

Australian Government Australian Transport Safety Bureau

Loss of control involving Cessna Aircraft Company U206G, VH-FRT

Caboolture Airfield, Queensland | 22 March 2014



Investigation

ATSB Transport Safety Report

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Addendum

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Safety summary

What happened

On 22 March 2014, a Cessna Aircraft Company (Cessna) U206G aircraft, registered VH-FRT, was being used for tandem parachuting operations at Caboolture Airfield, Queensland. At about 1124 Eastern Standard Time, the aircraft took off from runway 06 with the pilot, two parachuting instructors and two tandem parachutists on board. Shortly after take-off, witnesses at the airfield

VH-FRT



Source: Burt Van Drunick

observed the aircraft climb to about 200 ft above ground level before it commenced a roll to the left. The left roll steepened and the aircraft then adopted a nose-down attitude until impacting the ground in an almost vertical, left-wing low attitude. All of the occupants on board were fatally injured. A post-impact, fuel-fed fire destroyed the aircraft.

What the ATSB found

The ATSB identified that the aircraft aerodynamically stalled at a height from which it was too low to recover control prior to collision with terrain. The reason for the aerodynamic stall was unable to be determined. Extensive fire damage prevented examination and testing of most of the aircraft components. Consequently, a mechanical defect could not be ruled out as a contributor to the accident.

A number of safety issues were also identified by the ATSB. These included findings associated with occupant restraint, modification of parachuting aircraft and the regulatory classification of parachuting operations.

What's been done as a result

The Australian Parachute Federation (APF) mandated a requirement for all member parachute training/tandem organisations to have their own safety management system. The APF have also increased the number of full-time safety personnel to audit their member organisations.

The Civil Aviation Safety Authority (CASA) has increased the available information on their website about the risks associated with sports aviation. CASA also introduced an Airworthiness Bulletin to provide guidance about co-pilot side flight control modifications.

In response to the identified safety issues, the ATSB has recommended that CASA take safety action to increase the fitment of the Cessna secondary pilot seat stop modification and reduce the risk associated with the aviation aspect of parachuting operations. Finally, recommendations were issued to CASA and the APF to increase the use of dual-point restraints in parachuting aircraft.

Safety message

The current classification of parachuting as a private operation means there are fewer risk controls than for other similar aviation activities that also involve payment for carriage. Prospective tandem parachutists should be aware that accident data indicates that parachuting is less safe than other aviation activities, such as scenic flights.

The ATSB's investigation of this accident, and a previous fatal parachuting accident, indicated that the single-point restraints currently fitted to Australian parachuting aircraft may not be consistently used by occupants. While research shows that they may not be as effective as dual-point restraints at preventing injury in an accident, they do limit the movement of parachutists within the aircraft, therefore reducing the likelihood of load shift during flight. That affords some occupant protection and ensures that the aircraft remains controllable.

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The occurrence

On 22 March 2014, a Cessna Aircraft Company U206G aircraft, registered VH-FRT (FRT), was being used for tandem parachuting operations at Caboolture Airfield, Queensland. The aircraft landed at about 1050 Eastern Standard Time¹, after completing the second flight of the day. Fuel was added to the aircraft from a refuelling facility located at the airfield.

At about 1124, the aircraft took off from runway 06² with the pilot, two parachuting instructors and two tandem parachutists on board. Witnesses at the airfield observed that, shortly after take-off, the aircraft climbed to about 200 ft above ground level before commencing a roll to the left. The left roll steepened and the aircraft adopted a nose-down attitude until impacting the ground in an almost vertical, left-wing low attitude. All of the occupants on board were fatally injured. A post-impact, fuel-fed fire destroyed the aircraft.

Figure 1 shows an overview of Caboolture Airfield and the aircraft's approximate take-off point, flight path, impact point and the locations of a number of witnesses to the accident.

Figure 1: Caboolture Airfield overview showing a number of witness locations (highlighted in yellow and numbered 1–12) and the approximate aircraft flight path and impact point



Source: Google earth, modified by the ATSB

Table 1 provides a summary of witness observations. Each of the witnesses were pilots and their locations corresponded to the numbers in Figure 1.

¹ Eastern Standard Time (EST) was Coordinated Universal Time (UTC) + 10 hours.

² Runway number: the number represents the magnetic heading of the runway.

Witness	Observation
1	The witness was airborne in the circuit area and preparing to land on runway 12. They reported hearing a radio call from the pilot of FRT saying the aircraft was operating on 06. The witness reported that FRT's take-off roll seemed normal until the aircraft banked sharply in what appeared to be a controlled turn to the left, before half-rotating and diving into runway 12/30. The witness reported that they did not see a high aircraft nose-up or hear any further radio calls.
2	The witness's view was reported to have been obstructed by hangars to the west. Consequently, the witness only viewed the final stages of the take-off. The witness reported hearing the roar of the engine and observing the aircraft just above tree level in a high nose-up attitude. The witness stated that the aircraft 'just about stood on its tail', before the airspeed appeared to decrease prior to impact.
3	This witness was co-located with witness 2 and similarly only viewed the final stages of the take-off due to their view being obstructed. They reported that the engine sounded like it went rapidly from 'dead silent' to 'full power'. The witness reported observing the aircraft pitch up, with the aircraft's belly visible before it impacted the ground with the left wing down.
4	The witness was working in a communications van for a gliding club at the left side of the threshold of runway 12. They reported hearing the start of the take-off but did not observe it fully as it was initially obscured by trees. When the aircraft came into view above the tree line, the take-off seemed normal to the witness. Overhead the intersection of the runways, at an estimated 130 ft above ground level, the left wing was observed by the witness to drop slowly at first and then the speed of the wing drop and angle of bank increased. The nose then dropped and the aircraft was reported to impact the ground at a near-vertical angle. The witness indicated that it appeared that the pilot may have been attempting to land on runway 30. The witness did not recall any specific engine and propeller sounds during the accident sequence.
5	The witness was also working in the communications van with witness 4. They reported observing the aircraft when it came into view above the tree line. The witness stated that the aircraft appeared to be in a 'hard, unbalanced turn' to the left, and that the nose was raised, like it was trying to gain height. The witness assessed that the aircraft then stalled. ³ They reported that it looked like the pilot wanted to land on runway 12/30. The witness did not hear any change in the aircraft's engine or other sounds.
6	The witness was conducting glider recovery to the left of runway 12 in company with witnesses 7 and 8. The witness did not observe the aircraft take-off before it started a turn to the left. The witness stated that the aircraft's nose was pitched high (30° to 40°) and that the aircraft was rolling left. In the opinion of the witness, it appeared to be a 'classic stall into a spin', and that that the pilot was trying to recover the aircraft and land on runway 30. The witness did not hear any change in the aircraft's engine or propeller sounds, but felt that the engine was running when the aircraft impacted the ground.
7	The witness was also conducting glider recovery to the left of runway 12 with witnesses 6 and 8. They reported observing the aircraft above tree height and assessing that it was in a fairly steep climb. The witness stated that they heard the engine power reduce like the throttle came back, and that the aircraft visibly slowed down, but the aircraft's pitch attitude remained the same. The aircraft was then reported to have banked to the left, like the pilot was trying to land on 30, before colliding with the ground left wingtip first.
8	The witness was co-located with witnesses 6 and 7. Their attention was reported drawn to the aircraft after hearing witness 7 state 'this isn't right'. They assessed the aircraft was nose up at an angle of about 45° to the horizon and was not gaining height or airspeed. It then rolled to the left and descended nose first into the ground. They reported that the engine and propeller were operating the whole time, but they were unsure about how much power was being produced.
9	The witness was located adjacent to runway 06 and had an uninterrupted view of the entire take-off and accident sequence. They reported observing the aircraft commence its take-off from the start of the runway, becoming airborne at the runway 06 displaced threshold markers. The aircraft was reported in a 'normal' take-off attitude until it was abeam the fuel bowser, when the engine was heard to 'throttle back', similar to it being reduced to idle. A second or two later, while at an estimated height of 200 ft, the aircraft was observed to bank left in what was described as a coordinated turn. The aircraft remained nose up and the witness assessed that the speed reduced while the bank angle increased. The aircraft then appeared to the witness to enter a stall/spin before colliding steeply with the ground. The witness assessed that the pilot was attempting to turn and land on runway 12/30.
10	The witness was working in a hangar and stated that the take-off was heard but not seen. They reported that the aircraft initially sounded 'normal', before a significant engine power reduction was heard, followed a few seconds later by a power increase. In response, the witness starting walking towards the hangar door when a loud bang was heard. They then observed smoke and flames coming from the vicinity of the accident site.
11	The witness observed the aircraft start its take-off prior to becoming obscured by the hangars. The aircraft was reported to come back into view once it climbed above hangar height. The aircraft was observed to make a shallow left banking turn of about 10° to 20° with a pitch-up angle of about 5° before again being lost from view. They then heard a loud thump. The witness reported that there was 'nothing unusual' about the engine and propeller sounds during the entire sequence.
12	The witness was adjacent to runway 06 waiting to taxi an aircraft across the runway. The witness reported that, as they were wearing a helmet and headset, they could not hear external sounds. They indicated that they observed the aircraft take-off and climb normally, before turning left at about 100 to 200 ft, with the bank angle increasing. The aircraft then entered a very steep nose-down angle and collided with the ground left wing first.

³ Aerodynamic stall: occurs when airflow separates from the wing's upper surface and becomes turbulent. A stall occurs at high angles of attack, typically 16° to 18°, and results in reduced lift.

Context

Pilot information

The pilot was appropriately qualified to conduct the private category flight in the Cessna U206 aircraft. Most of the pilot's flight training was conducted at Caboolture Airfield, meaning that they were very familiar with the airfield layout. The pilot was also familiar with parachute operations, having worked for the parachuting operator on a casual basis since August 2011. The pilot was reported to have been well rested with no medical issues or sickness on the day of the accident. Table 2 lists the pilot's experience and license types at the time of the accident.

Table 2: Pilot details

Licence details:	Commercial Pilot (Aeroplane) Licence, issued February 2010
Endorsements:	Manual propeller pitch control, retractable undercarriage, single engine aeroplanes less than 5,700 kg maximum take-off weight
Ratings:	Jump pilot and jump pilot examiner authorisations
Medical certificate:	Class 2 ⁴ (valid, no restrictions)
Flying experience (total hours):	Approximately 1,100 ⁵
Hours on type:	Approximately 500
Hours flown last 90 days:	Approximately 42
Last flight review:	30 January 2014

Post-mortem examination and toxicological analysis did not identify any pre-existing medical conditions that may have contributed to the accident.

Aircraft information

The Cessna Aircraft Company (Cessna) U206G is a high-wing, fixed tricycle undercarriage, single piston-engine aircraft, with a three-bladed variable pitch propeller. The aircraft is normally configured with six seats and dual controls. These controls allow for the aircraft to be flown from either the left or right pilot seat.

The aircraft is commonly converted for parachuting operations due to its relatively low purchase price, lifting capacity and double cargo doors which, when removed, allow for a large exit at the right-rear of the aircraft.

The accident aircraft, serial number U20604019, was manufactured in the United States (US) in 1977 and was first registered in Australia as VH-FRT (FRT) that year (Figure 2). The owner/operator at the time of the accident purchased the aircraft, and had it modified for parachuting operations, in September 2010. FRT, the operator's only aircraft, was used for parachute training operations from that time until the accident.

The aircraft had a current certificate of appointment of registered operation, certificate of registration and was approved for day and night operations under the visual flight rules⁶. It had accumulated about 11,110 hours total time in service at the time of the accident.⁷

⁴ Parachuting operations were conducted in the private flight category, requiring the pilot to hold a Class 2 Aviation Medical Certificate.

⁵ The pilot's total flying experience could not be accurately determined as their logbook was unable to be located and was thought to have been in VH-FRT at the time of the accident.

⁶ Visual flight rules (VFR): a set of regulations that permit a pilot to operate an aircraft only in weather conditions generally clear enough to allow the pilot to see where the aircraft is going.

Figure 2: VH-FRT



Source: Supplied

Pilot seat

The Pilots Operating Handbook stated that the pilot seat may be moved forward or aft and adjusted for height, and that the seat back angle was infinitely adjustable.

The seat slides fore and aft along two seat rails that are fixed to the aircraft's floor. The seat is secured in the desired position by the primary seat stops, which are controlled via a lever under the front of the seat base. The seat rail also has two rail stops, located at each end of the inboard rail. The rail stops limit the fore/aft seat movement, ensuring that the seat feet remain attached to the rails.

The seat can be moved to the aft end of the rail to allow the pilot unrestricted movement in and out of the aircraft's forward-left door. Removal of the rail stops is required to remove the seat for maintenance.

A number of pilot forums and publications have discussed uncommanded rearward movement of the pilot seat(s) in Cessna aircraft.

Primary seat stop

Each seat rail has 15 locator holes, which allow the pilot to select their desired fore/aft position in relation to the flight and engine controls. Lifting the control lever raises two primary seat stop pins clear of the locator holes and allows the pilot to move the seat fore and aft on the rails. Releasing the lever allows spring pressure to pull the latch pins down and engage in the holes on both seat rails to prevent further movement (Figure 3).

⁷ The aircraft's total time in service at the time of the accident was calculated using the last documented hours and the aircraft's average usage since September 2010.



Figure 3: Exemplar primary seat stop mechanism showing the primary seat stop (latch) pin engaged in the seat rail at left inset (circled in red)

Source: ATSB

Pilot seat rail inspection

The US Federal Aviation Administration (FAA) released Airworthiness Directive (AD) 2011-10-09 *Seat Rails and Roller Housing Inspections* to provide inspection criteria and limitations for seat rails and associated seat components in response to the following identified 'Unsafe Condition':

This AD was prompted by reports of seats slipping on the rails where the primary latch pin for the pilot/co-pilot seat is not properly engaged in the seat rail/track and reports of the seat roller housing departing the seat rail. We are issuing this AD to prevent seat slippage or the seat roller housing from departing the seat rail, which may consequently cause the pilot/co-pilot to be unable to reach all the controls. This failure could lead to the pilot/co-pilot losing control of the airplane.

The AD became effective on 17 June 2011 with compliance due every 100 hours or 12 months, whichever came first.

Secondary seat stop modification

On 14 May 2007, Cessna issued Single Engine Service Bulletin (SEB) 07-5 *Pilot and co-pilot secondary seat stop installation*. Cessna advised that the secondary seat stop is an additional device installed on the pilot or copilot seat that assists in preventing uncommanded rearward movement of the seat. The device provides an additional margin of safety by limiting the aft travel of the seat should the primary latch pins not be engaged in the seat rail. It is essentially a belt on an inertia reel that connects the seat frame to the cabin floor (Figure 4).

Cessna stated that the service bulletin was mandatory for the pilot seat and recommended for the copilot seat. Both should be accomplished within the next 200 hours of operation or 12 months, whichever came first. The service bulletin also advised that the costs associated with installation

of the pilot seat kit and associated labour, including freight costs as arranged through Cessna, would be reimbursed if the claim was submitted within 30 calendar days of the stipulated service bulletin compliance date. That was, before 14 May 2009.







Five further revisions to the service bulletin were issued between 17 December 2007 and 11 November 2013. These revisions changed the final mandatory⁸ compliance date to 11 November 2014 or 200 flight hours from the issue date, whichever came first. Cessna advised that ongoing revisions of the service bulletin were provided to extend the reimbursement period due to some kit supply delays and to allow coordination with maintenance inspections.

The ATSB sought a determination from the Civil Aviation Safety Authority (CASA) on whether the manufacturer's service bulletin was mandatory in Australia. CASA stated that, even though the manufacturer categorised the service bulletin as mandatory for the pilot's seat, it was not considered mandatory in Australia. CASA explained that as the regulator from the country of manufacture (US FAA) had not issued an AD to mandate the service bulletin, it had not automatically become mandatory in Australia.

The ATSB notes that CASA has previously issued ADs in response to significant safety issues.

Missing pilot's seat rail rear stop

The maintenance manual procedures for removal and fitment of the pilot's seat stated that the seat rail stops are to be installed on the inboard rail at each end, and are provided to limit fore and aft seat travel so that the seat feet remain engaged in the rails. The following warning was provided:

It is extremely important that the pilot's seat stops are installed, since acceleration and deceleration could possibly permit [the] seat to become disengaged from [the] seat rails and create a hazardous situation, especially during takeoff and landing.

Figure 5 shows an example of a U-shaped seat rail stop fitted in the rear of a pilot's seat rail.

⁸ Mandatory in accordance with the manufacturer's requirements, but not mandated by an airworthiness directive from the US FAA.



Figure 5: Exemplar pilot seat rail rear stop

Source: ATSB

A report from a person who observed FRT while it was on the ground a week before the accident reported that the pilot's seat rear rail stop was missing at that time. In addition, it was reported that the rear feet of the pilot's seat were sitting outside the rear of the rails when the seat was fully back. The person, who was also a qualified pilot, further stated that they placed the seat feet back in the seat tracks and reported the issue to the pilot. The operating pilot that day was the same as was operating the aircraft at the time of the accident.

Review of a number of parachuting videos from previous flights identified that the pilot's seat rear rail stop was in place up until 16 February 2014 (Figure 6). Several other videos confirmed that the rear rail stop was missing for flights after that date, including the flight immediately prior to the accident (Figure 7). It could not be determined from the videos if the seat feet were outside the seat rails during any of those flights.

Figure 6: Seat rail stop fitted



Figure 7: Seat rail stop not fitted

Source: Supplied

Engine and propeller

The engine and propeller fitted to FRT were not standard for the Cessna U206G. Instead, they were installed as part of an approved supplementary type certificate on 19 March 2010. According to the certificate holder, the modified engine and propeller combination provided a better power to weight ratio for increased take-off and climb performance. Since fitment, the engine and propeller underwent several periodic inspections with no major maintenance issues noted in the engine logbook. Tables 3 and 4 show the engine and propeller details.

Manufacturer:	Teledyne Continental
Model:	IO 550N 56B
Туре:	6 cylinder, horizontally opposed, fuel injected
Serial number:	100798
Time since overhaul:	591.5 hours at last maintenance release - 12 February 2014
Total time in service:	Engine total time in service zeroed at the last rebuild, prior history unknown

Table 3: Engine information

Table 4: Propeller information

Manufacturer:	Hartzell
Model:	PHC-J3YF-1RF
Туре:	3 blade, controllable pitch
Serial number:	FP7140B
Time since overhaul:	591.5 hours at last maintenance release – 12 February 2014
Total time in service:	591.5 hours at last maintenance release – 12 February 2014

Aircraft maintenance and modification history

A review of maintenance records identified that the aircraft was maintained in the Class B charter/airwork⁹ category in accordance with Civil Aviation Regulation (CAR) 42B Maintenance Schedule 5. This included a requirement for a periodic inspection every 100 hours or 12 months, whichever came first. The last 100-hourly periodic inspection was conducted on 12 February 2014 at 11,092.6 flight hours.

Pilot seat and rail inspection

The last seat rail inspection was conducted as part of the 100-hourly inspection 6 weeks prior to the accident, in accordance with AD 2011-10-09. Prior to that, the AD was carried out on 23 August 2013, when the left outboard pilot seat rail was found to be outside of serviceable limits. The rail was replaced with an aftermarket item manufactured under a parts manufacturing approval. The work sheets noted that some rivets on the left inboard pilot seat rail were replaced at that time.

Secondary seat stop service bulletin

The secondary seat stop was not fitted to FRT at the time of the accident however, the aircraft was still within the manufacturer's compliance date for the modification. The owner reported that a kit was ordered for the aircraft after the last 100-hourly inspection.

⁹ Although the aircraft was operated in the private category, the regulations stipulated that the aircraft had to be maintained in the charter category.

Parachute operation modification

Maintenance documentation indicated that the modifications to the aircraft to enable parachute operations were completed on 8 October 2010 and included the:

- removal of all seats with the exception of the pilot seat
- replacement of the right passenger double doors with a retractable wind deflector (blind), which could be manually closed by the pilot once the parachutists had departed the aircraft
- installation of two external grab handles, a step, six single-point restraints and a parachuting floor mat
- disconnection of the copilot's control column (corresponding with the right control seat) by removal of the elevator pushrod and the control yoke, including a duplicate inspection (Figure 8).

Figure 8: Copilot's control column assembly showing the elevator pushrod disconnection points and control yoke



Source: Cessna, modified by the ATSB

A review of the work sheets for the modification did not identify any part numbers, serial numbers or release notes for the parts fitted. The engineer who oversaw the modifications advised that the components installed in FRT were removed from the owner's previous aircraft.

The first three modifications detailed above were conducted under CAR 35¹⁰ engineering orders. Although also required to be, the copilot's control column disconnection was not removed in

¹⁰ An approval by CASA, or an authorised person, made pursuant to CAR 35. An approval under CAR 35 signified that the design of a repair or modification to an aircraft complied with the design standard applicable to that aircraft.

accordance with an approved maintenance procedure or engineering order. The licensed aircraft maintenance engineer (LAME) who supervised the task advised that the modification was quite common and confirmed that it was not conducted in accordance with an approved procedure. When queried about the conduct of the task, the LAME stated that the elevator pushrod would have been removed in its entirety and the control column secured with a cable tie to a stationary point behind the instrument panel to prevent it from moving freely in and out. Removal of the control column allowed a parachutist to be seated against the control panel on the copilot's side without interfering with the flight controls.

The LAME who conducted the modification on FRT stated that they could not remember how it was conducted. However, they thought that in the Cessna 206 the pushrod could be removed from the control column, or disconnected with the end tied back out of the way.

With regards to this modification, Cessna advised that the copilot's (right) control yoke is a required part of the aircraft and there was no manufacturer-approved maintenance procedure for operation with the copilot's yoke disconnected. They indicated that they were familiar with a modification to disconnect the copilot's control column, but that it should be done with regulatory approval.

The parachuting operations were recorded on each flight by the tandem skydive instructors, using wrist-mounted, solid-state video recorders. A number of videos of parachuting preparation training, flights to altitude and parachute jumps from 4 January to 22 March 2014 were reviewed. The last available recording was of the flight preceding the accident.

Video footage taken on 8 February 2014 from inside FRT during a parachute flight showed that the copilot's control column had moved a substantial distance out of the control panel (Figure 9). That indicated that the control column was not secured to a stationary point behind the instrument panel as indicated by the LAME who supervised the original modification for parachuting operations.



Figure 9: VH-FRT in flight on 8 February 2014 with the copilot's control column protruding out of the control panel

Source: Supplied

The aircraft owner stated that following the right control column modification, it was reconnected for use by a pilot operating in command under supervision. Such flights required the use of the pilot's and copilot's seats and controls. There was no maintenance log or maintenance release entry recording the flight control reconnection or disconnection by a LAME. Despite being required by the regulations following primary flight control disturbance, no independent inspection certification was recorded.

Right wheel brake defect

Two people who participated in recent tandem skydives in FRT, including one on the day of the accident, stated that there may have been an issue with the aircraft's wheel brakes. Both witnesses indicated that their pilot conducted a 270° turn to the left in order to turn right. One of these witnesses also reported overhearing the pilot discussing an issue with the use of the right wheel brake.

The Cessna 206 Pilot Operating Handbook stated that:

Effective ground control while taxiing is accomplished through nose wheel steering by using the rudder pedals. Left rudder pedal to steer left and right rudder pedal to steer right. When the rudder pedal is depressed, a spring loaded bungee (which is connected to the nose gear and rudder bars) will turn the nose wheel through an arc of approximately 15 degrees. By applying either left or right brake, the degree of turn may be increased up to 35 degrees each side of centre.

The 270° left turns reported by the witnesses suggested that the pilot may have been experiencing difficulty turning the aircraft to the right while taxing. This may have been due to an ineffective right brake and asymmetric steering. An entry in the logbook for maintenance on the right brake included resealing and bleeding the calliper on 12 February 2014. When asked about the possible brake issue, the owner indicated that the right brake calliper was leaking and he had asked the pilot to refrain from using the brakes unless it was absolutely necessary.

If allowed to continue, a defect such as a leaking brake could result in the oil remaining in the brake system being depleted to a point where braking effectiveness reduced or was rendered

ineffective. The ATSB was unable to determine if the right brake system was degraded at the time of the accident.

Previous aircraft damage

The ATSB identified the following previous damage and unserviceability to FRT that was rectified prior to the accident:

- fuselage structural damage
- nose landing gear collapse and subsequent nose gear drag link bolt replacement.

Fuselage structural damage

Maintenance documentation recorded a significant structural repair to the rear fuselage between 26 July and 23 August 2013. An insurance report indicated that the:

- rear fuselage bulkhead frame was buckled on the right top and bottom edges
- right-rear fuselage skin below the quarter window was creased (Figure 10)
- right fuselage skins and corresponding stringers aft of the double door opening were dished inwards and that all required replacement.

The LAME who conducted the repair advised that the full extent of the damage was only visible following removal of the interior trim and upholstery.

18.07.2013 10:32

Figure 10: Right-rear fuselage damage (looking to the rear of the aircraft)

Source: Supplied

Figure 11 shows the extent of the repair to the right-rear fuselage.



Figure 11: Right-rear fuselage repair (the extent of the repair is indicated by the two-tone, unpainted grey area)

Source: Supplied

The aircraft owner stated that when they became aware of the fuselage damage they questioned the pilot¹¹ who had been operating the aircraft as to the cause. The pilot reportedly stated that they could not recall any event that could have contributed to the damage.

The ATSB sent the insurance report photos of the damage to FRT to Cessna for assessment. Cessna responded that:

The deformations seen in the aft fuselage skin and in the FS 138 Bulkhead, are consistent with damage seen on other Cessna model 206's after the cargo door was not latched properly and the rear half of the door came open in flight.

Cessna provided photographs of similar damage to two other Cessna 206 aircraft.

While the cause of the fuselage damage to FRT could not be determined, Cessna indicated that the level of damage sustained would have required inspection by a suitably-qualified engineer to assess the aircraft's serviceability before further flight. Cessna stated further that after engineering inspection, the two aircraft that sustained damage similar to that by FRT were permitted to remain in limited service, prior to repairs/replacement of damaged skins and bulkheads. Cessna also noted that the damage to FRT was '...most likely not extensive enough to have made the aircraft's tailcone incapable of withstanding 206 Type Design Loads.'

The insurance report and aircraft maintenance documentation showed that the aircraft was operated for 5 months, encompassing about 44 flight hours, following identification of the damage. The aircraft's maintenance release did not have an endorsement to show that the aircraft tail

¹¹ Not the same pilot as operated the aircraft at the time of the accident.

section was damaged, or that it had been assessed for serviceability as required by the regulations during that period. The aircraft was then flown to a maintenance facility for that assessment and repair as part of its scheduled 100-hourly maintenance inspection. Following an engineering assessment, the aircraft was grounded until completion of repairs to the tail section.

Nose landing gear

Maintenance documentation indicated that a nose landing gear bolt was replaced and a repair carried out to the wheel well. The aircraft owner reported that they became aware of this unserviceability when advised by a pilot while the aircraft was at Caboolture Airfield. The owner indicated that, with people weighting the tail, the nose was raised sufficiently to see that the nose landing gear drag-link bolt had sheared and that the nose gear leg was resting on the forward wheel well structure. The owner advised that the bolt was replaced and the aircraft flown to Archerfield Airport, Queensland to enable repair of the wheel well. A 100-hourly inspection was also carried out at that time.

There was no maintenance log entry or release endorsement for the defect or field replacement of the bolt at Caboolture Airfield. Further, the normal maintainers of the aircraft had no knowledge of the field repairs to the aircraft. According to the maintenance documentation, the bolt that was fitted during the field repair was subsequently replaced with an item ordered from Cessna. The bolt replacement and wheel well repair were certified at the last periodic inspection on 10-12 February 2014. The ATSB could not ascertain who conducted the field repair and interim fitment of the nose landing gear drag link bolt.

Parachutists' cabin position

The owner of FRT indicated that the parachutists were typically loaded from the front to the rear of the aircraft, all facing rearwards (Figure 12). The normal configuration for a dual tandem jump¹² was for one instructor to sit on the floor adjacent to the pilot. The tandem parachutist would sit directly behind the instructor to which they were tethered for the parachute jump. The other instructor and their tandem parachutist would be positioned directly behind the pilot's seat in a similar manner, with the back of the instructor's parachute resting against the back of the pilot's seat.

Video footage from two previous flights, including the flight immediately prior to the accident, showed that the tandem instructor seated behind the pilot's seat was further to the rear of the aircraft than the normal position as reported by the aircraft owner. This instructor's tandem parachutist was seated adjacent to them, on the right of the aircraft. This variation from the advised normal configuration may have been done with the intention of getting better video footage of the tandem parachutist. The same two parachute instructors as involved in the immediately-preceding flight were on the accident flight.

The ATSB was unable to ascertain the configuration of the parachutists at the time of the accident. However, if the instructor was positioned away from the pilot's seat in the same manner as the previous flight, in the absence of appropriate seat locking, there would have been no impediment to uncommanded rearward movement of the pilot seat during take-off.

¹² Involving two instructors and two tandem parachutists.





Source: ATSB

Weight and balance

The aircraft's take-off weight was calculated to be about 3,162 lb (1,434 kg) at the time of the accident, which was 438 lb (199 kg) below the aircraft's maximum take-off weight of 3,600 lb (1,633 kg). The aircraft's calculated take-off performance and ground roll at that weight was consistent with the witness reports of the aircraft being airborne by the displaced threshold of runway 06.

The aircraft's centre of gravity (c.g.) was calculated for the seating configurations from the previous flight and for the reported normal seating configuration. Given the estimated operating weight at the time of the accident, the aircraft's c.g. was in limits for both seating configurations.

The ATSB considered the effect on the c.g. if, during the take-off and climb, the parachutists shifted toward the rear of the aircraft or, during the initial left turn, to the left of the aircraft due to them being unrestrained. A shift rearward could have moved the aircraft's c.g. outside the aft limit of the aircraft's flight envelope, thus making pitch control of the aircraft more difficult.

Stall speed

Aircraft stall speed is dependent on a number of factors including the aircraft's weight, its c.g., the flap setting and the angle of bank. For example, the stall speed at maximum take-off weight with flaps retracted, power off and zero angle of bank was 55 kt. If the angle of bank was increased to 45° the stall speed would increase to 65 kt, meaning that the pilot would be required to fly the aircraft faster in a steep turn to avoid an aerodynamic stall. Other stall speeds for different aircraft configurations are detailed in appendix A.

Fuel management

The aircraft was approved to use 100 LL grade aviation fuel or 100 (formerly 100/130) grade aviation fuel. The fuel system consists of one 46 US gallon (174 I) tank in each wing, providing a total of 88 US gallons (333 I) of usable fuel. Each tank gravity feeds to a corresponding reservoir

with a fuel selector valve determining which side is the feeder tank. The fuel selections consisted of LEFT, RIGHT and OFF positions. The system also contained auxiliary and engine-driven fuel pumps.

The operator's fuel management procedure was that pilots generally refuelled one wing of the aircraft with flight fuel and that the other wing was used to carry the fixed reserve fuel. Pilots were instructed to fly with a minimum fuel load for the flight to prevent possible overloading when seven occupants were carried.

To ensure pilots maintained a maximum fuel load of 100 I, the operator limited the amount of fuel the pilots could purchase. On the day of the accident, the pilot refuelled the aircraft at the Caboolture Airfield refuelling facility with 28 I of 100 LL at 0853 and again at 1055 with 30 I. A flight duration of about 25 minutes at an aircraft weight of 3,300 lb and including a climb to 12,000 ft was estimated to burn about 30 I. That fuel usage was consistent with the amount of fuel taken on board by the pilot at each refuel on the day of the accident.

Other aircraft refuelled using the same batch of fuel from the Caboolture Airfield facility before and after the accident. There were no reported fuel-related problems from the pilots of those aircraft.

Examination of the wreckage identified that the aircraft's fuel tank selector was in the left tank position. This was consistent with reports by the operator that the pilot would normally refuel and select the left fuel tank for use during flight and hold the contents of the right tank as the fixed reserve.

While it was not possible to identify the amount of fuel remaining in the left fuel tank prior to refuelling, the fuel amounts added to the aircraft prior to each of the parachuting flights were sufficient for the intended flight.

Meteorological information

Weather information was not recorded at Caboolture Airfield. However, witness accounts and images taken soon after the accident indicated that the prevailing wind was from the east at about 10 kt.

Witnesses also reported scattered cloud¹³ but no rain in the local area at the time of the accident. Weather information recorded at a nearby airport indicated that about 1 hour after the accident the temperature was 27 °C and the QNH¹⁴ was 1016 hPa.

Aerodrome information

Caboolture Airfield is at an elevation of 40 ft above mean sea level and has two grass runways, 12/30 and 06/24. It was reported that prior to the accident flight, the pilot operated from runway 12.

Witnesses indicated that the pilot commenced the take-off at the runway 06 threshold, allowing use of the runway's full length of 1,120 m (Figure 13). It was estimated that a slight crosswind from the right and a 10 kt headwind component affected the take-off. As the pilot reportedly became airborne by the displaced threshold markers, about 820 m of useable runway remained at that time in case of an aborted take-off.

¹³ Cloud cover: in aviation, cloud cover is reported using words that denote the extent of the cover – 'scattered' indicates that cloud is covering between a quarter and a half of the sky.

¹⁴ QNH: the altimeter barometric pressure subscale setting used to indicate the height above mean sea level.



Figure 13: Caboolture Airfield, showing runways 06 and 12 and the respective thresholds

Source: Caboolture Aero Club Inc., modified by the ATSB

Management of engine power loss

Engine failure during take-off

Cessna U206G Pilot Operating Handbook

The Cessna U206G Pilot Operating Handbook highlighted that insufficient altitude and airspeed can inhibit a turn back to the runway following an engine failure after take-off. The handbook recommended that the pilot should:

- · promptly lower the nose to maintain airspeed
- establish a glide attitude
- plan to land straight ahead with only small changes in direction to avoid obstructions.

Australian Parachute Federation Jump Pilots and Aircraft Operations Manual

The Australian Parachute Federation (APF) Jump Pilots and Aircraft Operations Manual also provided guidance for managing engine failures. It stated that in the event of the aircraft suffering an engine power loss during take-off or initial climb out, it might be necessary for the pilot to conduct a forced landing. The manual highlighted that the pilot should maintain control and not turn back to the airfield.

Further, the manual identified that in the event of an engine failure, the pilot should check that the parachutists' equipment had not:

- pulled the mixture towards idle cut-off
- unlocked the fuel primer
- turned off the magnetos
- retarded the throttle
- turned off the fuel.

Aeroplane flight review

The management of engine failures and other emergency procedures were required to be assessed during pilot's biennial flight reviews. The pilot conducted an aeroplane flight review from Caboolture Airfield in January 2014. The flight review records showed that the pilot satisfactorily demonstrated:

- · the correct procedure following an engine failure after take-off
- · recognition of and recovery from an aerodynamic stall
- proficiency in the conduct of a practice forced landing.

The flight review assessment form did not indicate if a partial engine power loss was simulated or if the engine failure procedures in the aircraft Pilot Operating Handbook or APF Jump Pilots and Aircraft Operations Manual were reviewed.

Pilot decision making during a partial power loss on take-off

The ATSB published an avoidable accidents report titled *Managing partial power loss after take-off in single-engine aircraft* (www.atsb.gov.au). The report identified the difficulties distinguishing between partial power loss and complete engine failures during take-off as follows:

From January 2000 to 31 December 2010, there were 242 occurrences (nine of which were fatal) reported to the ATSB involving single-engine aircraft sustaining a partial engine power loss after take-off and 75 occurrences (none of which were fatal) reported as sustaining an engine failure [complete power loss] after take-off.

A partial power loss presents a more complex scenario to the pilot than a complete engine power loss. Pilots have been trained to deal with a complete power loss scenario with a set of basic checks and procedures before first solo flight. Furthermore, this training, which encompasses the limited time available to respond, is continually drilled in an attempt to make it second nature. However, pilots are not generally trained to deal with a partially failed engine. Following a complete engine failure a forced landing is inevitable, whereas in partial power loss, pilots are faced with making a difficult decision to continue flight or to conduct an immediate forced landing.

The course of action chosen following such a partial power loss after take-off can be strongly influenced by the fact that the engine is still providing some power, but this power may be unreliable. As the pilot, you may also have a strong desire to return the aircraft to the runway to avoid damage associated with a forced landing on an unprepared surface.

The report identified that pilots may focus on the negative consequences of an off-field landing, and therefore try to avoid it by attempting to land back on the airfield from which they departed. Accident statistics show that attempted turn backs with reduced power can lead to an aerodynamic stall and loss of control at an altitude from which it is too low to recover before impacting terrain.

Wreckage and impact information

Overview

The accident site was located in the area between runway 12 and the airfield perimeter fence. Ground scarring and impact marks indicated that the aircraft's left wingtip touched the ground first, then the nose section, before the aircraft came to rest, inverted, about 35 m beyond the initial impact point (Figure 14). The wreckage trail was orientated on a magnetic bearing of about 340°.

All major aircraft components were identified in the wreckage. Additionally, a search of the aircraft's flight path did not reveal any other aircraft components outside the immediate area of the main wreckage, or any evidence of a bird or animal strike. Most of the aircraft, including the cabin area, was destroyed by the post-impact, fuel-fed fire. This precluded a detailed examination of numerous components. However, no pre-accident structural defects were identified.



Figure 14: Main wreckage and accident site looking north-north-west, showing the left wing point of impact in the foreground and the fuselage and engine in the background

Source: ATSB

There were three propeller slash marks in the ground commencing about 9.5 m along the wreckage trail from the initial ground contact mark. An approximate angle of impact of 60° nose down was calculated from the angle of the propeller slash marks with the ground.

Flight controls

The flight control system and cables were examined to the extent permitted by the fire and impact damage. With the exception of one elevator trim cable, which was worn but not to the point of failure, all cables, chains and rods inspected showed no evidence of pre-existing defects.

The copilot's control yoke was not located in the wreckage and information provided later revealed that it was removed as part of the modification of the aircraft for parachute operations. The pushrod that connected the copilot's elevator arm assembly to the control column was also found disconnected and the associated bolt was not located. However, the pushrod was still attached to the elevator arm assembly (Figure 15).



Figure 15: Copilot's elevator control pushrod showing the disconnected rod end

Source: ATSB

Inspection of the flap actuator indicated that the flaps were in the fully-retracted position at the time of impact with terrain.

Examination of the elevator trim actuator identified that it was in the neutral position. However, because of the disruption associated with the accident sequence, that position may not have been an accurate reflection of its position at the time of the accident.

Propeller

The propeller detached from the engine due to an impact-related overstress fracture at the crankshaft attachment point. It came to rest between the initial impact point and the main wreckage, outside the fire-affected area. For further details, refer to the section titled *Examination of recovered components*.

Engine and engine components

The engine was located with the fuselage and was extensively fire damaged. Only the butterfly mechanism of the fuel control was evident, the rest of the component having melted. Continuity of the throttle linkage from the butterfly, through the engine firewall, to the cockpit was confirmed. Additionally, continuity of the mixture control linkage was established. For more details of the engine examination, refer to the section below.

Examination of recovered components

A number of items and components were recovered for technical examination, including:

- two digital video recorders
- the engine assembly
- the propeller
- several flight control components
- several fuel system components
- parts of the pilot's seat and associated seat rails.

Video recorders

Two video recorders were located in the aircraft wreckage. Both recorders had extensive thermal damage that prevented retrieval of any stored imagery.

Engine assembly

The engine was disassembled and examined at a CASA-approved engine overhaul facility under the supervision of the ATSB. The engine showed evidence of ground impact damage on the forward-left corner and extensive fire damage. The section of crankshaft that connected to the propeller had failed due to overstress associated with the ground impact (Figure 16).

Figure 16: Upright engine assembly viewed from the left side showing extensive fire damage



Source: ATSB

The propeller governor, which is located on the forward-left of the engine, had separated from its mounting point and its drive shaft had failed due to impact forces.

Damage to the external engine components prevented their functional testing. However, all external components were disassembled and inspected to the extent possible, with no defects identified.

Several engine crankcase and cylinder through-bolt securing nuts were either cracked or missing. The corresponding through-bolts had migrated through the crankcase. The cracked nuts were examined by the ATSB and found to have failed due to overstress, with no evidence of fatigue cracking or hydrogen embrittlement. The engine manufacturer indicated that in situations where the engine is exposed to post-impact fire, the through-bolt nuts tend to fail due to crankcase expansion loads.

Although not considered to have influenced the development of the accident, the plain bearings that support the crankshaft exhibited greater wear than would be expected of an engine with about 600 hours in service. This advanced wear may have been due to the nature of parachute operations, which include multiple take-off-climb-descent-land power cycles and associated changes in engine operating temperatures.

In summary, examination of the engine and associated components did not identify any pre-existing defects that may have contributed to the accident.

Propeller

The propeller was functionally tested prior to disassembly and inspection at a CASA-approved propeller overhaul facility under the supervision of the ATSB.

Inspection of the propeller actuator oil pressure tube showed that it was about 75 per cent obstructed with a build-up of a grey, solidified substance (Figure 17). There was also a significant amount of the substance around the outside of the oil tube. The substance was most likely a by-product of mineral-type engine oil.

The effect of the obstruction would be that the propeller was less responsive to pitch changes commanded by the propeller governor or from pilot-initiated control changes. The initial actuator tests showed that the propeller was still capable of adjusting the pitch of the propeller blades. The propeller overhaul facility personnel noted that the build-up of grey material was not unusual, but that it was unusually large for a propeller that had only run about 600 flight hours. The ATSB assessed that the obstruction did not contribute to the accident.

Figure 17: Rear of the propeller hub showing the obstruction of the oil pressure tube by the build-up of grey, solidified substance



Source: ATSB

Transfer marks from the propeller blade pitch change linkages on the propeller hub internal components indicated that the propeller blades were in fine pitch on contact with terrain. Fine pitch is the normal propeller blade position for take-off and low-speed flight.

Inspection of the propeller blades showed chordwise paint abrasion and twisting damage and rearward bending (Figure 18). Examination of the spinner showed deformation opposite to the direction of rotation. The propeller hub showed impact marks indicative of rotational and rearward propeller blade loading. The pitch change links had sheared due to twisting loads. Inspection of the remaining section of crankshaft and propeller hub attachment pad showed that it failed predominantly due to side loads.

The propeller damage indicated that the engine was operating and driving the propeller when it impacted terrain. The exact amount of engine power was unable to be determined; however, it was considered to be significant. No pre-accident defects were identified in the propeller system that would have contributed to the accident.



Figure 18: Disassembled propeller showing the propeller blade and spinner damage. Note that the propeller blades are viewed from the trailing edge

Source: ATSB

Fuel selector

The fuel selector was disassembled and examined to ascertain which fuel tank was selected at the time the aircraft impacted terrain. Consistent with the operator's reported normal operating procedure (see the section titled *Fuel management*), the selector was determined to be in the left tank position.

Gascolator

The airframe fuel filter bowl was removed from the housing and some internal debris, oxidation and pitting corrosion was noted. However, the airframe fuel filter appeared free of debris. A gap was noted in the fuel filter in an area where two mating surfaces had been soldered together. Given its low melting point, it was considered likely that the soldered joint separated in the postimpact fire.

Pilot seat components

The primary locking mechanism and three of the four seat feet were the only components from the pilot's seat available for inspection (Figure 19).



Figure 19: Pilot seat locking mechanism and a section of the seat frame

Source: ATSB

A detailed examination of those items revealed that the:

- left primary seat stop had failed at a drill hole about 50 mm above its end due to bending overload from a left-to-right side load
- right primary seat stop was unbroken and did not display any bending or deformation at the point where the stop inserts into the seat rail holes
- three recovered seat feet:
 - were worn in the tang area where they engage with the seat rail, but were still within serviceable limits
 - did not display any splay-type outward bending damage that would be indicative of the seat feet being forced past the seat rail.

Pilot seat rails

The entire outboard pilot seat rail and the front third of the inboard pilot seat rail were recovered from the accident site. The remainder of the inboard rail was thought to have been destroyed by fire (Figure 20).



Figure 20: Recovered sections of the pilot's seat rails

Source: ATSB

The seat rail sections were examined in detail in an attempt to ascertain:

- the pre-accident serviceability of the rails
- the pilot seat position at the time of impact with terrain
- any evidence of primary seat stop and seat feet engagement in the rails at that time.

Where possible, the seat rails were checked for pre-accident serviceability in accordance with the aircraft manufacturer's requirements and were found to be within the stipulated wear limits.

A contact mark was identified that may have been indicative of a seat foot position at the time of the impact with terrain. That mark was located on the outboard rail between the second and third seat stop holes from the rear of the rail (Figure 21). However, it could not be determined if the mark was made by the forward or rear foot of the pilot's seat, or if the seat had moved position before the mark was made. It was therefore not possible to determine the pilot's seat position at the time of the accident.



Figure 21: Pilot seat outboard rail viewed from the right side showing possible pull out damage from the seat foot and the location of the damage

Source: ATSB

Further damage was noted at the rear of the outboard rail (Figure 22), possibly indicating that one seat foot had disengaged from the track on at least one occasion and was sitting on top of the rail with pressure applied. It was not possible to determine when the damage occurred.



Figure 22: Rear of outboard seat rail showing indentation damage

Source: ATSB

Survival aspects

In general, survival in the case of an aircraft accident depends on four separate aspects, the:

- impact forces imparted on the aircraft occupants must be within human tolerance
- occupants being restrained to prevent flail-type injuries
- liveable space inside the aircraft being maintained
- occupants having a means of escape.

The absence of these survival aspects and post-impact fire in this case meant that the accident was not survivable. The limited restraint afforded to parachutists, as compared to restrained, seated occupants, is discussed in the following section.

Occupant restraints

As FRT was configured for parachuting operations, the occupant restraints consisted of a lap sash seatbelt for the pilot and single-point floor restraints for the parachutists.

The condition and configuration of the pilot's seatbelt could not be ascertained due to the extent of the post-impact fire. However, a number of video recordings showed that the pilot normally wore the lap portion of their seatbelt during take-off, without utilising the shoulder harness.

The US National Transportation Safety Board (NTSB) published research paper SR 85-01 titled *Impact Severity and Potential Injury Prevention in General Aviation Accidents*. The paper highlighted the potential benefits of shoulder harnesses in reducing injury as follows:

There were five survivable accidents in which shoulder harnesses were worn by only one of two front-seat occupants. A comparison was made of the relative injuries of each occupant. It was found in each case that injury severity was less for the occupant who wore the shoulder harness.

For example, in one accident each of two occupants sustained serious injuries, but the pilot, wearing a shoulder harness, sustained a broken leg and a slight concussion while the passenger without a shoulder harness sustained severe head injuries. The differences in the injuries in these comparisons were related to head and upper body injuries. Those persons who wore shoulder harnesses had markedly fewer head injuries.

The NTSB research also showed that if an aircraft occupant wore a shoulder harness, they increased their chances of survival by 20 per cent. Further, the chance of serious injury decreased by 32 per cent.

Single-point restraints

Single-point restraints were provided in FRT to secure the parachutists to the floor through their respective harnesses. However, interviews with people who conducted recent tandem jumps with the operator stated that the single-point restraints were not used, nor were they mentioned in their respective safety briefings. The aircraft operator reported using the restraints, and enforcing their use, but also acknowledged that some instructors did not.

As discussed in the following section, while not as effective as dual-point restraints, single-point restraints do provide some survivability benefits in the event of an aircraft accident. Additionally, if installed and secured correctly, they prevent load shift on take-off, which can affect aircraft controllability.

Parachute aircraft restraint research

Following a parachuting accident in the US in 2006¹⁵ the NTSB recommended that, in respect of parachute aircraft restraints, the FAA should:

Conduct research, in conjunction with the United States Parachute Association, to determine the most effective dual-point restraint systems for parachutists that reflects the various aircraft and seating configurations used in parachute operations. (A-08-71)

and that:

Once the most effective dual-point restraint systems for parachutists are determined, as requested in Safety Recommendation A-08-71, [the FAA should] revise Advisory Circular 105-2C, Sport Parachute Jumping, to include guidance information about these systems. (A-08-72)

In support of its safety recommendations, the NTSB highlighted extensive research that was conducted by the Civil Aerospace Medical Institute of the FAA, in conjunction with the US Parachute Association. The research showed that dual-point restraint systems, which attach to parachute webbing, are significantly more beneficial than single-point restraints for rear-facing passengers (the normal parachutist orientation for aircraft without side seating). The FAA responded to the NTSB recommendations stating that:

The recommended guidance [in Advisory Circular 105-2C] provided the relative effectiveness of the restraint options applicable to each seating configuration. The dual point-dual tether restraint method was identified as the superior method available for aft facing occupants. The recommended guidance also included illustrations showing the most effective method for attaching restraints to the parachute harness. In addition, it included the most effective installation geometry for each restraint method. Although the seating and restraint methods available are limited by each aircraft's size and configuration, CAMI recommended that the revised advisory circular guidance provide jump aircraft operators the information they need to implement the most effective restraint configuration applicable to their aircraft. Based upon CAMI's recommendations, we published AC [Advisory Circular] 105-2D, Sport Parachuting, on May 18, 2011.

The relevant section of AC 105-2D was updated in 2013, becoming AC 105-2E *Sport Parachuting*, and is included at appendix B.

Seatbelt and single-point restraint regulatory requirements

CAR 251 required seatbelts to be worn by all crew members and passengers during take-off and landing, during instrument approaches, when the aircraft was flying less than 1,000 ft above terrain and at all times when in turbulent conditions. Sub-regulation 5 also required an operator to appoint a member of the crew to ensure that a seatbelt or safety harness was worn by each occupant during the specified times and to ensure that each belt or harness was adjusted appropriately.

Civil Aviation Order 20.16.3 *Air Service Operations - carriage of persons* sub-section 15 allowed carriage of parachutists without an approved seat as long as they were provided with a position in which they could be safely seated. In addition, except when about to jump, parachutists were required to occupy that seat or seating position and wear a:

- seatbelt
- safety harness
- or
- parachute that was connected to an approved single-point restraint (Figure 23).

These items were to be adjusted to ensure adequate restraint.

¹⁵ NTSB investigation AAR-08-03 available at www.ntsb.gov



Figure 23: Exemplar single-point restraint secured through the parachutist's webbing

Source: FAA, modified by the ATSB

The Australian Parachute Federation (APF) Operational Regulations, section 6.2.1, which was current at the time of the accident, stated:

An aircraft used for parachuting (other than a balloon) must be fitted with:

- a) Sufficient parachutist restraints that are manufactured to a standard approved by CASA and labelled accordingly, or
- b) Sufficient aircraft seats and seatbelts

Further, section13.2.9 required that:

Unless otherwise approved in writing by the Director Safety, tandem parachutists must be restrained in the aircraft at all times while in flight in such a manner that enables them to be attached to the Tandem Master before detaching from the restraint.

Additionally, the APF Jump Pilots and Aircraft Operations Manual, section 10.1 stated:

It is required that there be approved restraints available for each parachutists [sic] and Flight crew and that these restraints are used in accordance with instructions.

Old cultures still exist with some parachutists reluctant to wear these restraints; however, these cultures are changing. Should there be an emergency situation below 1 000ft, or in the event of an aborted take-off or forced landing, there is little time for parachutists to attach restraints.

Safety briefings

CAO 20.11 *Emergency and life saving equipment and passenger control in emergencies* (paragraph 14.1) required a safety briefing to be given to passengers by the pilot or crew prior to each take-off. Among other items, the brief was to include the use and adjustment of seatbelts, the location of emergency exits and the presence of any survival equipment. Elements of this briefing were also required by the APF and detailed in their Training Operations Manual, sections 2.6 and 2.7.

A number of tandem parachutists who had participated in jumps with the operator indicated that they received instruction on how to conduct the tandem jump by the instructor. However, none reported receiving an aircraft safety briefing prior to take-off.

Organisational and management information

Aircraft operator

The operator predominantly conducted their parachute training/tandem jump operations at Caboolture Airfield. Weekend operations were also conducted at a private airstrip at Raglan, near Gladstone, Queensland about once a month. The operator had been conducting parachute

operations for about 4 years at the time of the accident, with the owner/operator as its chief instructor.

Regulatory oversight

Parachuting as a sport began in 1958 and the self-administration of the sport commenced in 1960 under the auspices of the Department of Civil Aviation (preceding CASA). In more recent times, parachuting operations in Australia were classified as sports aviation with CASA responsible for the regulatory oversight of this activity. CASA advised the following in respect of this oversight:

CASA sets the regulations for sports aviation but does not get involved in the day-to-day administration of the activities of sport aviation organisations, such as licensing and registration. These administrative responsibilities have largely been given over to peak bodies in each sports aviation sector.

This approach has several advantages. Firstly, it frees up CASA's resources to be focused on passenger-carrying operations, where the vast majority of Australians fly. If CASA was spending time carrying out surveillance of gliding flights, for example, there would be less time for safety checks on airlines. Secondly, it allows the aviation sports to be administered by the people who are expert in their field. The people who know most about ultralights, for example, are the people who are testing and licensing ultralight pilots and making sure safety standards are maintained.

CASA maintains its oversight of sports aviation by auditing the peak bodies that administer each sector. This involves a range of safety checks by CASA's sports aviation inspectors on a regular basis.

CASA surveillance priorities

CASA's surveillance priorities were detailed on their website as follows:

CASA gives priority to the safety of passengers. This is a policy that has been endorsed by government and is implemented under regulations and other requirements that have been subject to Federal Parliamentary scrutiny. The policy means most of CASA's time and resources are allocated to maintaining and improving safety on passenger-carrying flights. People travelling on airlines – large and small – and charter flights are CASA's highest priority. Careful analysis and safety judgement supports this allocation of priorities. Ninety six per cent of Australians who fly do so on airlines and they have a reasonable expectation that safety standards are applied. People who are flying on an Australian airline expect high standards of safety from their carrier, as well as responsible safety oversight by the aviation regulator. By making passenger-carrying flights a priority CASA can meet these expectations.

However, the priority classification policy does not mean CASA walks away from other sectors of Australian aviation. There are comprehensive safety rules covering the non-passenger commercial sectors of aviation, as well as private flying. Even sport aviation is covered by safety regulations, although in this area CASA is increasingly devolving responsibility for day-to-day administration to approved organisations. Where administration is devolved, CASA makes sure the people and organisations who take on these responsibilities are capable and effective.

CASA Self-Administering Sport Aviation Office

Within CASA, the Self-Administering Sports Aviation Organisations (SASAO) section was responsible for oversight of 10 Recreational Aviation Administration Organisations (RAAO), or 'peak bodies'. Nine of these, including parachuting operations, were subject to a deed of agreement, which detailed the functions undertaken by those organisations for and on behalf of CASA.

At the time of the accident, the SASAO section employed six full time staff to undertake the oversight of all the RAAO's. The SASAO worked in close cooperation with the RAAOs to ensure the regulations were applied and enforced. The RAAOs provided the SASAO with specialist knowledge of the respective sectors of the sport aviation industry.
The Australian Parachute Federation

As the oversighting body for almost all tandem parachute training operations in Australia,¹⁶ the APF was authorised by CASA to:

- set the parachuting operational regulations and standards
- audit member organisations to ensure compliance with the regulations and standards
- issue parachutist and parachute instructor certificates and jump pilot authorisations
- publish a magazine and newsletter to keep members informed of current events and safety standards
- control parachute rigger and packer standards in Australia.

APF structure

At the time of the accident, the APF had a technical committee of seven directors, including the Chief Executive Officer. All were full-time employees of the APF.

The technical committee met regularly and the directors managed the day-to-day operations of the APF in their various areas (for example instructors, safety, rigging and so on). They also attended board meetings to provide advice and recommendations.

The APF also had nine area councils, each of which appointed two members to the APF board and two Area Safety Officers (an ASO and deputy ASO) to conduct audits.

The ASOs were all elected volunteers who were selected by each council. The potential candidates were required to be highly-experienced skydivers, with a preference for the candidate to be a senior parachute instructor. Apart from parachuting experience, no other aviation experience was required. The APF regulations required the applicant to also be acceptable to the APF national director of safety.

Once appointed, ASOs were provided with external lead auditor training, a 1-day APF induction course and an APF area safety officer's guide. Once inducted, the ASOs conducted audits in their own state/territory areas.

Surveillance of the parachuting industry

As previously stated, CASA considered parachute training operations a sports aviation activity, with the aircraft operating in the private category (see the section titled *Categorisation of parachute operations*). CASA also considered that people who flew in parachuting aircraft were 'participants', not 'passengers'.

As indicated by CASA's surveillance priorities, sport and private category operations were lower priority than, for instance, scheduled public transport or charter operations. Therefore, CASA devolved most of its responsibility for parachute training/tandem operations to the APF. This was consistent with the content of the CASA Sport Aviation Self-administration Handbook 2010, which indicated that CASA would monitor RAAOs' performance by auditing RAAO headquarters (corporate audits) and conducting functional (in-the-field) audits. The handbook indicated that RAAOs, such as the APF, were to meet defined performance standards. These standards described the capability and competency requirements for RAAOs to self-administer effectively.

In relation to auditing the APF, CASA advised that:

Audits are scheduled on a risk basis through the prioritisation of greater surveillance on higher risk organisations. Auditing of RAAOs changed some years ago from [an] audit conducted every two years to being focussed on a risk basis, informed by data and prioritised across all sport aviation organisations to place limited resources in the most appropriate area to reduce the highest risk.

¹⁶ All but one parachute training operation in Australia was administered by the APF.

Generally, this meant that, depending on the RAAO's organisational risk as compared to that of other RAAOs, a RAAO was audited at a national level every 2–3 years. CASA reported that the APF were the fourth lowest level of risk of the 10 self-administered organisations.

CASA conducted corporate audits of the APF by visiting its headquarters. Functional audits entailed CASA officers accompanying an APF auditor or ASO on their audit of APF drop zones (DZ). In response to a request for clarification of CASA's approach to the in-the-field audit of parachuting operators, CASA indicated that:

CASA does not conduct the auditing of parachute jump operations directly; this is part of the regulatory oversight functions conducted by the APF. CASA's audit of the APF head office includes a random sampling of audit reports and outcomes to establish assurance that oversight of the parachute jump operations is appropriate

...the APF audits their parachute operators, normally on an annual basis. Because APF Area Safety Officers (ASOs) work on a voluntary basis, their audit schedules may need to be adjusted to the ASOs' full-time work obligations. Audits may be spread out over 12-month period, or concentrated within narrower time frame.

CASA corporate audits of the APF

Surveillance records showed that, in the period 2005–2015, corporate audits of the APF were carried out by CASA in 2008 and 2012. Details of these audits follow:

- 26–27 August 2008. This audit found that the APF documentation/records system was
 working adequately under the Deed of Agreement with the APF. The data system used to fulfil
 the service functions under the agreement was found to need update/replacement and the
 APF reported to the audit that this was already under review. Similarly, CASA and the APF
 agreed that additional training should be provided to ASOs. A recent APF parachuting risk
 assessment was intended by the APF to inform that additional training. The auditors
 recommended that the agreement with the APF continue and that an additional corporate
 audit be carried out in 2009.
- 23–26 July 2012. This audit determined that the APF had robust systems in place and that APF corporate governance was sound. The auditors felt that management responsibility could be improved in terms of processes to ensure the investigation and reporting of safety-related events to CASA. In addition, they noted that devolution of responsibility to Area Parachuting Councils could result in APF headquarters fulfilling an administrative rather than a management role. Finally, the auditors commented that, given they may not be pilots or maintenance trained, some ASOs do not have the skills to undertake an audit of the parachuting aircraft (see the section titled APF surveillance of parachute operations).

CASA special/functional audits of the APF

A review of CASA surveillance files for parachute operations from 2005 to 2015 identified two special audits of parachute training/tandem operations were conducted in 2008 and one functional audit in 2010. In each case, the audit report listed the APF as the auditee. The specifics and summary findings of the audits follow:

- 24 May 2008. This special audit audited an operator against the APF Operational Regulations and the operator's Cloud Jumping Procedures Manual. A number of non-compliances with the APF regulations were identified and the audit recommended suspending the operator's cloud jumping privileges until further review by either CASA or the APF.
- 14 June 2008. This special audit examined a second operator's role as an affiliate member of the APF that conducted their operations under the APF Operational Regulations. The audit was intended to provide a 'snapshot' of the effectiveness of the APF's self-audit process. A number of documentary oversights by the operator were identified and a pilot was counselled in writing. It was recommended that the operator continue operating as an affiliate member of the APF.

 30 November 2010. This scheduled functional audit was undertaken in the company of an APF auditor, as the responsible ASO was a new appointee and attended as an observer. CASA determined from its audit that the APF had an appropriate self-auditing process and, on that basis, recommended that the next functional audit of the APF take place in 2012. A corporate systems audit was recommended in the interim. No further functional audits were conducted by CASA up until the time of the accident.

None of the audits involved the occurrence operator.

CASA considered that, given the level of risk associated with the APF as compared to the other self-administered organisations, the appropriate level of oversight of the APF had been conducted.

APF surveillance of parachute operations

The APF annual report for 2014 indicated that they were responsible for the oversight of 57 parachute training organisations. The APF guide for ASOs indicated that each parachuting organisation should be audited at least once per year, with 1 months' notice given to the organisation. For the 2014 calendar year, the APF completed 44 of a planned 55 audits.

The ASO guide included a pro-forma audit checklist. This checklist covered aircraft operation, such as checking if the pilot had appropriate jump pilot qualifications and if the aircraft had a current maintenance release. However, most of the audit was centred on the parachuting activity itself.

The APF Training Organisation Club Audit & Risk Assessment Guidelines 2010 stated:

The inclusion of the aircraft operation in the DZ audit process is an initiative by the APF Board to assist member organisations to:

- a) Be prepared in case of a check by CASA and other agencies, such as Occupational Health and Safety organisations;
- b) Look after the interests of members by auditing some basic regulatory requirements of the aircraft operation.
- c) Demonstrate a basic level of awareness with regard to the requirements of operating an aeroplane in support of their particular parachute operation.

While the APF has no charter to ensure members and others involved in aircraft operations for skydiving adhere to the rules outside our own operational regulations, it does have a duty of care to see that, as far as possible, the aircraft operations members use are 'up to scratch' were basic safety functions are concerned.

In relation to DZ audits, the ASO guide included an aircraft section, which stated:

The aircraft are an important part of any parachuting operation and more often nowadays the APF is being asked to assist and advise with aircraft and pilot matters. An ASO needs to have some knowledge of aircraft and pilot operations and should be prepared to question an operator or experienced pilot to gain a working knowledge of requirements and procedures.

This was consistent with CASA's expectation of APF audits, in that they audited skydiving operations as a total system. In this respect, CASA stated that:

The airlift component of this system is considered an integral part of the whole operation; however is only part of the total system. CASA empowers the APF to administer all parts of the operations and does expect that the APF will provide a particular level of oversight of the airlift component, including the operation of the aircraft during the jump sortie, oversight of the pilot conducting the operations, the general condition of the aircraft or adherence to the aircraft manufacturer's maintenance schedule.

The CASA corporate audit of the APF in 2012 (see the section titled *CASA corporate audits of the APF*) commented on the possibility for ASOs to undertake DZ audits without any piloting or aircraft maintenance experience, observing that:

During this [type of] audit, the ASO may audit any aircraft undertaking parachuting operations at that DZ. However, as they may not be pilots or aircraft maintenance trained, they do not necessarily have

the skills to undertake such an audit. There is no subject matter expert (SME) employed to assist with this element of the ASO DZ audit which can lead to erroneous and misleading elements within an audit report.

In regard to this aspect of DZ audits, the APF relied on parachute aircraft being maintained by a qualified maintenance organisation and that any related issues were addressed via that means. Given this reliance, as part of the DZ audit the ASO confirmed:

- the validity of the maintenance release
- a doors off or steps modification approval in the aircraft's flight manual as appropriate
- a check of the aircraft for:
 - obvious deficiencies with the aircraft (for example, broken or other parts that could snag a parachutist)
 - sufficient single-point restraints.
- that the pilot has a Jump Pilot Authorisation
- that a senior pilot has been appointed.

In respect of the adequacy of this arrangement, CASA advised that:

APF Auditors are not expected to be able to provide formal engineering assessment of aircraft components and rely upon the maintenance performed by licenced aircraft maintenance engineers conducting maintenance under the authority of a CAR 30 [*Certificates of approval*] organisation. Skydiving aircraft are routinely assessed whilst undergoing maintenance, as part of CASA's auditing of the CAR 30 organisations where such maintenance is carried out.

The audit paperwork outlines all of the required information to be checked and is a simple recording system to ensure compliance with the APF and CASA requirements. An explanation of the requirements is outlined in the APF Audit Companion Guide.

APF audits of the operator

A Cease Operations Order was issued to the operator by the APF on 25 August 2010. The order related to an incident earlier that month and required a written explanation of the operator's actions in response. Issues requiring explanation included that:

- the pilot of the incident aircraft did not have a jump pilot qualification
- contrary to the regulations, at the time the aircraft's maintenance release was not appropriately endorsed
- one of the parachute rigs that was intended for use that flight was re-used without being checked by a rigger. That check was previously directed by the ASO.

The order had effect immediately and until such time as a full audit of the operator's training, DZ(s), equipment and instructors could be carried out.

Subsequently, the APF conducted three audits on the operator over a 4-year period. The first was conducted on 2 October 2010, the second on 13 February 2013 and the last on 12 October 2013. All of those audits included a basic inspection of FRT's documentation and safety equipment.

The audit conducted on 2 October 2010 identified no non-compliance issues and noted the introduction of a new operational procedures manual. The operator was cleared to continue parachute operations without restriction.

No major issues were identified with the operation in the 2013 audits.

Categorisation of parachute operations

Parachuting operations are broadly of two types, sport parachuting and training/tandem parachuting (collectively called training operations). Sport parachuting involves enthusiasts who conduct parachuting as a member of a club.

CASA detailed the various categories of aircraft operation in CAR 2 *Interpretation*. In respect of the inclusion of tandem parachuting operations in the private category, CASA stated:

CASA has treated the airlift component of skydiving as a private operation because CASA considers that the payment made by the parachutists is for the descent from the aircraft, not flight in the aircraft. CAR 2(7)(d)(v) categorises as a private operation one in which persons are carried without a charge for the carriage being made. CAR 2(7)(d)(v) operates to capture any activity of a kind substantially similar to an activity covered by CAR 2(7)(d)(v) as a private operation.

On this basis, some business jets, including Fly in/Fly out (FIFO) mining operations, are conducted by corporations which lease an aircraft and pay a pilot to fly staff of the corporation. Such operations are private operations because the corporation is not charging anyone for the flight.

All parachuting and skydiving operations, including the airlift component are subject to each person becoming a member of the APF and the aircraft are operated under the auspices of a parachuting organisation under APF control and in accordance with the APF Operational Regulations.

Parachute training operations vary in size and aircraft types, with some carrying thousands of paying occupants per year. Apart from training parachuting students for a fee, a significant proportion of these organisations provide tandem jumps to people seeking a one-off parachuting experience. Whereas CASA considers that payment is for the descent from the aircraft, and the operation, including the airlift component is subject to the jumper being a paid-up temporary member of the APF, clearly the parachute training organisation must cover the overall cost of the operation. This could be expected to include:

- use and maintenance of the operator's parachuting equipment
- possible payment of the crew (pilot and tandem instructor)
- the aircraft operating costs.

In addition, the operator's website stated that the purchase price included a 'scenic flight with views over Moreton Island, Brisbane and the Glasshouse Mountains'. This contrasts with CASA's position that payment for the private category flight was '...for the descent from the aircraft, not flight in the aircraft.'

Air operator's certificate requirements

In contrast to private category operations, any operator conducting commercial activities is required to have an Air Operator's Certificate (AOC). The requirements for the issue/maintenance of an AOC include (but are not limited to) appointing key personnel and establishing an operations manual with documented policies and procedures covering all activities.

CASA conducts regular audits of holders of AOCs using its flight operations and airworthiness specialists. These audits ensure that operators conduct their operations in a safe manner and in accordance with their safety management system and operations manual.

Consistent with its position that skydiving/parachuting was a private operation, CASA indicated that parachuting operators do not require an AOC because:

CASA does not consider parachute operations as commercial activities, however in relation to tandem operations of informed participants in a private skydive operation, any aircraft can be operated in the private category without requiring an AOC, so long as the operations are consistent with requirements governing private operations...

and that:

CASA considers an AOC is not required to authorise a parachute operation because of the sporting nature of the purpose of the flight and the absence of payment specifically for flight in the aircraft.

That said, CASA has recognised that there should be a greater level of safety associated with the private airlift component of parachute operations. To that end, CASA instrument CASA 09/15 - Direction under regulation 209 [Private operations] — conduct of parachute training operations,

imposes additional requirements on the conduct of such flights. Directed conditions under CAR 209 are expressly applicable to operators and pilots-in-command of aircraft engaged in private operations.

In pertinent part, CASA Instrument No. 09/15 [now instrument 06/16 under Civil Aviation Safety Regulation 11.245¹⁷] provides as follows:

6 General Conditions

(1) a jump aircraft when dropping parachutists must be operated in accordance with the APF Jump Pilot Manual.

- (2) a jump pilot must hold an APF Jump Pilot authorisation.
- (3) a jump aircraft must have a current maintenance release.
- (4) a jump aircraft that is not a Class A aircraft must either:
 - a) be maintained in accordance with an approved system of maintenance; or

b) undergo a maintenance release inspection at the earlier of 100 flight hours and 12 months, and have all engines maintained in accordance with:

i. for piston engines - requirement 2 of AD/ENG/4; and

ii. for turbine engines - requirement 1 of AD/ENG/5.

(5) Any alteration of the APF Jump Pilot Manual must be notified to CASA for acceptance.

An APF Jump Pilot authorisation imposes additional training requirements on a pilot of a parachuting aircraft and provides for enhanced oversight and control by the APF of Jump Pilot operations.

Classification of tandem parachutists

As part of the classification of operations, CASA made a distinction between passengers and participants. Passengers (fare-paying and non-fare-paying) were defined by CASA as aircraft occupants who were not expected or assumed to have knowledge of the risks to which they were exposed and had little or no control over those risks. Participants were aircraft occupants who voluntarily engaged in an aviation activity, were informed of the risks and had explicitly accepted the risks of their involvement in that activity.

CASA considered that the parachutists were either crew or participants and not passengers. This covered parachutists who paid for a tandem parachute jump and those parachuting as a sport. Given CASA's priority is on the safety of passengers, the rules for carrying passengers specify higher safety standards than for carrying participants and crew.

CASA explained their distinction between passengers and participants as follows:

The concept of a participant was identified in the policies mentioned below. Although these policies are not currently in effect [as at 10 September 2015], the principles underlying the distinction between passengers and participants remain sound.

Classification of Operations CASA Policy, 1997 (extract)

General Aviation brings within its ambit those aircraft activities which have historically been considered "private", "recreational" or "sport" in nature. This classification involves the lowest level of CASA regulation. Participants are taken to be knowledgeable of the risks they are exposed to and to voluntarily assume those risks.

Another principle is that the level of safety provided should reflect the degree to which participants in an aviation activity are able to inform themselves of and avoid risk. CASA's responsibilities to individuals who are informed of the risks inherent in an aviation activity and voluntarily assume those

¹⁷ At the time of the accident, the conduct of parachute training operations was detailed in CASA instrument 239/13 Direction under regulation 209 – conduct of parachute training operations. This instrument was repealed a number of times in the interim and, at the time of writing, instrument 06/16, made under Civil Aviation Safety Regulation 11.245 was in force.

risks, are considered less than its responsibilities to those who have limited knowledge or control of the risks they are exposed to.

Regulatory Policy – CEO-PN001-2004 CASA's Industry Sector Priorities and Classification of Civil Aviation Activities

In accordance with this policy, three levels of safety oversight were identified as applying in relation to occupants of aircraft who were not members of the aircraft's crew, namely, **passengers, task specialists** and **participants**—the last of which were described as 'occupants who voluntarily engage in an aviation activity, are informed of the risks, and have explicitly accepted the risks of their involvement in that activity'.

In relation to the appropriate amount of information participants would need to ensure that they were informed of the risk associated with an activity, CASA advised that:

Skydiving is generally recognised as an activity involving more than a modicum of risk, and any person undertaking or contemplating this activity can reasonably be assumed to do so cognisant of that risk.

The amount of information a person would require to ensure they were appropriately informed of the risks involved in parachute jumping would depend on the individual's existing knowledge and understanding of those risks. In all cases, however the APF provides a briefing to people undertaking a parachute jump, advising them of the risks involved both in the jump itself and in the airlift component of the operation.

In the case of parachuting operations involving FRT, the APF briefing that included advice of the associated parachuting risk was covered in the APF temporary membership form and in the operator's parachuting contract. In addition to serving as the method of briefing participants about the risks involved in parachuting, these forms included an 'Exclusion of liability' waiver for the providers. The tandem parachutists were presented with both documents when they arrived for the jump and were informed the documents had to be signed before they were permitted to conduct the jump.

The operator's parachuting contract had a heading that stated (in bold) 'PARACHUTING IS DANGEROUS'. Additionally, the last item prior to signing was a warning of the risks involved in parachuting, stating that:

Parachuting and flying in parachuting aircraft is inherently dangerous. Serious accidents can & often do happen which may result in the parachutist suffering injury to person and/or property or being killed. The parachutist has voluntarily read and understood this warning and accept and assume the inherent risks in parachuting and flying in parachuting aircraft.

In addition to the operator's documentation, the APF club application for membership required parachutists to sign a section titled DECLARATION OF UNDERSTANDING with the sub-title that 'Parachuting is Dangerous'. That section of the declaration stated that, if the parachutist did not understand the terms of the contract, then a request had to be made for an independent person to explain them to the parachutist.

At the time of the accident, the operator's website did not present information that would have enabled an assessment of the risk of parachuting, including flying in parachuting aircraft, prior to booking. This was consistent with a number of other tandem parachute organisation websites reviewed.

Further, a search of the CASA website also did not reveal any information about the inherent risks involved in parachuting or flight in a parachuting aircraft. However, CASA advised that it was, as at 10 September 2015:

...considering the value of providing information to prospective participants in parachuting activities at the point of sale similar to that which is provided to participants in adventure flight operations conducted under the auspices of the Australian Warbirds Association.

...reviewing the information and details available on the CASA website in regard to each facet of sport and recreational aviation to provide greater detail to inform participants of the risks involved in the respective operation.

Research

Safety of parachute jump operations

The United States National Transportation Safety Board (US NTSB) conducted a research investigation into parachuting operations in the US in 2008 titled *Special Investigation Report on the Safety of Parachute Jump Operations*.¹⁸

The investigation report stated, in part, that:

...The risks of parachuting are generally perceived to involve the acts of jumping from the aircraft, deploying the parachute, and landing; parachutists are aware of and manage these risks. However, a review of accident reports reveals that traveling on parachute operations flights can also present risks. Since 1980, 32 accidents involving parachute operations aircraft have killed 172 people, most of whom were parachutists.

...The Safety Board's review of parachute operations accidents since 1980 identified the following recurring safety issues:

• Inadequate aircraft inspection and maintenance;

• Pilot performance deficiencies in basic airmanship tasks, such as pre-flight inspections, weight and balance calculations, and emergency and recovery procedures; and

• Inadequate FAA oversight and direct surveillance of parachute operations.

Although parachutists, in general, may accept risks associated with their sport, these risks should not include exposure to the types of highly preventable hazards that were identified in these accidents and that the parachutists can do little or nothing to control. Passengers on parachute operations aircraft should be able to expect a reasonable level of safety that includes, at a minimum, an airworthy airplane, an adequately trained pilot, and adequate Federal oversight and surveillance to ensure the safety of the operation.

The NTSB also referenced the United States Parachute Association safety records from 1992 to 2007, which showed that 'about 30 parachutists per year were killed in jumping mishaps'. For the same timeframe, NTSB accident data showed that 'about 5 parachutist fatalities per year resulted from accidents involving parachute operations aircraft'. The NTSB also noted that parachutists in the US conducted at least '2.16 to 3 million jumps annually'.

Parachute aircraft occurrences in Australia

Between 2005 and 2014, there were 14 accidents involving parachute aircraft operations, two of which resulted in fatal injuries (including this accident). The ATSB analysed the fatal accident and total accident rates per million departures for aircraft operating parachuting operations and compared these with rates for all charter and private¹⁹ operations for this 10 year period.

Data was sourced from the ATSB occurrence database and included all accidents within the relevant operation types. As most accidents occurred either during departure or the approach and landing phases of flight, departures were used where possible for normalising the data to compare different operation types, as they were considered to be a more appropriate measure than hours flown.

Departures for parachute and charter operations, and hours flown for parachute operations and all private operations, were supplied by the Bureau of Infrastructure, Transport and Regional

¹⁸ <u>http://app.ntsb.gov/safety/safetystudies/SIR0801.html</u>

¹⁹ Private, business and sports aviation. Sports aviation includes gliding, parachute operations, ballooning, warbird operations and acrobatics.

Economics (BITRE). It should be noted that the parachute departures and hours flown were an estimate as accurate data was not available.²⁰

The rate of fatal accidents (per million departures), averaged for aircraft conducting parachute operations was about 8.7 (1.8–27.8, 95 per cent credible intervals $(CI)^{21}$). For charter operations, it was 2.1 (0.9–3.1, 95 per cent CI) (from 12 fatal accidents over the same period). Although parachute operations had a higher fatal accident rate than charter, it was not a statistically greater probability. The statistical comparison is limited considering that only two fatal parachute accidents were included in this analysis.

For total accident rates per million departures, the average was about 60.6 (34.7–99.0, 95 per cent CI) for parachute operations (from 14 accidents) and 24.3 (20.6–28.3, 95 per cent CI) for charter operations (from 156 accidents). That is a statistically significant increased probability of an accident for aircraft conducting parachute operations as compared to charter.

The accident and fatal accident rates per million flight hours²² for aircraft conducting parachute operations (fatal accidents: 14.1, all accidents: 98.6) were consistent with other private/business/sports aviation operations (fatal accidents: 16.2, all accidents: 108.3).

The average number of fatalities per fatal accident for aircraft conducting parachute operations was five (over the period 2005–2014). Over the same time period, the average for charter and private/business/sports aviation operations was 1.6. While the fatal accident rate for parachute operations is not statistically significant compared to charter, the number of fatalities per fatal accident is significantly greater.

For the same time period, the total number of accidents for scenic flights (including balloon and joy flights) was 34, with four fatal accidents. While it was not possible to ascertain the activity rate over the 10-year period, indicatively, in 2014, the hours flown for scenic flights were about five times that of parachuting operations.

Tandem parachute jump occurrences in Australia

The APF had oversight of 57 parachuting organisations across Australia. For the 2014 calendar year, the APF registered 152,678 new members, with 151,611 of these being temporary memberships for tandem jumps. That is, the majority were for one-off, tandem jumps.

To allow a comparison of accident data, the APF provided training/tandem jump statistics, including injury rates for the 10-year period from 2005–2014 inclusive (Table 5).

²⁰ Departures and hours flown for aircraft conducting parachute operations between 2005 and 2014 were calculated by BITRE derived from a list of known aircraft that conducted parachute operations within the CASA registry and a list of parachute aircraft supplied by the APF. This estimate of parachute departures and hours was necessary, as historical parachute operation activity had not been collected. In the case of charter operations, departures between 2005 and 2013 were also estimated by BITRE. In addition, as the 2014 departures for charter were not available at the time of analysis, they were estimated based on past years. Charter hours are reported to BITRE through the BITRE *General Aviation Activity Survey*. Departures were estimated because departures were not recorded separately for different types of operations in the survey. The estimation model calculates the rate of departures per hour flown for aircraft that only perform charter operations. This ratio is used to estimate the number of charter-related departures for all aircraft based on the number of charter hours flown.

²¹ Credible intervals: the upper and lower limits between which the true value is expected to lie for a given probability (that is 95 per cent). These intervals have large ranges indicating the relatively large uncertainty in the estimation of the rates, which is due to the low number of accidents and fatal accidents during the time period.

Hours flown was used as the 'normaliser' as the number of departures for private/business/sports aviation operations between 2005 and 2014 were not available.

Table 5: Tandem	n parachute	jump statistics	2005–2014
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Total number of tandem jumps	1,002,675
Number of tandem jumps conducted in 2005	72,981
Number of tandem jumps conducted in 2014	151,611
Number of serious injuries ²³	229
Number of tandem jump fatalities not involving aircraft operations	0 (1 fatality was reported as a result of a medical condition after landing)

The statistics showed that the number of tandem jumps more than doubled in the last 10 years. This is consistent with information on CASA's website that the profile of parachuting operations had changed, with a large increase in one-off tandem jumps in recent years.

Related investigations²⁴

ATSB investigation 200104684

The ATSB conducted an investigation into the fatal accident involving Cessna 172, registered VH-ECT, at Latrobe Valley, Victoria on 28 September 2001. The final report stated, in part:

Witnesses at the airfield heard the sound of engine power increasing and saw the aircraft commence what appeared to be a missed approach from about 100 ft on short final. They reported that the aircraft entered a steep left climbing turn onto a reciprocal heading with flaps fully extended. At an estimated height of about 300 ft the wings were seen to roll level and the aircraft, with a nose high attitude, "fishtailed". Then with the engine noise unchanged, the aircraft pitched nose down and impacted the ground adjacent to the runway. The pilot was fatally injured and the aircraft was destroyed by impact forces. The reason for the go-around was not determined.

and that:

...The possibility of aircraft mishandling during the initial stages of the go-around and the subsequent loss of control at a low height above the ground cannot be discounted. However, the event as described by witnesses, and confirmed by ground and flight tests, was consistent with the pilot seat sliding back and denying the pilot adequate control input to avoid an accident.

Coronial inquest

The State Coroner of Victoria inquest made six recommendations in respect of this accident, including:

Recommendation 1

That Cessna consider renewing its offer of "a free secondary seat-stop system for all single engine Cessna owners" (as some time has elapsed since that offer was made, there may be some potential for safety improvements in the design and operation of the seat slide, locking and seat stop system – this should be considered by the manufacturer. A particular focus may be needed on the locking of the pins in the holes).

In the event that the original; Cessna offer is reinstated (whether with the original secondary seat stop system or a newly designed part or complete slide arrangement) notifications of the offer should be as wide as possible throughout the aviation industry (to pilots, owners and maintenance engineers).

Recommendation 2

In the event that Cessna follow Recommendation 1 (above) then, after a reasonable period to allow for owners of relevant Cessna aircraft to fit modified parts to improve the safety of the seating, compliance should be regarded as mandatory by the Civil Aviation Safety Authority.

²³ Defined by the APF as broken bones, dislocations and multiple injuries.

²⁴ All ATSB investigations available at <u>www.atsb.gov.au</u>.

Accordingly, future maintenance programs should also audit compliance of the fitting of additional seat safety mechanisms as approved by the manufacturer as a matter of airworthiness of relevant models of this brand of aircraft.

Transportation Safety Board of Canada investigation

A 2010 Transportation Safety Board of Canada investigation into an accident involving a Cessna 172K aircraft, registered C-GQOR, noted:

Several general aviation aircraft types, including but not limited to the Cessna 172, have been involved in accidents and incidents in which it was established or suspected that the pilot's seat dislodged from its desired position and slid backwards. In Canada, 5 accidents involving aircraft damage are recorded in the past 20 years, none of which resulted in more than minor injury. As none of the occurrences were investigated beyond data gathering, a limited amount of information as to cause and circumstance is available.

In all cases, the seat slid back during the take-off acceleration or immediately after rotation. Four resulted in runway excursions without the aircraft taking off. In one instance, the aircraft became airborne and the nose pitched down, resulting in a collision with the ground. There was insufficient data to determine if the aircraft had stalled. In another instance, the pilot pulled both the control column and the throttle back, resulting in the aircraft losing power and pitching up. The pilot released the control column, repositioned the seat, regained control of the aircraft, and landed safely without damage.

Several foreign occurrences involving Cessna aircrafts with similar seat rails and locking mechanisms were also studied. Most occurred during the take-off run or shortly after rotation and most resulted in runway excursions. Two accidents occurred during go-around, and both cases involved an aircraft configured with full flap. In this configuration, substantial forward force is required on the yoke to overcome the nose-up trim change that occurs when go-around power is applied. After the seat slid back, the pilot was unable to control the nose-up aircraft, the nose rose to an excessively high pitch attitude and the aircraft stalled.

Other seat slippage reports

An occurrence involving a Cessna 172 was recorded in the US National Aeronautics and Space Administration Aviation Safety Reporting System in 2009. In that report, the Chief Flying Instructor, who was seated in the right-front seat, stated that the trainee's seat slipped aft as the trainee rotated the aircraft for take-off. The instructor took control, recovered the aircraft and continued the take-off.

A review of the ATSB notifications database identified 16 occurrences of uncommanded seat slide/movement in single-engine Cessna aircraft between April 1969 and March 2014. Table 6 lists those occurrences.

Aircraft	Date	Summary
C172	19 April 1969	The pilot's seat came adrift. The previous pilot did not correctly install the seat stop.
C182	31 October 1971	The pilot aborted the take-off run when the seat came loose. The seat was not secured during the pre-flight checks.
C180	24 February 1973	The pilot's seat moved rearward as the seat stops were not fitted correctly. The pilot could not reach the rudder pedals and the aircraft ground looped.
C180	15 February 1976	An unauthorised person incorrectly fitted the pilot's seat. The seat slid rearwards during take-off and the lost directional control and ground looped.
C172	15 May 1976	The pilot's seat slid rearwards with the result that pilot was unable to apply brakes.
C150	19 October 1976	The pilot's seat moved rearwards a number of times. The locating holes in the seat rail were worn.

Table 6: Reported uncommanded seat slide/movement occurrences in Australia for the period April 1969–March 2014

Aircraft	Date	Summary
C182	30 January 1978	The throttle was open on start. The aircraft moved forward and the seat slid back. No limit pins were fitted.
C180	5 May 1979	During the take-off run, the pilot's seat moved rearwards. The pilot closed the throttle but could not retain directional control. The aircraft swung left, the right wheel dug in and the aircraft tipped over.
C185	28 July 1979	During the landing roll the seat slid off the seat rails. The seat stops were left out during the 100-hourly inspection.
C172	4 August 1979	The pilot lost control during an abandoned take-off. The seat locking mechanism failed and the seat came off the rails.
C180	30 November 1979	The pilot's seat unlocked and moved rearwards during the take-off. The pilot could not reach the rudder pedal and brakes and lost directional control.
C185	24 June 1982	The pilot's seat moved forward on downwind and back during landing. The pilot inadvertently pulled back on the controls, losing directional control.
C152	18 February 1994	During a reported aerobatic manoeuvre, the pilot's seat slid aft. The pilot recovered straight and level before landing. A spring had broken on the seat locking pin, allowing the pin to come out of the locating hole.
C180	18 January 1995	The pilot's seat unlatched and slid backwards during take-off. The aircraft impacted terrain, the three aircraft occupants were uninjured.
C172	28 September 2001	See the above section titled ATSB investigation 200104684.
C206	2 November 2009	The pilot was on late final approach when their seat slipped back several inches before locking in. The pilot could still reach the pedals although not with full deflection. The aircraft veered from the runway.

ATSB investigation 200600001

At about 1040 on 2 January 2006, a Cessna Aircraft Company U206 aircraft, registered VH-UYB, took off from the parachuting centre at Willowbank, Queensland on a tandem parachuting flight. On board the aircraft were the pilot and six parachutists.

The surviving tandem master parachutist, who was also a private pilot, reported that, at about 100 ft, the aircraft performed as if the power had been 'pulled back'. The aircraft was observed to bank right, before it impacted a tree and became submerged in a dam. The aircraft was destroyed and five persons on board received fatal injuries. The two survivors received serious injuries. Technical examination and test of the aircraft's engine and its associated components did not reveal any anomalies with the potential to have individually contributed to the partial engine power loss.

However, the investigation could not discount the potential that:

- a number of less significant anomalies that were identified during the engine and components examination may have coincided to reduce the available engine power
- there may have been an anomaly of the engine or its components present during the accident flight that was not apparent during the subsequent disassembly, examination and test of the engine and its components.

Coronial inquest

The Queensland Coroner held an inquest into this accident. As part of the inquest, the Coroner considered various issues relating to the improvement of public safety, including the regulation of tandem parachuting. In their findings, the coroner commented on the categorisation of parachuting in the private category and CASA's position on passengers and participants from an informed consent perspective, noting:

I have no doubt members of the public would assume that a business advertising tandem sky diving freely available to the public without any significant training or testing was subject to the same regulations as a business offering, say, joy flights.

While members of the public wishing to engage in tandem parachuting can be expected to make their own assessment of the risk of jumping out of a plane while harnessed to a tandem master, they cannot in my view be expected to assess the suitability of the plane, the modifications that may have been made to it, the competency of the pilot or any other aviation issue to any greater extent than can a passenger chartering a light plane to fly him or her to a destination. I can see no valid basis on which CASA can suggest that a distinction between "*passengers*" and "*participants*" in these circumstances provides a reasonable basis for absolving itself from any responsibility for oversighting such operations.

As a result, as part of delivering the findings of the inquest on 24 November 2008, the coroner issued the following recommendation to CASA:

Recommendation 2 – Reconsider self-regulation

I recommend that CASA reconsider its interpretation of s27 of the Civil Aviation Act and Civil Aviation Regulation 206 and revise its policy of devolving the surveillance of all aspects of publicly offered tandem parachuting to the APF.

CASA safety action

In response to this accident CASA released a number of instruments affecting the conduct of parachuting operations. Of these, *Explanatory Statement to F2015L00103* stated:

Explanatory statement

Civil Aviation Regulations 1988

Direction under regulation 209 - Conduct of parachuting operations (2012)

•••

Background

The dropping of parachutists engaged in training operations is regarded by CASA as a private operation. These operations are regarded by CASA as being in a separate category from those operations involving parachuting as a sporting activity carried out by established clubs. The second category is carried out in accordance with authorisations and specifications, issued under regulation 152 of CAR 1988.

Since the first category of parachute operations was regarded as private, the aircraft involved were maintained to private operations status and only required to be inspected annually, with engines being operated on condition, meaning that they could be operated until a licensed aircraft maintenance engineer refused to sign off on the annual inspection for that aircraft with that engine in it. Additionally, pilots on those operations only required a private pilot licence.

In 2006, at Willowbank in Queensland, 5 occupants died when an aircraft engaged in a parachute training operation crashed on take-off. The subsequent Queensland coroner's report was critical of CASA's policy of classifying such operations as private operations.

Enhanced maintenance standards for parachute aircraft

In response to the investigation findings of the Willowbank accident and CASA's analysis of the appropriate maintenance standards for aircraft engaged in parachute operations, CASA required aircraft engaged in parachute training operations and all tandem descents to be maintained to charter aircraft standards rather than private aircraft standards. Other requirements have also been imposed. The conduct of those operations is subject to supervision by the Australian Parachute Federation Incorporated (*APF*), with CASA exercising overarching control.

The instrument also repealed and replaced previous direction CASA 239/13 regarding the conduct of parachuting operations in controlled airspace and the need to remain clear of a specified restricted area. Expected maximum jump aircraft and parachutist distances from drop zones were promulgated - unless otherwise agreed.

ATSB investigation AO-2010-062

On 12 August 2010, Cessna U206, registered VH-TZV, was being used for tandem parachuting operations near Gladstone, Queensland. The pilot reported that shortly after take-off, there was a loss of engine power. The pilot was unable to restart the engine and conducted an emergency landing on a gravel road. The aircraft sustained serious damage and a number of the aircraft occupants sustained serious injuries. The reason for the engine failure could not be determined and technical examination did not identify anything that would have prevented normal operation. However, fuel contaminant was identified in the fuel system, upstream of the fuel filter screen. The magnitude of this contamination was considered unlikely to have led to the loss of engine power.

Additional information

New Zealand Civil Aviation Rule Part 115

The New Zealand Civil Aviation Authority implemented Civil Aviation Rule, Part 115 Adventure aviation – certification and operations on 10 November 2011. This rule established the requirements 'for the certification and operation of a person conducting an adventure aviation operation' in New Zealand and brought those operations under the direct control of the Civil Aviation Authority.

A Civil Aviation Authority explanation to prospective adventure aviation operators on the intent and requirements of Part 115 indicated that it covers adventure aviation operations:

...carrying passengers for hire or reward where the purpose of the operation is for the passenger's recreational experience of participating in the flight, or engaging in an aerial operation. This includes hot air ballooning, tandem hang gliding and paraglider operations, tandem parachute descents, and parachute-drop aircraft operations.

To comply with the rule part, all adventure aviation operations must hold an Aviation Operator Certificate that, although specific to the New Zealand context, would appear to address many of the requirements for the issue of an Air Operator's Certificate (AOC) in Australia. The description for Part 115 explains the intent of the rule as follows:

The objective of Part 115 is to introduce a new rule for the purpose of regulating the adventure aviation industry. Part 115 requires adventure aviation operators to be certificated in much the same way as air transport operators who use helicopters and small aeroplanes and are required to be certificated under Part 119/135. In particular, operators need to satisfy the Director, through their exposition, that:

- they have appropriate management systems, structures, and operating procedures in place to ensure compliance with the relevant safety standards;
- employees are appropriately qualified, and trained;
- equipment is appropriate to the task and properly maintained; and key people are fit and proper to undertake their responsibilities.

The requirements of Part 115, which require parachuting operators in New Zealand to hold an Aviation Operator Certificate, contrast with the conduct of such operations in Australia in the private category. This category of operation does not require an AOC.

Safety analysis

Introduction

Numerous witnesses reported that, shortly after take-off, the aircraft turned left with an increasing angle of bank and a nose-high attitude. These observations, combined with the physical evidence at the accident site, indicate that the aircraft aerodynamically stalled at a height that was too low for the pilot to recover control before impacting terrain.

This analysis will explore a number of possible factors that led to the accident. These include partial power loss, uncommanded rearward movement of the pilot's seat, and a flight control issue. The serviceability of the aircraft, occupant safety and the implications of the classification of parachuting operations in the private category will also be examined.

Development of the accident

Partial power loss

Based on the recollection of a number of witnesses that the sound of the engine reduced and/or varied during the take-off, the ATSB considered the possibility that the accident was a result of a partial power loss. However, while only indicative of the engine power at impact, examination of the propeller damage showed the engine was operating and driving the propeller with significant power when the aircraft impacted terrain.

The examination of the propeller and engine assembly did not identify anything that would have precluded normal operation. However, extensive fire damage prevented examination and functional testing of some of the engine components. Therefore, an unidentified mechanical defect could not be ruled out as a possible contributing factor.

The reported left turn tracked the aircraft towards the crossing runway. However, it could not be established whether this was a deliberate manoeuvre by the pilot, the result of the developing aerodynamic stall or movement for some other reason. Given the inconsistencies in, and lack of available evidence, it could not be determined whether the aircraft sustained a partial power loss.

Uncommanded pilot seat movement

The witness descriptions of the aircraft's movement after take-off were similar to previous accidents involving loss of control following inadvertent seat movement. There have also been efforts by the United States (US) Federal Aviation Administration (FAA) and Cessna Aircraft Company (Cessna) over a number of years to address the risk of uncommanded rearward pilot set movement. As a result, the ATSB considered whether uncommanded rearward seat movement was a factor on this occasion. If so, there was the potential for it to have prevented the pilot from reaching the flight and engine controls, contributing to the loss of control.

The extensive fire damage to the aircraft, in particular to the cockpit/cabin area, limited the ability to determine the pilot seat position and if the seat was secured in a forward position by the primary seat stops. Examination of the few components able to be recovered could not conclusively establish if the pilot seat was locked in position at the time of the accident. A contact mark was identified on one of the seat rails that may have been indicative of a seat foot being forced past the rail during the accident sequence. However, it was not possible to determine how, or when, that mark was created.

A review of previous in-flight video footage identified that while the seat rail rear stop was in place after the last maintenance inspection, it was likely not fitted on the day of the accident. If the primary locking pins were not secure or failed, and a secondary seat stop modification was not incorporated (as in VH-FRT (FRT)) or serviceable, a missing seat rail rear stop increased the risk of seat feet disengagement from the rear of the seat rails, and subsequent in-flight loss of control. The aircraft manufacturer advised that this risk increased during take-off or landing.

Overall, as the position of the primary locking pins could not be established, it was not possible to determine if the likely absence of the rear rail stop influenced the development of the accident.

Secondary seat stop modification

In 2007 Cessna issued Single Engine Service Bulletin (SEB) 07-5 *Pilot and co-pilot secondary seat stop installation* for the fitment of a secondary seat stop. Cessna categorised the service bulletin as mandatory for the pilot's seat, and recommended for the copilot's seat. The modification was designed to prevent uncommanded rearward movement of the pilot seats, and resulting loss of control, in the event that the primary locking pins did not engage, or failed.

The modification, including labour for fitment, was offered free of charge to aircraft owners of a significant number of Cessna aircraft models, including the 206. The compliance date for the service bulletin was extended several times due to part supply delays and was still current at the time of the accident.

The US FAA did not mandate the Cessna service bulletin. The Civil Aviation Safety Authority (CASA) indicated that the secondary seat stop modification was not mandatory in Australia because the FAA had not mandated the service bulletin by issuing an airworthiness directive. At the time of writing, CASA was considering whether to issue its own airworthiness directive to mandate the service bulletin in Australia to better align with the Cessna requirements.

The aircraft did not have the secondary seat stop modification fitted at the time of the accident, nor was it required to be fitted under the current Australian regulations.

Flight control obstruction

Examination of the aircraft's maintenance history and the wreckage identified that the flight control system on the copilot's side of FRT had been modified without reference to an approved procedure. Additionally, the copilot's controls were reconnected and disconnected after this initial modification without being documented. These actions removed any assurance that the work was conducted safely by qualified personnel. During the investigation, the ATSB became aware of other Cessna 206 parachuting aircraft, which had the copilot's control column modified without an approved maintenance procedure. CASA was informed and, in response, issued an airworthiness bulletin (see *Safety issues and actions*).

Examination of the wreckage also identified that the copilot's elevator control pushrod was disconnected at one end. While it is possible that the rod was cable-tied at the time of the accident, it is also possible it was unsecured. Unsecured, there was the potential for the rod to contact other flight control components located behind the instrument panel. That, in turn, could have prevented full and free movement of the flight control system. Given the extent of the impact and fire damage, the ATSB was unable to determine if that was the case.

Aircraft defects and serviceability issues

It was reported that on the day of the accident, FRT was being operated with a leaking wheel brake. Additionally, records indicated that FRT had been previously operated for a 5-month period with fuselage damage. Although the full extent of the damage was only visible after removal of internal trimming and upholstery, the damage necessitated structural repair. While neither of these issues contributed to the accident, they had the potential to reduce the safety margin of the aircraft.

The ATSB was also made aware of a nose landing gear repair that, in addition to the flight control reconnection and disconnection discussed above, was also not documented. This did not provide assurance that the tasks were conducted correctly and by appropriately-qualified personnel.

Occupant safety

A review of video footage indicated that the pilot generally only wore the lap portion of their seatbelt. It was therefore likely that the shoulder restraint portion of the pilot's seatbelt was not used on the accident flight. While not reducing the severity of the outcome on this occasion, the use of shoulder restraints will generally reduce the risk of injury during an accident. US National Transportation Safety Board research found that a shoulder harness increased the chance of survival by 20 per cent and reduced the chance of serious injury by 32 per cent.

Single-point restraints

As required by civil aviation regulation, and Australian Parachute Federation policy, there were six single-point restraints fitted in the cabin of FRT. Interviews with tandem parachutists who had recently jumped from FRT, including on the morning of the accident, indicated that these restraints were not used. On that basis, it is likely that the parachutists in FRT were also not wearing the single-point restraints at the time of the accident.

During the investigation of a previous fatal parachuting aircraft accident that occurred in 2006, the ATSB identified that available single-point restraints were similarly not used by the parachutists involved. This may indicate that the lack of restraint use in FRT was not an isolated case within the industry.

While research indicates that the use of single-point restraints provides limited protection when compared to dual-point restraints (discussed further below), they do reduce the risk of load shift, which can lead to reduced aircraft controllability. In the context of this accident, a load shift may have occurred after take-off as a result of the reported increasing angle of bank and/or nose-high attitude.

Dual-point restraints

As parachutists are rarely restrained in a seat, the ATSB considered the effectiveness of the available occupant restraint systems. Research was conducted by the Civil Aerospace Medical Institute of the US FAA in response to a recommendation from the US National Transportation Safety Board. This FAA study showed that single-point restraints are relatively ineffective at preventing injuries to rear-facing parachutists when compared to the dual-point restraint system tested. The results of this research appear in appendix B and detail the dual-point restraint system for rear-facing parachutists, how they are fitted, and the advantages over the single-point restraint system.

Despite the FAA findings, and a previous Coronial recommendation that the effectiveness of single-point restraints be reviewed, they are currently the only type mandated for use in Australian parachute aircraft.

Safety briefing

As required by civil aviation regulation and Australian Parachute Federation policy, safety briefings were to be given to parachutists prior to commencing a flight. Those briefings were intended to include the safety details of the aircraft, how to wear a restraint and how to brace or egress in the event of an emergency. Interviews with tandem parachutists who had recently jumped from FRT indicated that these briefings were not consistently carried out.

Notwithstanding the severity of this accident, in general, aircraft safety briefings improve the occupant's ability to react appropriately during an emergency situation.

Classification of parachuting operations

As distinct from other aviation activities that involve carriage of the general public for payment, CASA classifies parachuting operations in the private category. Given the large increase in

tandem parachuting operations since its inception, the ATSB considered the appropriateness of that classification.

ATSB Aviation Research Statistics report titled *Aviation Occurrence Statistics 2005 to 2014* showed that the rate of total and fatal accidents per million hours in the private category (which includes business and sport aviation but not gliding) was about five times higher than the rate for the charter category. When the total accident rate is analysed per million departures, there is a significant difference between charter and parachuting operations, with charter having a rate 2.5 times lower. A further review of the ATSB occurrence database examined the fatal accident rate in parachuting operations as compared to charter operations. This analysis identified that parachuting also had a higher fatal accident rate per million departures than in charter, although this was not a statistically greater probability due to the limited amount of fatal aircraft accidents in the parachuting category.

The 2006 fatal parachuting aircraft accident at Willowbank, Queensland, which was investigated by the ATSB, involved a loss of control following a partial power loss. Managing this situation can be difficult, as highlighted in the ATSB Research report *Managing a partial engine power loss after take-off in single-engine aircraft.* For the accident involving FRT, as previously discussed, it was not possible to determine the reason for the aerodynamic stall and loss of control. Given the two accidents have involved either a difficult situation to manage, or have an unknown cause, it is not clear that the classification of parachuting in the private category was influential.

Despite this, activity within the parachuting industry has increased substantially. When recreational parachuting began in Australia in 1958 it required written permission from the Director General of Civil Aviation (later becoming CASA). In the early 1980s, tandem jumps were introduced and the popularity of these has increased significantly since that time, doubling between 2005 and 2014.

In relation to the 2006 fatal parachuting aircraft accident at Willowbank, the Coroner noted that it was likely members of the public would assume tandem skydiving was equivalent to an activity such as joy flights. It is therefore reasonable to also assume that the general public would see no discernible difference between paying for a scenic flight and paying for a tandem parachuting flight, particularly as parachuting flights can be advertised as being partly 'scenic' (as in the accident involving FRT). It is also important to note that the demographic of parachuting has changed, with more tandem as opposed to recreational parachutists. It is likely that most tandem parachutists would, while having some understanding of the risk involved in conducting the jump, not conceive of the risk associated with the flight to jump height.

In contrast to parachuting operations, scenic flights are operated in the charter category and are therefore required to have an Air Operator's Certificate. This requirement adds additional risk controls to the activity that are absent from parachuting operations. These include the requirement for key personnel, pilot training, operations manuals and a defined safety system, many of which are reflected in the requirements in New Zealand for the issue of an Aviation Operator's Certificate under Civil Aviation Rule Part 115. This rule covers adventure aviation operations that carry 'passengers for hire or reward where the purpose of the operation is for the passenger's recreational experience of participating in the flight, or engaging in an aerial operation.' In particular, in New Zealand this covers tandem parachute descents and parachuting aircraft operations and, in addition to the need for an Aviation Operator's Certificate, requires accountable key personnel, documented policies and procedures and regulatory oversight. The benefits of an Aviation Operator's Certificate were also noted by the Coroner in relation to the 2006 parachuting aircraft accident at Willowbank.

The US National Transportation Safety Board noted three recurring safety issues in their special investigation report into parachuting jump operations. These safety issues centred on inadequate aircraft inspection and maintenance, pilot performance deficiencies and inadequate regulatory oversight and surveillance. Parachuting aircraft accidents in New Zealand and Australia would indicate that these issues are globally relevant.

While it is not possible to say that the reclassification of parachuting operations would reduce the accident rate, the introduction of additional risk controls associated with reclassification is likely to increase the safety of operations. While total activity data for scenic flights was only available for 2014, it showed an activity rate five times higher than that of parachuting operations. Yet the total number of accidents for scenic flights from 2005 to 2014 was 34, and for parachuting was 14. This indicates a potential safety benefit in parachuting under a similar regulatory framework as applied to scenic flights. The relative accident rate between private and charter flights discussed previously would also support this conclusion.

Findings

From the evidence available, the following findings are made with respect to the loss of control of Cessna Aircraft Company U206G, registered VH-FRT that occurred at Caboolture Airfield, Queensland on 22 March 2014. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (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 operating environment at a specific point in time.

Contributing factors

• Shortly after take-off, and for reasons that could not be determined, the aircraft aerodynamically stalled at a height from which the pilot was unable to recover control prior to collision with terrain.

Other factors that increased risk

- Past operation of VH-FRT with fuselage damage, and more recently with a leaking wheel brake, had the potential to reduce the safety margins of the aircraft. Additionally, the conduct of a nose landing gear repair and installation/removal of the copilot's flight controls was not documented and therefore did not provide assurance that these tasks were conducted correctly and by appropriately-qualified aircraft maintenance engineers.
- It was likely that the pilot seat rear rail stop was not fitted in VH-FRT at the time of the accident. This increased the risk of seat feet disengagement from the rear of the seat rails and, if the primary locking pins were not secure or failed, uncommanded rearward movement of the seat and subsequent in-flight loss of control.
- Despite being categorised as mandatory for the pilot's seat by the aircraft manufacturer, a secondary seat stop modification designed to prevent uncommanded rearward pilot seat movement and potential loss of control was not fitted to VH-FRT, nor was it required to be under United States or Australian regulations. [Safety Issue]
- Some Cessna 206 parachuting aircraft, including VH-FRT, had their flight control systems modified without an appropriate maintenance procedure or approval. That increased the risk of flight control obstruction. [Safety Issue]
- It was likely that the shoulder restraint portion of the pilot's seatbelt was not used on the accident flight. While not reducing the severity of the outcome on this occasion, use of shoulder restraints will generally reduce the risk of injury during an accident.
- Research has identified that rear-facing occupants of parachuting aircraft have a higher chance of survival when secured by dual-point restraints, rather than the standard single-point restraints that were required to be fitted to Australian parachuting aircraft. [Safety Issue]
- It was likely that the parachutists on the accident flight, as well as those that had participated in previous flights, were not secured to the single-point restraints that were fitted to VH-FRT. While research indicates that single-point restraints provide limited protection when compared to dual-point restraints, they do reduce the risk of load shift following an in-flight upset, which can lead to aircraft controllability issues. [Safety issue]
- Briefings detailing the safety features of the aircraft, how to wear a restraint and how to brace or egress in the event of an emergency were not consistently provided to tandem parachutists, despite being a regulatory and Australian Parachute Federation requirement.

• Classification of parachuting operations in the private category did not provide comparable risk controls to other similar aviation activities that involve the carriage of the general public for payment. [Safety issue]

Other findings

• The New Zealand Civil Aviation Authority introduced regulations in 2011 for commercial adventure aviation activities, including tandem parachute operations, which increased the number of risk controls associated with these activities.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and 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 directly involved parties were provided with 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.

The initial public version of these safety issues and actions are repeated separately on the ATSB website to facilitate monitoring by interested parties. Where relevant the safety issues and actions will be updated on the ATSB website as information comes to hand.

Secondary seat stop modification not mandatory

Number:	AO-2014-053-SI-01
Issue owner:	Civil Aviation Safety Authority
Operation affected:	Aviation: General Aviation
Who it affects:	Single engine Cessna aircraft operators

Safety issue description:

Despite being categorised as mandatory for the pilot's seat by the aircraft manufacturer, a secondary seat stop modification designed to prevent uncommanded rearward pilot seat movement and potential loss of control was not fitted to VH-FRT, nor was it required to be under United States or Australian regulations.

Response to safety issue by the Civil Aviation Safety Authority

CASA has reviewed the purpose and function of the secondary seat stop modification and concluded that this modification in itself would not address an unsafe condition. CASA issued Airworthiness Bulletin (AWB) 53-010 in July 2016 to clarify the legislative requirements relative to the Cessna Supplemental Inspection Documents (SIDS) inspection program. The AWB addresses the incorporation of Cessna Single Engine Service Bulletin SEB07-5 where CASA's position is that this modification, while highly recommended, does not have a legislative requirement for incorporation.

The US Federal Aviation Administration (FAA) released Special Airworthiness Information Bulletin (SAIB) CE-09-10 in February 2009, which alerted operators to the availability and potential safety concern that is addressed by this particular modification. SAIB's are issued with the following caveat:

At this time, this airworthiness concern is not an unsafe condition that would warrant AD action under Title 14 of the Code of Federal Regulations (14 CFR) part 39.

As such, the FAA did not, and has not since decided that regulatory action was appropriate for this condition.

The primary interest for CASA regarding the findings of this investigation is the lack of the seat rail stop. This stop was installed following the 100 hourly/annual inspection but was likely not present at the time of the event. As pilot maintenance allows for the removal of aircraft seats, it is reasonable to conclude that either a seat was removed and the seat rail stop was not reinstalled or the seat rail stop had simply dislodged. If the former is correct, then the factors that led to the seat rail stop not being reinstalled would also have the potential to be present in a secondary seat stop (i.e. if the seat rail stops were not reinstalled, why would the secondary seat stop be installed). The question was raised regarding similar systems for other aircraft types that do not have a similar modification available.

CASA believes the appropriate course of action to address this condition is to require the inspection of the seat stop hardware (i.e. seat stop hardware/mechanism) as part of the pilot's daily inspection in addition to the current requirements to check related hardware such as seat belts. CASA intends to legislate this through Schedule 5 of the Civil Aviation Regulations (CAR) and to also require the Australian Parachute Federation (APF) to amend their jump manual to reflect this requirement. That process will involve industry consultation. In the meantime, an AWB will be issued to draw attention to this requirement pending the legislative change to Schedule 5.

ATSB comment/action in response

Historical incident and accident data has shown that inadvertent rearward movement of the pilot seat in single engine Cessna aircraft is a safety issue that should be addressed.

Cessna designed, manufactured and mandated the secondary seat stop modification through Single Engine Service Bulletin SEB07-5 as a method of preventing seat slide occurrences. The modification was offered free of charge, inclusive of parts and labour, to all relevant single engine Cessna aircraft owners world-wide. These actions by the manufacturer are indicative of the significance of the safety issue.

While the intention of the Civil Aviation safety Authority (CASA) to draft an AWB for seat, seatbelt and stop inspections is welcomed, the ATSB remains concerned that due to Australian regulations for aircraft maintained in accordance with Maintenance Schedule 5 the modification is not mandatory in Australia.

As a result, the ATSB issues the following safety recommendation.

ATSB safety recommendation to the Civil Aviation Safety Authority

Action number: AO-2014-053-SR-017

Action status: Released

The ATSB recommends that the Civil Aviation Safety Authority takes action to strengthen incorporation of Cessna Single Engine Service Bulletin SEB07-5 Secondary seat stop modification.

Unapproved aircraft flight control modifications

Number:	AO-2014-053-SI-02
Issue owner:	Civil Aviation Safety Authority
Operation affected:	Aviation: General Aviation
Who it affects:	Parachute jump operators

Safety issue description:

Some Cessna 206 parachuting aircraft, including VH-FRT, had their flight control systems modified without an appropriate maintenance procedure or approval. That increased the risk of flight control obstruction.

Response to safety issue and Proactive safety action taken by the Civil Aviation Safety Authority

Action number: AO-2014-053-NSA-01

The ATSB informed CASA about this safety issue during a meeting on 3 August 2015. In response, CASA issued airworthiness bulletin AWB 02-054 on 22 January 2016, titled *Unapproved Modifications – Flight Controls, Structures and Systems*, which stated:

CASA recommends that owners, operators and maintainers carry out a physical examination of their aircraft and the aircraft's technical records to ensure:

- 1. All modifications have been fully accomplished in accordance with the approved data for the modification.
- 2. All unapproved and conflicting modifications are removed and the aircraft is returned to a serviceable and airworthy condition.
- The aircraft has the applicable flight manual supplement(s) for the associated manufacturer's kit, or approved modification for the intended operation.
- 4. The airworthiness and operation of the aircraft is not adversely affected by the incorporation of multiple STC's [Supplemental Type Certificate] and other modifications.
- 5. The continuing airworthiness requirements of each modification have been properly incorporated into the maintenance program.

CASA response to draft report on 27 Mar 2017

CASA has reviewed the current AWB 02-054 referenced in the report which was released in 2015 [2016] following this event. In consideration of the information provided in this ATSB report, CASA believes this document to be appropriate in its current form without further amendment required.

Australian Parachute Federation response

APF wrote to members regarding this directive. The first correspondence was on 9 September 2015 as soon as we were made aware of the potential issue, and again on 29 January 2016 as soon as the CASA Airworthiness Bulletin was released.

ATSB comment/action in response

The ATSB acknowledges the proactive safety action taken by CASA and the Australian Parachute Federation to address this safety issue.

Current status of the safety issue

Issue Status: Adequately addressed

Justification: As a result of the safety action taken by the Civil Aviation Safety Authority and the Australian Parachute Federation, aircraft operators have increased awareness of this safety issue. Consequently, the ongoing safety risk is considered acceptable.

Dual-point restraints

Number:	AO-2014-053-SI-03
Issue owner:	Civil Aviation Safety Authority
Operation affected:	Aviation: General Aviation
Who it affects:	Australian parachuting industry

Safety issue description:

Research has identified that rear-facing occupants of parachuting aircraft have a higher chance of survival when secured by dual-point restraints, rather than the standard single-point restraints that were generally fitted to Australian parachuting aircraft.

Response to safety issue by the Civil Aviation Safety Authority

The immediate survivability in a number of specific crash scenarios may be increased by the use of dual-point restraints. However, other possible scenarios requiring rapid emergency egress from an aircraft should also be taken into account. Survivability in possible scenarios, such as an emergency landing or crash into a body of water (e.g., ATSB Aviation Occurrence Investigation 200600001, Collision with terrain, Cessna U206, VH-UYB, Willowbank, Qld, 2 January 2006), post-crash fire (AO-2014-053, Collision with terrain involving Cessna U206G, VH-FRT, Caboolture Airfield, Qld, 22 March 2014) or the immediate emergency evacuation of passengers who are in an injured or non-conscious state should also be examined. The usage of dual-point restraints in these post-crash

scenarios may impede the rate that the emergency evacuation may be completed thus presenting additional risks as identified in the survival aspects section of this report.

The differing aircraft types utilised in parachuting operations in Australia also needs to be taken into account when examining the possible usage of dual-point restraints. With reference to Sport Parachuting, United States Federal Aviation Administration (FAA) Advisory Circular AC105-2E Appendix 3 (Seats and Restraint Systems) depicts an aircraft equipped with quick release track fittings. This type of floor mounted fitting, although standard in many large, turbine-powered aircraft such as the Cessna Caravan and Twin Otter, are not fitted to all aircraft. Smaller piston-powered aircraft in use for parachute operations, such as the Cessna 182 or 206, do not have these floor mounted fittings. In these types of aircraft the restraints need to be fitted to suitable anchor points, which may or may not be located at convenient loading points for the operation.

The anchor points used to secure the restraints in these smaller aircraft types are generally those approved by the aircraft manufacturer as the original seatbelt or seat mounting points. An STC [supplemental type certificate] owned by the APF [Australian Parachute Federation] allows certain models of Cessna 182 aircraft to operate with a total of 6 POB providing the MTOW is not exceeded. To allow this the STC requires an appropriate number of single-point restraints (SPRs) to be fitted to specific attachment points in the aircraft cabin. Any additional requirement to use dual-point restraints would double the number of attachment points required which would increase the compliance costs. CASA is required to take all relevant considerations, including cost, into account.

The research conducted into the use of dual-point restraints stems from a Twin Otter Skydiving Aircraft accident in the USA on 29 July 2006 (NTSB/AAR-08/03/SUM). The NTSB Aircraft Accident Summary Report contained the following safety recommendations:

Recommendations

The National Transportation Safety Board recommends that the Federal Aviation Administration:

Conduct research, in conjunction with the United States Parachute Association, to determine the most effective dual-point restraint systems for parachutists that reflects the various aircraft and seating configurations used in parachute operations. (A-08-71)

Once the most effective dual-point restraint systems for parachutists are determined, as requested in Safety Recommendation A-08-71, revise Advisory Circular 105-2C, Sport Parachute Jumping, to include guidance information about these systems. (A-08-72)

The National Transportation Safety Board recommends that the United States Parachute Association:

Work with the Federal Aviation Administration to conduct research to determine the most effective dual-point restraint systems for parachutists that reflects the various aircraft and seating configurations used in parachute operations. (A-08-73)

Once the most effective dual-point restraint systems for parachutists are determined, as requested in Safety Recommendation A-08-71, educate your members on the findings and **encourage** (edited to add emphasis) them to use the most effective dual-point restraint systems. (A-08-74)

ATSB comment/action in response

The ATSB acknowledges the concerns of CASA and the APF regarding egress following an accident. However, occupants of an aircraft must first survive the accident and remain conscious in order to extricate themselves and/or others. Research shows that this is more likely to occur if dual-point restraints are used for rear facing parachutists.

The Federal Aviation Administration (FAA) provided educational material to those engaged in parachuting in the form of advisory circular AC 105-2E (appendix B). That document has reference material which can and has been used by the industry in an effort to enhance safety. It provides guidance:

...to improve sport parachuting safety and disseminates information to assist all parties associated with sport parachuting to be conducted in compliance with Title 14 of the Code of Federal Regulations (14 CFR) part 105...

Appendix 3 to that circular states:

...

(3) Single point, single tether restraints are not recommended.[emphasis added]

(4) Dual point, dual tether restraints offer superior restraint compared to single point, single tether restraints. This restraint method consists of two straps, each connecting the parachute harness to the aircraft floor on both sides of the parachutist...

While the FAA have not made the use of dual-point restraints mandatory, they have provided guidance to industry that clearly shows that single point restraints are an inferior restraint option. As a result, the ATSB has issued the following safety recommendation to the Civil Aviation Safety Authority.

ATSB safety recommendation to the Civil Aviation Safety Authority

Action number: AO-2014-053-SR-018

Action status: Released

The ATSB recommends that the Civil Aviation Safety Authority, in conjunction with the Australian Parachute Federation, takes action to increase the usage of dual-point restraints in parachuting aircraft that are configured for rear facing occupants.

Number:	AO-2014-053-SI-03
Issue owner:	Australian Parachute Federation
Operation affected:	Aviation: General Aviation
Who it affects:	Australian parachuting industry

Safety issue description:

Research has identified that rear-facing occupants of parachuting aircraft have a higher chance of survival when secured by dual-point restraints, rather than the standard single-point restraints that were generally fitted to Australian parachuting aircraft.

Response to safety issue by the Australian Parachute Federation

Regarding the use of dual-point restraints, the Australian Parachute Federation (APF) stated:

...APF believes that the use of dual restraints will not result in a net improvement in safety due to additional complications. These include dealing with inexperienced or tandem parachutists in relation to in flight emergencies and the ability to disconnect them quickly and safely in reaction to an emergency...

ATSB comment/action in response

As detailed above, given the identified safety benefit offered by dual point restraints, the ATSB issues the following safety recommendation.

ATSB safety recommendation to the Australian Parachute Federation

Action number: AO-2014-053-SR-019

Action status: Released

The ATSB recommends that the Australian Parachute Federation, in conjunction with the Civil Aviation Safety Authority, takes action to increase the usage of dual point restraints in parachuting aircraft that are configured for rear facing occupants.

Number:	AO-2014-053-SI-04
Issue owner:	Occurrence operator
Operation affected:	Aviation: General Aviation
Who it affects:	Australian parachuting industry

Restraint use in parachuting aircraft

Safety issue description:

It was likely that the parachutists on the accident flight, as well as those that had participated in previous flights, were not secured to the single-point restraints that were fitted to VH- FRT. While research indicates that single-point restraints provide limited protection when compared to dual-point restraints, they do reduce the risk of load shift following an in-flight upset, which can lead to aircraft controllability issues.

Response to safety issue by the operator

While the operator did not provided any specific comment in relation to the safety issue, they advised that they had ceased operation.

Response to safety issue by the Civil Aviation Safety Authority

CASA advised that there are regulations in place that make the use of single point restraints mandatory for all non-aircrew occupants of skydiving aircraft during take-off, landing, flights below 1,000ft and during turbulence. They also stated that APF auditors examine parachute aircraft restraints and their use during their annual audit process.

Response to safety issue by the Australian Parachute Federation

The APF advised that they did not believe that the failure to use installed single point restraints was widespread across the parachuting industry.

ATSB comment/action in response

The safety issue owner was the occurrence operator. As they are no longer conducting parachuting operations, the issue is no longer relevant. While ATSB investigation 200600001 similarly identified that the single-point restraints were not utilised, there is insufficient evidence to determine if this is a broader issue across the parachuting industry.

As discussed in relation to safety issue AO-2014-053-SI-03, although single-point restraints should be used as they provide some occupant protection, research has identified that dual-point restraints offer a superior level of safety for rear facing occupants.

Current status of the safety issue

Issue Status: No longer relevant

Justification: The safety issue owner is no longer conducting parachuting operations.

Classification of parachuting operations

Number:	AO-2014-053-SI-05
Issue owner:	Civil Aviation Safety Authority
Operation affected:	Aviation: General Aviation
Who it affects:	Australian parachuting industry

Safety issue description:

Classification of parachuting operations in the private category did not provide comparable risk controls to other similar aviation activities that involve the carriage of the general public for payment.

Response to safety issue and/or Proactive safety action taken by the Civil Aviation Safety Authority

Under the applicable legislation, aircraft operations are classified as Regular Public Transport, Charter, Aerial Work or Private. As noted in the ATSB report, CASA classifies parachuting operations as private operations under CAR 2(7)(d) as the carriage of persons or goods without a charge. This interpretation is based on the conclusion that such operations involve activity of a kind substantially similar to those specified in the relevant sub-paragraphs, having regard to the intention of participants to make a parachute descent, with a payment being made for the parachute descent, not for the flight.

As noted in the ATSB report, parachute training operations vary in size and aircraft types. CASA's focus is on safety and, recognising the risks inherent in these private operations, CASA has given directions regarding the conduct of parachute training operations by the Australian Parachute Federation (CASA Instrument 244/12 applied in 2014; CASA Instrument 06/16 applies currently). These directions impose general conditions regarding aircraft operation, pilot qualifications and maintenance of Class B aircraft as well as specific requirements in respect of supervision of parachute training operations, the conduct of parachute operations, equipment and radio procedures. There are also additional requirements regarding operations in controlled airspace, radio procedures in the vicinity of a CTAF, operations at certified or registered aerodromes and operations above 10,000' AMSL.

The general conditions regarding aircraft operations in 244/12 required that the aircraft be operated in accordance with the APF Jump Pilot's (JP) Handbook (now Manual) and that the pilot in command of a jump aircraft must hold an APF Jump Pilot authorisation. The JP Manual provides the framework under which the APF implements aviation standards for parachuting operations and issues competent pilots with Jump Pilot Authorisations. Jump Pilot requirements and responsibilities are defined in APF Operational Regulations Part 5 and Regulatory Schedule 56. Taken together, CASA believes these specific conditions provide for a measure of safety appropriate to the risks involved in the operations they govern.

Consistent with these considerations, CASA anticipates the development of a revised classification of aircraft operations framework that contemplates three broad classes of operations: Air Transport Operations; Aerial Work Operations; and General Aviation Operations. In most cases operations under CAR 2(7)(d) would fall under the General Aviation operations class, in which operations involve the carriage of passengers on a flight that is not provided on a commercial basis. The maximum number of persons that may be carried on an aircraft engaged in General Aviation would be limited, and the carriage of passengers above those numbers would trigger the application of a higher classification of operations or increased regulatory attention.

Within each of the three classes of operations, CASA's regulatory program envisages that aircraft will be regulated to common baseline requirements, supplemented by additional requirements as may be necessary to mitigate additional risks. Specific regulatory requirements within each class will vary, depending on aircraft size, complexity of operations, number of persons on board, area of operation and specific operational risks. These, taken together, will determine the overall risk to safety posed by a particular operation.

In respect of parachuting, proposed CASR Part 91 (general operating and flight rules) and proposed Part 105 (parachuting from aircraft) will cover the baseline requirements (Part 91) and additional requirements (Part 105). Proposed CASR Part 105 will provide a regulatory basis for undertaking parachuting activities by an appropriately approved self-administering aviation organisation whose functions include administering a parachuting activity. Part 105 will incorporate the conditions attached to the current parachuting instruments and the pilot licensing and experience requirements in the APF operational regulations, as well as additional flight time requirements, into Regulation. Specifically, Part 105 will regulate:

- obligations applying to parachute operators;
- hazard mitigation;

- the wearing of reserve parachutes;
- pilot requirements for descents by trainee parachutists and tandem passengers;
- pilot licensing, experience and flight time requirements;
- aircraft operations
 - o restraint of parachutists;
 - o restrictions on aircraft occupants;
 - o requirements for aircraft used for descents;
 - o requirements relating to radio and oxygen equipment;
- parachute defects.

CASA Instrument 244/12 (applied in 2014) and 06/16 as applies currently provide significant additional requirements for aircraft and pilots engaged in parachuting. Those requirements are based upon policies developed for proposed CASR Part 105 provide for an increased standard for the parachute operators above current baseline requirements; and in the future under proposed Part 105 above baseline proposed Part 91 requirements.

CASA Instrument 244/12 (applied in 2014) and 06/16 as applies currently provide significant additional requirements for aircraft and pilots engaged in parachuting. Those requirements are based upon policies developed for proposed CASR Part 105 provide for an increased standard for the parachute operators above current baseline requirements; and in the future under proposed Part 105 above baseline proposed Part 91 requirements.

While the classification of Operations is for a private operation, the APF JP manual requires the engines to be maintained in accordance with the charter requirements of AD/ENG/4 for piston engine overhaul at manufacturers TBO and AD/ENG/5 for Turbines. With the exception of some minor cabin trim defects, the maintenance release of an aircraft under "private" is essentially equivalent to a "charter" category. The long-term solution as mentioned above is the release of Part 105, which will specify parachute operations including "minimum maintenance for aircraft used for training and tandem parachute operations".

CASA advised that Civil Aviation Safety Regulations (CASR) Part 91 is expected to be made in late 2018 and commence in late 2019 with no planned transition period. CASR Part 105 is planned to be made in late 2018. At the time of writing, the commencement and transition periods for that part had not been determined.

Proactive safety action taken by the Australian Parachute Federation

In 2016, APF appointed three Safety and Training Managers. These full-time employees replaced the previous volunteer Area Safety Officers who conducted audits throughout Australia on student training/tandem parachute organisations. The AFP assessed that this provided a more cohesive approach to the audit process.

The APF also mandated the requirement for each Student Training Organisation to have a safety management system (SMS) by 1 July 2016. The SMS is used to proactively assess and mitigate risk. The SMS is audited as part of the club audits by the APF on an annual basis.

ATSB comment/action in response

The safety action taken by the AFP in appointing full-time safety personnel and introducing SMS requirements to parachuting organisations is welcomed.

The ATSB acknowledges that, when introduced, CASR Part 91 and Part 105 provide an opportunity to increase the standard of parachute operations above the current baseline standards. However, use of the current CASA instrument 06/16 content as the policy basis for Part 105 offers limited assurance that effective risk controls such as key operational/maintenance personnel, pilot checking and training, formalised operating procedures and increased oversight will be applied to parachuting operations.

The United States National Transportation Safety Board (NTSB) identified inadequate aircraft inspection and maintenance, pilot performance deficiencies and inadequate regulatory oversight and surveillance as recurring safety issues in parachuting operations. The ATSB considers that the introduction of the above risk controls, currently present in charter operations, would mitigate

the issues identified by the NTSB. The relatively lower total accident rate for charter flights compared to private flights, supports that conclusion.

As a result, the ATSB has issued the following safety recommendation to the Civil Aviation Safety Authority.

ATSB safety recommendation to the Civil Aviation Safety Authority

Action number: AO-2014-053-SR-020

Action status: Released

The ATSB recommends that the Civil Aviation Safety Authority introduce risk controls to parachuting operations that provide increased assurance of aircraft serviceability, pilot competence and adequate regulatory oversight.

Additional safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Civil Aviation Safety Authority

CASA provided the ATSB with the following advice regarding informed participation in parachuting:

CASA reviewed the current Sport Aviation webpages to include further review and explanation of the concept of informed participation in August 2016. Sport Aviation also distributed by Safety Update 03/2016 in August 2016 information and safety education relating to informed participation to all Sport Aviation Organisations, including explanation on safety risks in sport Aviation operations and how these differ to large passenger carrying jets and further detailed the higher safety risks in sport aviation participation

CASA audited the APF in November 2015 and highlighted the importance of further education of informed participation and raised observations relating to parental consent for under 18 year old participants as well as risk and indemnity pre-reading for APF participants prior to conducting their jump and written receipt of waiver policy details.

General details

Occurrence details

Date and time:	22 March 2014 - 1124 EST
Occurrence category:	Accident
Primary occurrence type:	Loss of control
Location:	Caboolture Airfield, Queensland

Pilot details

Licence details:	Commercial Pilot (Aeroplane) Licence, issued February 2010
Endorsements:	Manual propeller pitch control, retractable undercarriage, single engine aeroplanes less than 5,700 kg maximum take-off weight
Ratings:	Jump pilot and jump pilot examiner authorisations
Medical certificate:	Class 2, with no restrictions
Aeronautical experience:	Approximately 1,100 hours
Last flight review:	30 January 2014

Aircraft details

Manufacturer and model:	Cessna U206G				
Year of manufacture:	1977				
Registration:	VH-FRT				
Serial number:	U20604019				
Total Time In Service	Approximately 11,110 hours				
Type of operation:	Private				
Persons on board:	Crew - 1	Passengers – 4			
Fatalities:	Crew – 1	Passengers – 4			
Damage:	Destroyed				

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the aircraft manufacturer
- the owner and maintainers of the aircraft
- a number of the parachuting operator's personnel
- the Civil Aviation Safety Authority
- the Australian Parachute Federation
- the United States National Transportation Safety Board
- the United States Federal Aviation Administration
- the Civil Aviation Authority of New Zealand.

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 Cessna Aircraft Company, the owner and maintainers of the aircraft, the Civil Aviation Safety Authority, the United States National Transportation Safety Board and the Australian Parachute Federation.

Submissions were received from the maintainers of the aircraft, the Civil Aviation Safety Authority and the Australian Parachute Federation. The submissions were reviewed and where considered appropriate, the text of the draft report was amended accordingly.

Appendices

Appendix A – Cessna U206G stall speeds

CESSNA MODEL U206G SECTION 5 PERFORMANCE

STALL SPEEDS

CONDITIONS: Power Off

NOTES:

- 1. Maximum altitude loss during a stall recovery may be as much as 240 feet.
- 2. KIAS values are approximate.

MOST REARWARD CENTER OF GRAVITY

WEIGHT LBS	FLAP DEFLECTION	ANGLE OF BANK							
		00		30 ⁰		45 ⁰		60 ⁰	
		KIAS	KCAS	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS
3600	UP	55	62	59	67	65	74	78	88
	20 ⁰	49	57	53	61	58	68	69	81
	40 ⁰	45	54	48	58	54	64	64	76

MOST FORWARD CENTER OF GRAVITY

WEIGHT L8S	FLAP DEFLECTION	ANGLE OF BANK							
		00		30 ⁰		45 ⁰		60 ⁰	
		KIAS	KCAS	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS
3600	UP	62	67	67	72	74	80	88	95
	20 ⁰	54	60	58	65	64	71	76	85
	40°	48	57	52	61	57	68	68	81

Appendix B – United States Federal Aviation Administration Advisory Circular AC 105-2E-Appendix 3

AC 105-2E Appendix 3

APPENDIX 3. SEATS AND RESTRAINT SYSTEMS

 Seating Configuration and Restraint System Safety. Not all seating and restraint system configurations used in jump aircraft provide the same level of safety in the event of an emergency landing. This appendix provides general information concerning the relative safety of commonly used seating configurations and restraint systems. These safety assessments are based on available research data and in-service experience.

2. General Information.

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a. Quick Release Track Fittings. Single stud quick release track fittings have been shown to release from the track at dynamic loads much lower than their rated strength. Dual stud quick release fittings did not exhibit this behavior in dynamic tests. Therefore, dual stud quick release fittings of the type shown in Figure 2, Dual Stud Quick Release Track Fitting, provide a much more reliable restraint anchorage than single stud fittings.

b. Lap Belts. Lap belts are only effective if there is a solid support surface behind the occupant, such as a seat back, aircraft sidewall, or bulkhead. Otherwise, a tether restraint that attaches to the parachute harness provides more effective restraint.

c. Restraint for Aft-Facing Parachutists. Research has shown that to restrain aft-facing parachutists, the most effective point to attach a tether restraint to a parachute hamess is at the junction of the leg straps, main lift web, and the horizontal back strap. Figure 3, Tether Restraint Usage, illustrates this attachment method, in which the tether loop encircles the junction by passing between the main lift web and the horizontal back strap, and between the upper leg strap and the lower leg strap. One way to achieve this is to route the tether loop under the upper leg strap, then under the main lift web before latching the loop, as depicted in Figure 4, Pass Tether Loop Under Upper Leg Strap, Figure 5, Pass Tether Loop Under Main Lift Web, and Figure 6, Latch Tether Loop Around Parachute Harness. Since these two components of the harness are easily accessible by the wearer, this attachment method should not be prone to misuse. It also provides more effective restraint than attaching at other points on the parachute harness since the restraining force is applied near the seated occupant's center of gravity (CG).

d. Restraint Belts or Tethers. Past experience and testing have shown the validity of attaching a restraint belt(s) or tether(s) to the parachute harness as part of the overall integrated restraint system. However, most manufactuers have not tested their parachute harness configurations to see if they can accept the load vectors that would be experienced during the actual use of this type of restraint configuration. Because of this, any parachute harness that has been subjected to actual use as part of an integrated restraint system must be removed from service and inspected by the manufacturer or a parachute rigger designated by the manufacturer to determine the continued airworthiness of the parachute harness. If the inspection shows that the harness is Airworthy, it may be returned to service.

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AC 105-2E Appendix 3

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3. Specific Seating/Restraint Configurations.

a. Side-Facing. Conventional side-facing bench seats employing dual point lap belts are a superior means of carrying parachutists in aircraft large enough to accommodate them. They offer the advantages of being simple to use and can be designed to provide significant vertical energy absorption.

b. Rear-Facing Floor Seating.

(1) Restraints are more effective if attached to the floor instead of the sidewall. Only use sidewall attachments if floor attach points are not available.

(2) Effectiveness is increased if overall tether length is kept as short as possible and the tether attachment to the aircraft is aft of the harness attachment point.

(3) Single point, single tether restraints are not recommended.

(4) Dual point, dual tether restraints offer superior restraint compared to single point, single tether restraints. This restraint method consists of two straps, each connecting the parachute harness to the aircraft floor on both sides of the parachutist as shown in Figures 7, Tether Restraint Attachment To Floor For Rear-Facing Floor Seats, Figure 8, Dual Point, Dual Tether Restraint Configuration For Rear-Facing Floor Seats, and Figure 9, Dual Point, Dual Tether Restraint Attachment To Floor For Rear-Facing Straddle.

c. Rear-Facing on Straddle Bench.

(1) Straddle benches can offer more occupant crash protection than floor seating since they can be designed to provide significant vertical energy absorption.

(2) As with floor seating, restraints are more effective if attached to the floor instead of the sidewall.

(3) Restraint effectiveness is improved if the tether strap is attached to the floor such that it is at an approximately 45 degree angle, as shown in Figure 9.

(4) Single point, single tether restraints are not very effective.

(5) Dual point, dual tether restraints offer superior restraint compared to single point, single tether restraints.

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FIGURE 8. DUAL POINT, DUAL TETHER RESTRAINT CONFIGURATION FOR REAR-FACING FLOOR SEATS



FIGURE 9. DUAL POINT, DUAL TETHER RESTRAINT ATTACHMENT TO FLOOR FOR REAR-FACING STRADDLE



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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 operations involving the travelling public.

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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vestigation

ATSB Transport Safety Report Aviation Occurrence Investigation

Loss of control involving Cessna Aircraft Company U206G, VH-FRT Caboolture Airfield, Queensland, 22 March 2014

AO-2014-053 Final – 23 June 2017