraft until the pilot completed the inspection. The pilot and passengers boarded the aircraft. The pilot started the engine and completed the pre-take-off checks, which were reported as normal.

The pilot recalled that there was a tailwind of less than 5 kt on runway 16.[2] Therefore, to allow for an immediate departure to the south, the take-off was planned from that runway. The pilot was aware that the minimal tailwind might prolong the take-off roll.

Just prior to taxiing, the pilot of ZFW conversed with the pilot of an inbound aircraft who was intending to land on runway 34. The pilot of ZFW then taxied to the threshold of runway 16 and waited for the other aircraft to land. After that aircraft vacated the runway, the pilot of ZFW commenced the take-off at about 1309. Ten degrees of wing flap was reported set for the take-off.

The pilot indicated that initially the take-off proceeded normally. However, shortly after becoming airborne, when at an estimated 200–300 ft above the ground, engine oil appeared on the windscreen, predominantly on the left. The pilot initiated a rejected take-off by reducing engine power to idle and lowering the nose of the aircraft. In response to the temporarily-obscured forward vision, the pilot looked out to the left of the aircraft to assess their position. Shortly after, the pilot realised that they were a lot further along the runway than expected as they[3] could see the threshold of the reciprocal runway 34 ahead (Figure 1). The pilot determined that there was insufficient distance remaining to land safely and commenced a go-around. The intent was to return to the airport for an immediate landing. However, the pilot reported that when full power was applied, the engine did not respond. The pilot initiated a forced landing.

The pilot was aware of the need to clear the boundary fence and ensure that the aircraft's airspeed remained above the stall[4] speed. The pilot identified a cleared area to the right and turned the aircraft toward that area. The pilot reported having no further recollection of the forced landing until after the impact when the aircraft was on fire.

The pilot exited the aircraft and assisted the passengers. Shortly after, a number of people arrived and found the occupants clear of the burning wreckage. They moved the occupants further away and provided assistance until emergency services personnel arrived.

The pilot and front seat passenger were hospitalised with serious injuries. The second passenger, who was sitting in the middle row of seats, received minor injuries. The front seat passenger later succumbed to their injuries. The combined effects of the impact forces and post-impact fuel-fed fire destroyed the aircraft (Figure 2).

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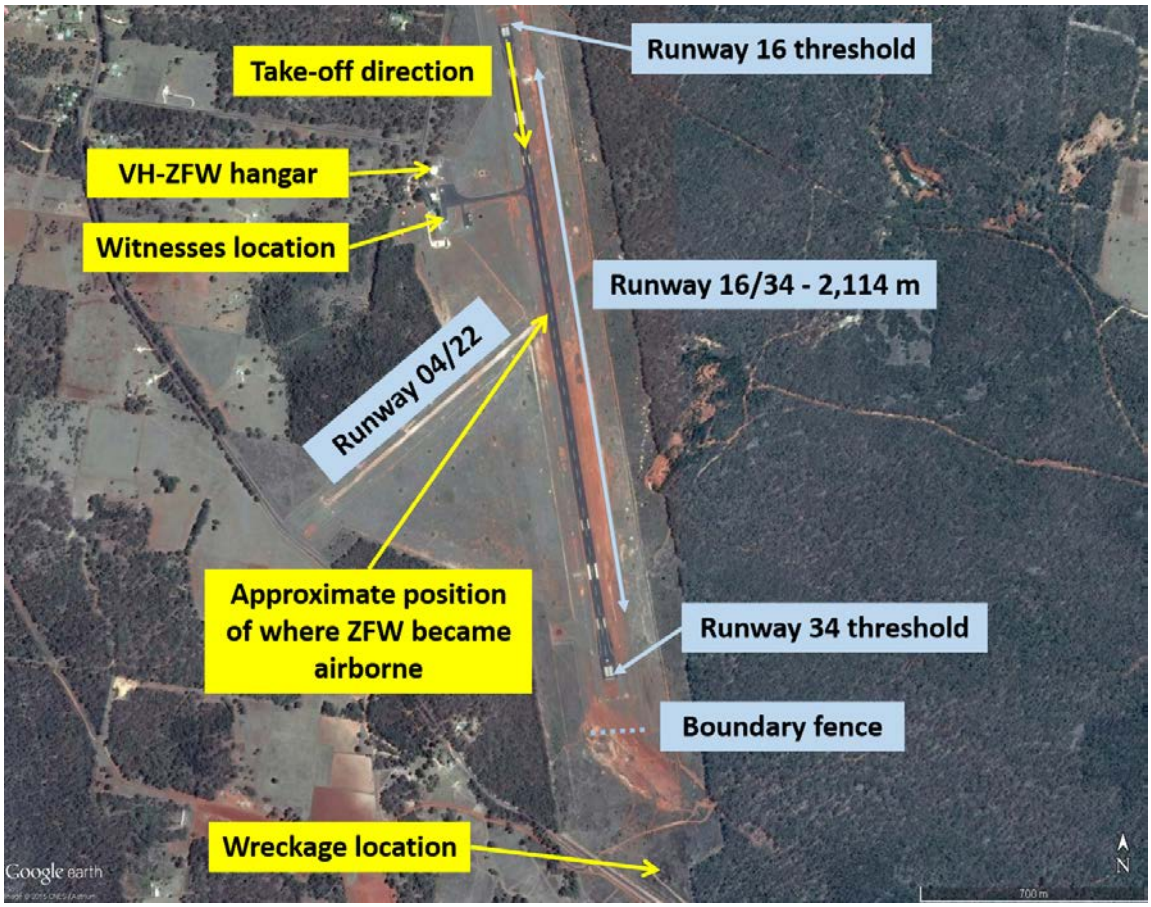
1 Eastern Standard Time (EST) was Coordinated Universal Time (UTC) + 10 hours.
2 Runways are named by a number representing the magnetic heading of the runway.
3 Gender-neutral plural pronouns such as they, them and their are used throughout the report to refer to an individual.
4 Term used when a wing is no longer producing enough lift to support an aircraft's weight.

Figure 1: Runways at Inverell Airport, showing the location of the witnesses, approximate position that VH-ZFW became airborne and wreckage location



Source: Google earth, modified by the ATSB

Passenger observations

The passenger seated in the middle row reported that the engine sounded normal until some way down the runway when they started to notice something was wrong. The passenger reported removing their headset and noting that the engine sounded 'weak'. At that time, the aircraft's wheels were slightly above the ground and the aircraft about 10 m from the airport boundary fence. Shortly after, the passenger observed the pilot applying rearward pressure on the control column. The passenger felt the aircraft bounce before going over the fence. The aircraft then went to the right and flipped before coming to rest inverted. A fire commenced shortly thereafter. The passenger exited the aircraft and went to the main road to seek assistance.

The passenger did not observe any oil on the windscreen.

Witness observations

Witness 1

A witness who was familiar with ZFW and had observed the aircraft take-off from Inverell Airport on numerous occasions was positioned near a hangar overlooking runway 16/34 (Figure 1). The witness reported hearing ZFW start up and observed it taxi to the runway end and, soon after, commence the take-off. The witness indicated that during the initial stages of the take-off, the aircraft's acceleration along the runway and engine sound appeared normal.

When in-line with their position, the witness was expecting the nose of the aircraft to lift but instead the aircraft continued along the runway. The witness indicated that if the nose did in fact lift from

the runway, it would have only been centimetres above the ground. The witness became concerned and notified his colleagues.

As the aircraft passed runway 04/22, which is about 1,000 m along runway 16 and just before the depression in this runway (see the section titled *Operational information - Airport information*), it became airborne to about 10–13 ft (3–4 m). The witness reported that it looked like there was a slight crosswind as the aircraft's tail moved to the right. The witness believed the pilot then rejected the take-off, as the aircraft appeared to settle back onto the runway. However, due to the depression in the runway, the witness could only see the aircraft's wings. By this time, a second witness came of out of the hangar.

Witness 2

The second witness, who was also familiar with the aircraft, heard ZFW start up and the engine and other sounds associated with the pre-take-off checks. All were reported as sounding normal. The witness further indicated that, dependent on a number of conditions, ZFW would normally become airborne when about 500–800 m along the runway. By the upwind end of the runway, it would typically be about 200–300 ft above the ground.

Approaching the upwind end of the runway

Shortly after, as the aircraft neared the upwind end of the runway, both witnesses observed the aircraft suddenly climb to about 100–150 ft. Both commented that the aircraft appeared to be 'labouring'. Neither witness could recall hearing the engine operating at that time, but the second witness believed that they should normally have been able to hear the engine from their position. The aircraft then turned right and descended below the rising terrain. Shortly after, the witnesses observed smoke in the area of the descent and went to assist.

The ATSB could not reconcile the discrepancy between the pilot's recollection of the height gained after becoming airborne to that observed by the witnesses. However, it was possible that the accident and/or subsequent medical treatment affected the pilot's recall.

Figure 2: Aerial view of the accident site showing VH-ZFW (looking west-north-west)

Source: New South Wales Police Force, modified by the ATSB

Context

Pilot information

The pilot held a Private Pilot (Aeroplane) Licence that was issued on 10 June 2011 and a valid Class 2 Aviation Medical Certificate. The pilot's logbook showed a total flying experience of 231.1 hours to the last entry dated 25 May 2014. Of these, about 118 hours were in ZFW. The pilot reported that, in the intervening period, they carried out a return flight to Archerfield Airport, Queensland and a local flight in ZFW in the weeks prior to the occurrence.

The pilot last completed a flight review on 8 November 2012.

Aircraft information

General

The Cessna T210N is a high-wing, single-engine aircraft with a retractable landing gear. The aircraft was manufactured in the United States (US) in 1980 and imported into Australia by the current owner/pilot. The aircraft was registered as VH-ZFW on 26 September 2012.

The aircraft was fitted with a six-cylinder, horizontally-opposed Teledyne Continental Motors TSIO-520-R9B engine. The engine drove a three-bladed McCauley Propeller Systems constant-speed propeller.

A review of the aircraft's records indicated that ZFW was maintained in accordance with the approved Civil Aviation Safety Authority (CASA) maintenance schedule. The last periodic inspection was on 11 October 2013, at a total time in service of 3,973.6 hours. This included the last recorded engine oil change. Since that time, the aircraft accumulated about 40 hours. The maintenance records did not identify any defects or unserviceability with the aircraft prior to the occurrence.

Engine oil system

Oil for engine lubrication, propeller governor operation and turbocharger system control was supplied from a sump located on the bottom of the engine. The engine sump capacity was 10 quarts (about 10 L). Looking from the rear of the aircraft, the oil dipstick was located at the rear-left of the engine. The oil filler tube and cap was on top of the crankcase, near the front of the engine. Both the oil dipstick and filler tube were accessible through separate doors on the engine cowling.

The engine manufacturer advised that the oil filler cap fitted to the engine had been used on a large range of their engines since 1973. They further advised that the design of the cap was simple but effective and that they did not foresee a need to change the design.

The engine manufacturer's recommended interval between oil changes was 50 hours or 6 months, whichever occurred first. The Cessna T210N pilot's operating handbook (POH) also recommended changing the oil at least every 6 months, even though this may be less than the 50 hours accumulated. The POH further advised to reduce the interval when conducting short flights and during operations that involve long periods at idle revolutions per minute to avoid oil 'sludging'. The term oil sludge refers to viscous deposits or gelling of the oil, which can lower the effectiveness of the lubrication system.

Turbocharger system

The aircraft was fitted with a Kelly Aerospace 400 series turbocharger. The function of the turbocharger was to maintain a desired manifold pressure at a given throttle setting, regardless of the ambient air temperature and pressure. A butterfly-type waste gate regulated the amount of exhaust gas fed to the turbocharger turbine wheel. The waste gate actuator and controller used

engine oil pressure to operate. In the event of a turbocharger failure, the waste gate would move to the open position to prevent an overboost situation (excessive manifold pressure). The engine manufacturer stated that:

> Rapid throttle movements may cause undershooting or overshooting of the desired manifold pressure, necessitating a subsequent adjustment once the turbocharger has stabilized. Gradual throttle movement will permit the turbocharger to keep pace with the change in power.

Speedbrakes

Precise Flight speedbrakes were installed on the aircraft to reduce shock engine cooling and allow for accelerated descents without decreasing engine power. The speedbrakes were located on the upper surface of each wing and were electrically actuated by an electric clutch. If the aircraft experienced a loss of electrical power, the clutch would automatically retract the speedbrakes. The speedbrakes took between 1.8–2.3 seconds to deploy.

Operational information

Meteorological information

The aerodrome forecast[5] for Inverell Airport indicated the wind would be from 300° (west-north-west) at 10 kt (19 km/h) with a temperature at the time of 15 °C. The pilot reported that, at the time of take-off, there was a tailwind of less than 5 kt on runway 16. This was consistent with witness observations of conditions including light and variable winds, with about a 5 kt tailwind on runway 16.

Airport information

Inverell Airport had two runways aligned 16/34 and 04/22. Runway 16/34 was the main runway and was 2,114 m long, with a 1 per cent upslope on runway 16. Runway 04/22 was to the west of and about 1,000 m along the main runway (Figure 1). Just beyond that point, there was a distinct depression in the main runway. Due to this variation in runway level, aircraft may not be sighted on opposite ends of the runway. The Airservices Australia Aerodrome Chart for the airport included a caution to this effect.

There was a 2 m high airport boundary fence about 160 m beyond the end of runway 16. Outside this fence was a semi-cleared area covered in low-lying shrubs and tall grasses.

Estimation of take-off and landing distances

An estimation of the aircraft's expected take-off and landing distance (ground roll) that day was undertaken using the Cessna T210N POH. Taking into account the runway characteristics, the calculations were based on information from the aerodrome forecast and the pilot's and witness recollections (Figure 3).

The POH indicated that a normal take-off was possible using a 0°–10° wing flap setting. However, 10° wing flap was preferred as it resulted in an earlier nose wheel lift-off and a 10 per cent reduction in ground run compared with 0° flaps. Based on the manufacturer's preferred configuration, the take-off ground roll distance for the occurrence flight with a 10° flap setting and 5 kt tailwind was estimated to have been about 485 m. With a 0° flap setting, the estimated distance was about 535 m. The pilot reported that they would normally select 10° flap for take-off and be airborne well before passing runway 04/22.

The landing distance was also estimated from information in the POH and was based on a flap setting of 30°, engine power at idle and the application of maximum braking. Given these conditions, depending on the aircraft's actual configuration at the time, the minimum distance

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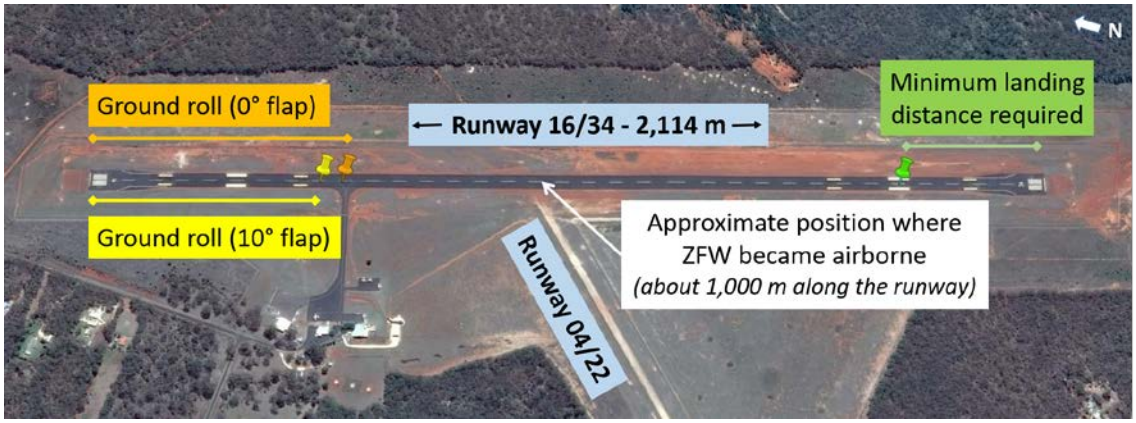
[5] Aerodrome forecasts are a statement of meteorological conditions expected for a specific period of time, in the airspace within a radius of 5 NM (9 km) of the aerodrome.

required for landing and braking to a complete stop would have been at least 320 m (Figure 3). However, the actual runway distance remaining when the pilot rejected the take-off was unable to be determined.

Figure 3: Estimated take-off distances with 10° (in yellow) and 0° (in orange) of wing flap set, the observed lift-off position along runway 16 and the minimum estimated landing distance (in green)



Source: Google earth, modified by the ATSB

Take-off considerations

The pilot could not recall when the aircraft became airborne but reported that the take-off was normal until the oil appeared on the windscreen. However, after initiating the rejected take-off, the pilot realised that they were a lot further along the runway than expected. The pilot indicated that the aircraft would normally be about 500 ft above the ground by the runway end (runway 34 threshold). The pilot did not know why the aircraft was lower than normal at that time.

The pilot reported that they did not have a specific go/no-go decision point along the runway. In respect of the application of such decision points, the US Federal Aviation Administration (FAA) Airplane Flying Handbook stated that:

> Prior to takeoff, the pilot should have in mind a point along the runway at which the airplane should be airborne. If that point is reached and the airplane is not airborne, immediate action should be taken to discontinue the takeoff.

Pre-flight inspection procedure

The Cessna T210N POH advised pilots to check the engine oil quantity during a pre-flight inspection walk-around but did not require a check of the security of the oil filler cap. In contrast, the Cessna service manual, which provided the recommended procedures and instruction for ground handling, servicing and maintaining the aircraft, included a requirement to check that the filler cap was tight and the oil filler cap was secure. A review of other handbooks for a range of aircraft types found that inclusion of that check in the pre-flight inspection process was inconsistent.

The daily inspection requirements, under the CASA maintenance schedule to which the aircraft was maintained, included a check of the oil level and that the oil dipstick and cap were secure and locked. The CASA Maintenance guide for pilots stressed the importance of the daily inspection in terms of it being:

> …the only thorough inspection between periodic inspections and is the last opportunity to inspect the aircraft to ensure that it is airworthy and fit to fly…and must be carried out prior to the first flight of each day the aircraft is flown.

and the purpose of the pre-flight inspection being:

> …to inspect the aircraft to ensure that it is safe, that nothing untoward has occurred since the daily inspection, and to determine if flight requirements can be met.

The pilot reported that they used the memorised flow pattern for each pre-flight inspection based on the checklist published in the POH. Consistent with this checklist, they checked the oil quantity on every pre-flight inspection. The pilot indicated that they were not aware of the CASA maintenance schedule daily inspection requirements, and would only check the security of oil filler cap after adding engine oil.

The pilot reported that on one previous occasion they had double-checked the oil filler cap and found it unsecured.

Wreckage and impact information

An examination of the wreckage found that the aircraft approached terrain in a relatively level attitude, with the nose and left wing slightly down. The nose wheel contacted the ground first and detached from the aircraft. The right wing then impacted a shrub, sustaining significant impact damage and the aircraft flipped, before coming to rest inverted. A post-impact, fuel-fed fire destroyed most of the fuselage (Figure 4).

The wreckage examination also found:

- That the damage to the propeller blades and strike marks on the ground were consistent with the engine producing some power at impact, but not full power.
- That the left side of the engine sustained more fire and heat damage then the right. After placing the engine in an upright position, the oil filler cap was found detached from the oil filler tube but hanging by its chain. There was evidence of oil around the oil filler tube and on the ground. The separate oil dipstick remained secured in position.
- Small amounts of oil spotting on the rear of the left empennage and on the underside of the left horizontal stabiliser. There were also oil droplets on several windscreen fragments around the accident site.
- A small amount of oil sludge inside the propeller hub shaft.
- The propeller governor control was in a low pitch, high revolutions per minute position, consistent with the propeller pitch setting required for take-off.
- The wing flaps were in the fully-retracted position (0°).
- The speedbrake on the left wing was partially-deployed, while the speedbrake on the right wing was in the retracted position.

The engine was recovered from the wreckage and transported to an approved overhaul facility for technical inspection under the supervision of the ATSB. The speedbrake assembly from each wing was also removed for further examination at the ATSB's technical facilities in Canberra, Australian Capital Territory.

Figure 4: Aircraft wreckage showing the tail empennage inverted to the right and the propeller visible on the left (looking south-south-west)

Source: ATSB

Test and research

Engine examination

The engine examination found that, while less than 2 L of oil was collected from the engine, there was no damage consistent with oil starvation. Overall, there was no evidence of internal mechanical failure that would have prevented normal operation of the engine prior to the occurrence. Externally, the engine was impact- and fire-damaged.

The turbocharger waste gate was in the open position and the turbine wheel assembly could not be rotated within its housing. The turbocharger assembly and the engine oil filler cap and tube were removed from the engine for further examination.

Engine oil filler cap and tube examination

The engine oil filler cap and gasket, which was located at the underside of the cap rim, showed evidence of significant fire damage. However, the cap did not appear distorted or damaged. The locking tangs used to secure the cap into the oil filler tube showed no contact marks to indicate the forcible removal of the cap from the filler tube during the impact sequence. There was evidence of oil on the outer surface of the oil filler tube. The physical appearance of the interacting cap and filler tube surfaces showed no deformation or mechanical damage. Therefore, it was considered very unlikely that the cap came off during the impact sequence.

Turbocharger examination

The turbocharger assembly sustained extensive heat damage from the post-impact fire. Examination of the waste gate determined that the valve was fixed in the open position, consistent with fire damage and the build-up of debris from exposure to water during the firefighting activities. There was evidence of oil residue on the bearings, which were in good condition and showed no signs of damage or distortion. Examination of the turbocharger assembly found no evidence to suggest that it was not operational prior to the occurrence.

Speedbrake examination

Both speedbrakes showed signs of post-impact fire damage and their spring mechanisms and wiring were compromised. Heat markings on the right speedbrake indicated that it was not in the open position during the fire. Discolouration from heat damage to the left speedbrake showed that it was extended to an angle of 30° during the fire. However, it was determined that the left speedbrake was released by the impact and there was no evidence to suggest that it deployed in-flight.

Pilot reaction times

In 1999, the United Kingdom Civil Aviation Authority commissioned a simulator-based study into helicopter pilot reaction times in response to an emergency. The study determined that the mean total reaction time (time taken to detect and respond) generally ranged between 2–4 seconds, with 4–6 seconds typical of a longer but acceptable reaction time. The US FAA Airplane Flying Handbook also stated that the typical time for a pilot to react to an emergency situation was about 4 seconds.

Related occurrences

A review of the ATSB occurrence database identified eight occurrences in the period 2005 to 2014 where pilots reported oil on the windscreen or engine cowl in flight. Specifically, these involved single-engine aircraft and occurred because of an unsecured engine oil filler cap or dipstick. Below is a selection of these occurrences:

- During the take-off, at about 30 ft above the runway, the pilot observed oil leaking from the engine cowl. The pilot rejected the take-off. After shutdown, the pilot found that the oil filler cap was not secured correctly (ATSB occurrence 201311271).
- During the initial climb, the airspeed indicator failed and a large quantity of oil flowed onto the windscreen. The pilot returned for landing and inadvertently landed with the landing gear retracted. An inspection revealed that the oil filler cap was not secured prior to departure (ATSB occurrence 201106695).
- At about 300 ft after take-off, the flight instructor noticed oil splatter on the windscreen. After shutdown, the student pilot realised that they replaced the oil cap but did not lock it in place (ATSB occurrence 201103050).
- At about 1,500 ft after take-off the pilot noticed a small amount of oil on the windscreen. The aircraft was returned for an immediate landing. The pilot realised that the oil filler cap was not secured after adding oil during the pre-flight inspection (ATSB occurrence 201102652).

The following is a selection of similar international occurrences:

- During the pre-flight inspection, the pilot added engine oil and placed the oil filler cap on top of the battery box. Subsequently, the pilot became distracted by the flight instructor. After departure, the pilot noticed oil on the windscreen and realised that they did not secure the cap. After landing, the filler cap was found still resting on top of the battery box (US Aviation Safety Report System occurrence 581462).
- During the climb, the pilot noticed oil droplets that shortly after covered the left side of the windscreen. The pilot had not secured the oil filler cap after adding engine oil during the pre-flight inspection. The pilot reported that the aircraft manufacturer's pre-flight inspection procedure as detailed in the POH called for a check of the oil level, but not the fitment of the oil filler cap (US Aviation Safety Report System occurrence 784956).
- After take-off, the aircraft was climbed to about 100–200 ft before the pilot turned back toward the runway. The pilot reported obscuration of the windscreen by a layer of oil as the oil filler cap was mistakenly left off. The aircraft descended into terrain about 274 m beyond the runway

in a wings level, 20° nose-down attitude. The pilot reported no pre-impact mechanical issues (US National Transportation Safety Board (NTSB) investigation LAX04LA225).

- The pilot reported oil on the windscreen shortly after take-off and returned to the airport. Witnesses observed the aircraft level off at 300 ft, slow down and turn toward the airport. During the turn, the right wing dropped and the aircraft subsequently impacted terrain. The oil filler tube was found without the cap. The cap was attached to the neck by a chain and was found between cylinders No. 4 and 6. No pre-impact anomalies were found with the aircraft that would have affected its performance (US NTSB investigation SEA04F165).
- Shortly after becoming airborne, the pilot observed oil streaming from the engine compartment, severely impairing their visibility. The pilot had inadvertently left the oil filler cap off (United Kingdom Air Accidents Investigation Branch investigation EW/G2012/07/02).

Safety analysis

Shortly after take-off, oil appeared on the windscreen, temporarily obscuring the pilot's visibility. The pilot initiated a rejected take-off but then assessed that there was insufficient landing distance remaining to continue the rejected take-off safely. The pilot reported commencing a go-around by applying full power; however, the engine did not respond. The pilot then initiated a forced landing into a semi-cleared area beyond the airport boundary. During the landing, the aircraft impacted a shrub and flipped before coming to rest inverted. A post-impact, fuel-fed fire injured the occupants and destroyed most of the aircraft fuselage.

This analysis will examine the security of the oil filler cap, the longer-than-normal take-off distance and the oil change interval requirements and their potential influence on the development of the occurrence. It will also consider the pre-flight inspection checklist with regard to the security of the oil filler cap and the reported lack of engine response during the go-around.

Oil filler cap security

The pilot could not initially recall adding engine oil during the pre-flight inspection, nor did any of the witnesses observe this action. However, the pilot reported later that they believed they replenished the engine oil. The pilot's injuries and medical treatment may have affected their memory during the ATSB's initial interview. Subsequently, increased understanding of the circumstances of the occurrence, including potentially from media or other reports, friends and so on may have enhanced or otherwise affected the pilot's recollection.

Following the occurrence, the oil filler cap, which was located on the left or pilot's side of the engine, was found unsecured. This was consistent with the pilot's recollection of oil appearing on the left side of the windscreen and oil spotting on that side of the aircraft wreckage. The oil temporarily obscured the pilot's visibility during the take-off and climb.

Technical examination of the oil filler cap and tube determined that it was very unlikely that the cap came off during the impact sequence. Therefore, it was most likely that the cap was not secure before the flight commenced.

Prolonged take-off

A witness who was familiar with the aircraft's operation at Inverell Airport saw it become airborne about 1,000 m along runway 16. This roughly aligned with being abeam the threshold of runway 22 at lift-off. ATSB estimations of the take-off ground roll distance that day indicated that the aircraft should have become airborne at about 500 m, which was consistent with the witness's previous observations.

The pilot could not recall where the aircraft became airborne but believed that the take-off was normal until the oil appeared on the windscreen. The pilot further indicated that the aircraft would normally be airborne well before passing runway 04/22. A longer-than-normal take-off roll was consistent with the unexpected position of the aircraft as observed by the pilot after initiating the rejected take-off.

The ATSB considered a number of factors that may have prolonged the take-off roll. This included the aircraft's configuration, meteorological conditions, runway characteristics, possible effect of any mechanical issues and pilot distraction. However, none of these factors was identified as contributory and the reason for the longer-than-normal take-off was not established. Despite this, pilots should be aware of such factors and how they degrade aircraft performance during a critical phase of flight, including the effect of tailwind conditions.

Discontinuation of the take-off at the position the aircraft was observed getting airborne should have allowed sufficient distance remaining to safely reject the take-off. However, the time taken for the oil to appear and the pilot to react to the loss of forward visibility compounded the already

longer-than-normal take-off. In combination with the estimated minimum landing distance needed of 320 m, by the time the oil leak appeared and the pilot reacted to the associated loss of forward visibility, it was very likely that there was insufficient runway remaining for the pilot to continue the rejected take-off. This was consistent with the pilot and passenger's assessment of the aircraft's position at that time.

Emergency or abnormal situations during take-off may require a pilot to reject the take-off. The decision to reject a take-off may appear simple but becomes critical under certain conditions. Further, the decision may be more complex when compared to the conditions under which the procedure was trained (Kaempf and Orasanu 2014). Therefore, prior to take-off, pilots should have in mind a go/no-go decision point along the runway by which time the aircraft should become airborne. The decision point should provide for sufficient runway distance remaining to allow the pilot to safely stop the aircraft by the end of the runway. If the aircraft is not airborne by the decision point, the pilot should reject the take-off.

It could not be determined if having a decision point would have changed the outcome of the flight. However, the occurrence emphasises the benefit of having such a point to assist pilot decision making during a critical phase of flight.

Oil change interval

The engine manufacturer's oil change interval was 6 months. This was exceeded in ZFW by 3 months. However, there was insufficient evidence to determine if this contributed to the small amount of oil sludge found in the propeller hub. Despite this sludge, given the results of the examination of the engine and associated components, the overdue oil change had no effect on the operation of the engine.

Pre-flight inspection checklist

The pilot's previous identification of an unsecured oil filler cap was the result of self-checking, not from following a checklist. Therefore, it could not be established if a specific checklist item would have resulted in the pilot identifying the unsecured cap prior to the occurrence flight. However, as documented in the United States Federal Aviation Administration Airplane Flying Handbook:

> Checklists have been the foundation of pilot standardization and cockpit safety for years. The checklist is an aid to the memory and helps to ensure that critical items necessary for the safe operation of aircraft are not overlooked or forgotten.

The pilot's pre-flight inspection, carried out from memory based on the checklist in the pilot's operating handbook (POH), was a daily inspection as it was the first flight of the day. In this respect, the pilot was not aware of the CASA daily inspection requirements for the aircraft. The POH checklist required pilots to check the engine oil level during their pre-flight inspection. However, unlike the CASA daily inspection requirements for the aircraft, it did not require a check of the security of the separate oil filler cap. In the absence of any other safety mechanisms, the inclusion of this check in the POH pre-flight checklist may have increased the likelihood of the pilot identifying the insecure cap.

This occurrence highlights the importance of being aware of the daily inspection requirements when operating aircraft under a CASA maintenance schedule and how these requirements may differ from the aircraft manufacturer's pre-flight inspection procedure. Had the pilot carried out the CASA daily inspection they likely would have identified the insecure engine oil cap.

Reported lack of engine response

Examination of the engine and turbocharger found no mechanical defect or failure that would have precluded normal operation prior to the occurrence. However, it was possible that the reported lack of engine response during the go-around was the result of a temporary issue. For example, the turbocharger may not have had sufficient time to stabilise because of a rapid sequence of

throttle movements in this case. These included setting full power for the take-off, idle power for the rejected take-off and then full power again for the go-around. However, there was insufficient evidence to establish if a temporary issue occurred and the reason for the reported lack of engine response was not established.

In addition, a search of various aviation occurrence databases found only one occurrence where rapid throttle movement led to a temporary turbocharger issue. In that occurrence, the pilot of a Piper PA-31 aircraft advanced the throttle rapidly during the take-off, which resulted in the turbocharger surging. The pilot successfully rejected the take-off (ATSB occurrence 197504806). Of note, pilots may not report temporary issues if they are resolved without further concern.

Similar occurrences of oil dipstick or filler cap insecurity and oil being expelled onto the aircraft have led to varying outcomes but mostly resulted in a safe landing. However, the longer-than-normal take-off roll, the time taken for the oil to appear and the pilot to react, and the reported lack of engine response limited the options available to the pilot. From a low height, the pilot conducted a forced landing into unfavourable terrain, resulting in a collision with terrain and a post-impact fire.

Findings

From the evidence available, the following findings are made with respect to the collision with terrain and subsequent post-impact fuel-fed fire involving a Cessna Aircraft Company T210N, registered VH-ZFW, which occurred near Inverell Airport, New South Wales on 4 July 2014. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- In response to oil on the windscreen, the pilot initially rejected the take-off, but deemed the remaining available runway insufficient to land safely and commenced a go-around. During the go-around, the engine did not respond as expected, resulting in a forced landing off the airport.
- The oil filler cap was not secured, which resulted in oil being expelled onto the windscreen and temporarily obscuring the pilot's visibility during a critical phase of flight.
- For reasons undetermined, the take-off was longer than normal, which reduced the distance available for the pilot to reject the take-off after detecting and responding to engine oil on the windscreen.

Other factors that increased risk

- The aircraft manufacturer's pilot operating handbook advised pilots to check the engine oil level during a pre-flight inspection, but not the security of the oil filler cap.
- The oil change interval exceeded the engine manufacturer's recommended period of 6 months.

Other findings

- The reason for the reported lack of engine response during the go-around could not be established.

General details

Occurrence details

Date and time:	4 July 2014 – 1309 EST	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	Near Inverell Airport, New South Wales	
	Latitude: 29° 53.30' S	Longitude: 151° 08.65' E

Aircraft details

Manufacturer and model:	Cessna Aircraft Company T210N	
Year of manufacture:	1980	
Registration:	VH-ZFW	
Serial number:	21063801	
Total Time In Service	About 4,010 hours	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 2
Injuries:	Crew – 1 (Serious)	Passengers – 2 (Fatal and minor)
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the pilot of VH-ZFW
- the Licenced Aircraft Maintenance Engineer for VH-ZFW
- a number of witnesses
- the Civil Aviation Safety Authority.

References

Federal Aviation Administration 2004, *Airplane Flying Handbook*, United States Department of Transportation.

Flight Safety Foundation 1999, 'Simulator-based study of emergencies yields insights into pilots' reaction times', *Helicopter Safety*, March-April 1999, vol. 25, no. 2.

Kaempf GL, Orasanu J 2014, *Naturalistic decision making,* 2nd edition, Psychology Press New York.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the 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 VH-ZFW, the Licenced Aircraft Maintenance Engineer for VH-ZFW, witnesses, the aircraft manufacturer, the Civil Aviation Safety Authority and the United States National Transportation Safety Board.

Submissions were received from the aircraft manufacturer and a witness. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The 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

Collision with terrain involving Cessna T210N, VH-ZFW
near Inverell Airport, New South Wales, 4 July 2014

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