Accident

Aircraft Type and Registration:	Beechcraft Super King Air 200, G-FLYW	
No & Type of Engines:	2 Pratt & Whitney Canada PT6A-61 turboprop engines	
Year of Manufacture:	1977 (Serial no: BB-209)	
Date & Time (UTC):	20 March 2020 at 1141 hrs	
Location:	Exeter Airport	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Propeller damage, engines shock-loaded, minor rear fuselage damage	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	59 years	
Commander's Flying Experience:	8,500 hours (of which over 3,000 were on type) Last 90 days - 26 hours Last 28 days - 26 hours	
Information source:	Aircraft Accident Report Form submitted by the pilot, engineering diagnostic report, ATC investigation report and further enquiries by the AAIB	

Synopsis

The accident flight was recurrent training for a pilot who had recently re-joined the aircraft operator's company. G-FLYW took off from Bristol Airport and the pilots conducted general handling training before positioning for two Global Navigation Satellite System (GNSS) approaches at Exeter Airport. The trainee occupied the left seat and was handling pilot for the flight.

The second GNSS approach at Exeter was made in a simulated single-engine configuration and was terminated by an asymmetric go-around to join the visual circuit. The intention was to complete a single-engine landing before returning to Bristol. Due to landing traffic ahead, the handling pilot elected to extend the downwind leg and the landing gear was selected down when the aircraft was on left base. All appeared normal and the pilots remembered seeing three green lights indicating that the landing gear was locked down. No undercarriage position warnings were evident. When the aircraft was being flared for touchdown both pilots heard a loud metallic noise and a go-around was initiated. Eyewitnesses reported seeing the aircraft touch down with the landing gear retracted and its propellers striking the runway.

During the go-around, and before the landing gear was selected up, the pilots noted that the green undercarriage indicator lights were extinguished. After the go-around, the pilots

attempted to recycle the landing gear using the normal system, but it remained retracted. Lowering the landing gear using the emergency mechanism was successful and the aircraft landed at Exeter Airport without further incident.

It was not possible to positively determine how the aircraft had come to touch down with its landing gear retracted.

Following this accident, the CAA undertook to review whether its process for one-off flight approvals should include a wider set of criteria.

History of the flight

The flight was recurrent training for a pilot who had recently re-joined the company that operated G-FLYW. The trainee occupied the left seat and was PF for the detail. The commander, a Type Rating Examiner, was in the right seat and acted as PM for multi-pilot elements of the flight.

The aircraft took off from Bristol Airport and the pilots conducted general handling training before positioning for two GNSS approaches and go-around's at Exeter Airport. The second approach at Exeter was flown in a simulated single-engine configuration where "the simulated failed engine was set at 1,600 rpm and approximately 200 torque lbs. The 'live' engine was set at 400 lbs fuel flow to give appropriate power to maintain asymmetric flight."

After the single-engine go-around, the pilots joined the visual circuit to complete an asymmetric stop-and-go[1] landing before returning to Bristol Airport.

To increase separation from landing traffic ahead of them, the handling pilot elected to extend the downwind leg of the visual circuit, achieving an estimated 3 nm straight-in final approach. Landing checks, including down selection of the landing gear, were carried out on left base. Both pilots remembered seeing three greens[2] after landing gear selection and did not see or hear any landing gear position warnings. They stated that the approach was made with "one stage of flap" and that the approach speed was "spot on around 125 kt". The trainee reported that at a late stage on finals the speed had started to trend upwards unexpectedly, requiring a reduction in power to stabilise it. At the time he thought it was because of minor turbulence but, while diagnosing the approach subsequently, surmised that it could have been a symptom of an uncommanded undercarriage retraction.

When the aircraft was being flared for touchdown both pilots heard a loud metallic noise as its propellers struck the runway. A go-around was immediately initiated and the aircraft climbed away from the runway. Prior to selecting the landing gear up as part of the go-around procedure, the pilots saw that, while the gear handle was down, the three green landing gear position indicator lights were "extinguished". Even though they were wearing active noise reduction headsets, neither pilot thought it possible to have missed the undercarriage warning horn should it have been sounding on the approach.

Footnote

1 A landing coming to a stop on the runway and then taking off using both engines.
2 Cockpit indication that the landing gear is down and locked. See later section, *Landing gear system overview.*

Just before G-FLYW touched down, the driver of an airfield operations vehicle parked on the Main Apron (Figure 1) saw the aircraft approaching the runway with its gear retracted. The driver attempted to alert ATC using his UHF radio, but the aircraft touched down before he could do so. Similarly, the pilot of an aircraft conducting pre-takeoff checks at Holding Point B1 saw G-FLYW too late to transmit an alert over the VHF Tower frequency.

During the latter stages of G-FLYW's approach the preceding landing traffic had been completing its rollout prior to vacating onto Taxiway C towards the South Apron (Figure 1). The Tower ATC controller (ATCO) warned G-FLYW to expect a late clearance and focused on monitoring the runway traffic. As soon as the landing traffic had left the runway, and while still looking at the vacating aircraft, the ATCO issued landing clearance to G-FLYW. When he turned to his left, he saw the King Air climbing away from the runway with its gear retracted and assumed that the pilots had gone around due to the late clearance. It was not until after G-FLYW had landed that the ATCO became aware that it had sustained a double propeller strike.

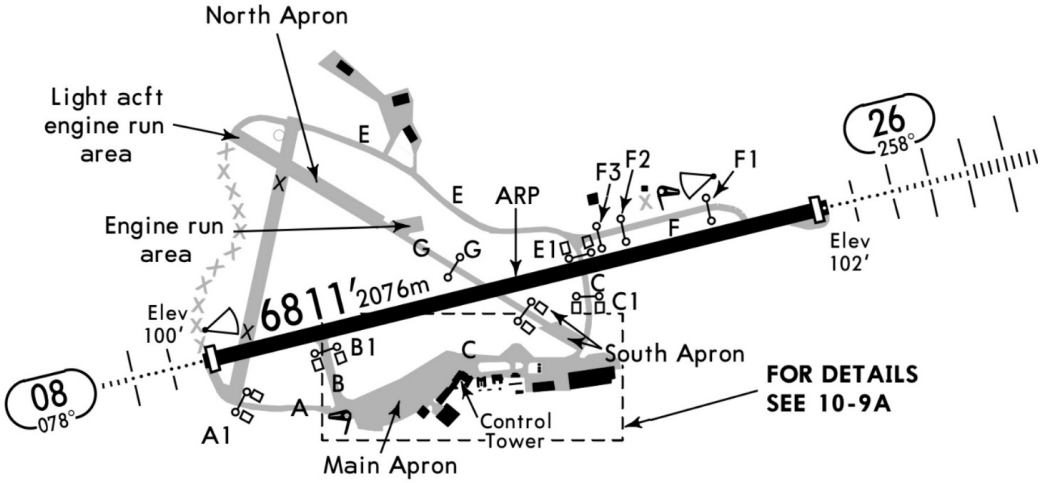

Figure 1

Exeter Airport landing chart

After going around, the pilots repositioned downwind and attempted to lower the landing gear using the normal system, but it did not extend. Confused as to what may have occurred, the pilots held clear of the visual circuit to diagnose the problem. After following the Quick Reference Handbook checklist, they managed to obtain three greens using the emergency undercarriage lowering mechanism. The pilots then flew past the Control Tower for a visual check from ATC to confirm that the landing gear had extended and declared their intention to make an approach to land. The pilots had not formally declared an emergency and the ATCO, unaware of the potential for damage to G-FLYW's engines, had been expecting the aircraft to return to Bristol. On realising that the pilots intended to land at Exeter the ATCO initiated the airfield's '*full emergency*' procedures.

Due to confusion over of the exact weight category of the King Air, G-FLYW was categorised as a 'Large' rather than a 'Small' aircraft when ATC activated their emergency procedures.

The airfield fire service was immediately available and additional Local Authority emergency services were in position to support them 17 minutes after the emergency state was initiated. While assistance is sought from the Local Authority responders for any full emergency, the scale of augmentation is greater when a Large aircraft is involved. G-FLYW could have landed without delay but, when ATC asked the pilots if they wished to wait until the additional emergency assets were in place, it was interpreted as an instruction and the pilots thought they were required to hold off until advised.

Once the emergency services were in position, the pilots carried out an uneventful landing. Due to their suspicion that the landing gear might earlier have self-retracted, the pilots minimised their use of braking during the landing roll.

Accident site

A runway inspection immediately after G-FLYW's go-around found the remains of an aircraft light on the runway in the vicinity of the reported touchdown point. After G-FLYW had landed a second runway inspection discovered propeller strike marks either side of the centreline that corelated with G-FLYW's earlier approach (Figure 2).

Figure 2

Propeller strike marks and debris from broken aircraft light (centre image)

Meteorology

Good weather prevailed at the time of the accident. The measured wind velocity, reported in ATC's landing clearance to G-FLYW, was 050°/23 kt.

Personnel

The handling pilot had previously been employed by the operator as a captain on their King Air aircraft. He was undergoing refresher training on type having recently returned to the company. Due to COVID-19 restrictions adversely impacting simulator availability, and contrary to the operator's normal policy, the training was conducted in the aircraft. The CAA had issued a 'one-off flight approval' for the event, the purpose of which was to conduct a combined LPC/OPC. Following this accident, the CAA undertook to review their internal processes to determine whether the barrier analysis for one-off flight approvals needed to routinely review a wider set of criteria.

Recorded data

G-FLYW was not fitted with flight data or cockpit voice recorders. No other data source was available to support the investigation into how the landing gear came to be up when G-FLYW first touched down at Exeter Airport.

Aircraft information

Landing gear system overview

G-FLYW is a variant of the Beechcraft Super King Air with electro-mechanically actuated landing gear. The Pilots Operating Manual[3] (POM) describes the landing gear operation as being '*controlled by the switch placarded LDG GEAR CONT · UP · DN on the pilot's right subpanel*' (Figure 3). Three lights adjacent to the landing gear selection lever illuminate green when the respective undercarriage leg is down and locked. Two red indicator lights located in the control handle illuminate to show that the gear is in transit or not locked. They also illuminate when the landing gear warning horn is actuated.

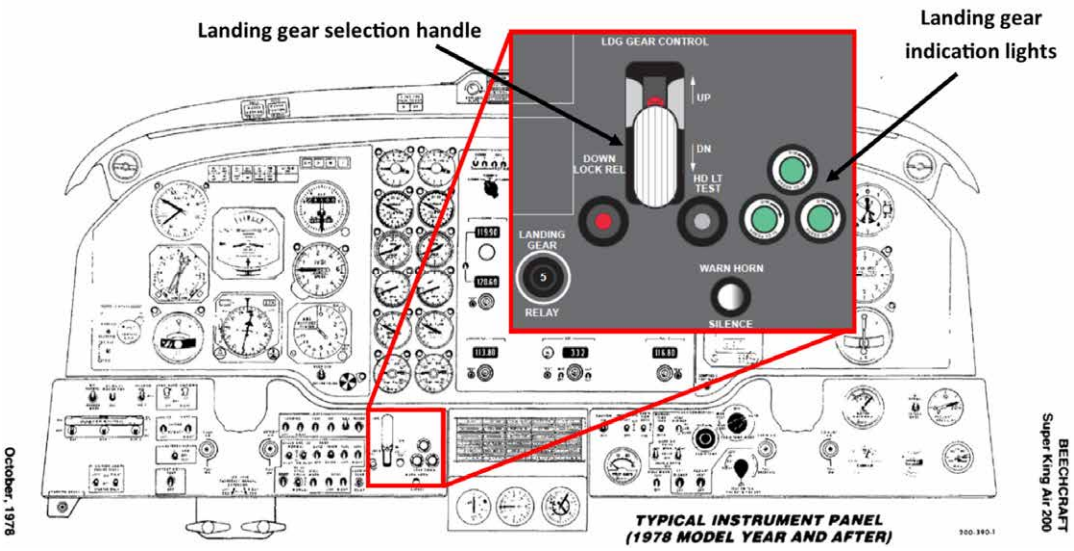

Figure 3

Typical King Air instrument panel with highlighted cockpit controls for landing gear

Landing gear warning system

A landing gear warning system is provided to alert pilots if the landing gear is not down and locked during '*specific flight regimes*.' The system's warning modes depend on the position of the flaps. With flaps in the approach position (single stage of flap) '*… and either or both power levers retarded below a certain power level, the warning horn and landing gear switch handle lights will be activated and neither can be cancelled.*' The POM does not quote a specific figure for the power level below which the landing gear warning system will trigger the visual and audio alerts.

Footnote

[3] Beechcraft Super King Air 200 Pilots Operating Manual (101-590010-127) Section 7: Systems Description.

Neither the trainee nor the commander saw or heard any undercarriage position warnings during the asymmetric approach and subsequent go-around.

Landing gear operation

The landing gear selection handle controls a sliding assembly within an undercarriage electrical control unit (Figure 4). Contactor plates mounted at either end of the sliding assembly and on a fixed terminal block control electric current flow to the motor which lowers and raises the landing gear. One set of contactors is associated with landing gear UP selection and the other with DOWN. With the gear handle in either the UP or DOWN position, the respective contactor on the slider presses against its partner contactor on the fixed terminal block to create an electric circuit. If the landing gear is not in the commanded position the electric actuator motor is energised. When sensors detect that the gear has travelled to the required position, the current is interrupted and gear travel ceases. Whenever one set of contactors is made the opposite set is un-made, isolating that side of the circuit until the alternate gear position is selected. With the gear handle in the DOWN position, the sliding assembly's UP contactor is physically separated from the fixed terminal block and it is not possible to energise the landing gear UP circuit. The AAIB found no evidence of previous incidents where King Air landing gear self-retracted.

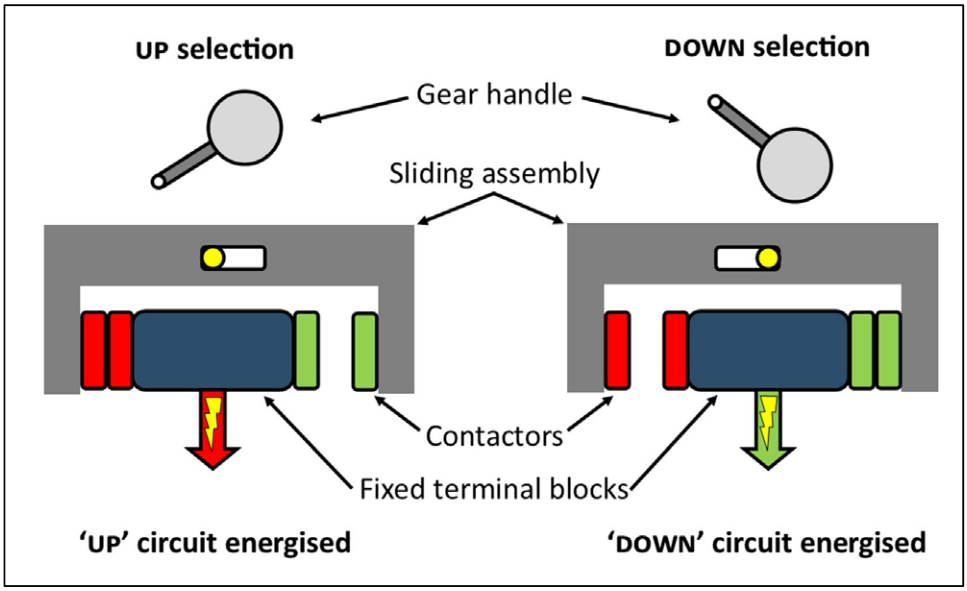

Figure 4

Simplified schematic of G-FLYW's gear electrical contactor assembly and operation

Aircraft examination

As part of the initial engineering fault diagnosis the aircraft was put on jacks and, when the landing gear was selected UP, it retracted normally but a subsequent DOWN selection failed. The fault was traced to a damaged down-select contactor in the undercarriage electrical control system (Figure 5). Once the damaged component had been replaced the landing gear operated correctly. The engineers did not find any fault with the landing gear warning system.

Minor skin damage was found on the lower rear fuselage. In addition, two aerials and the lower anti-collision beacon were also eroded.

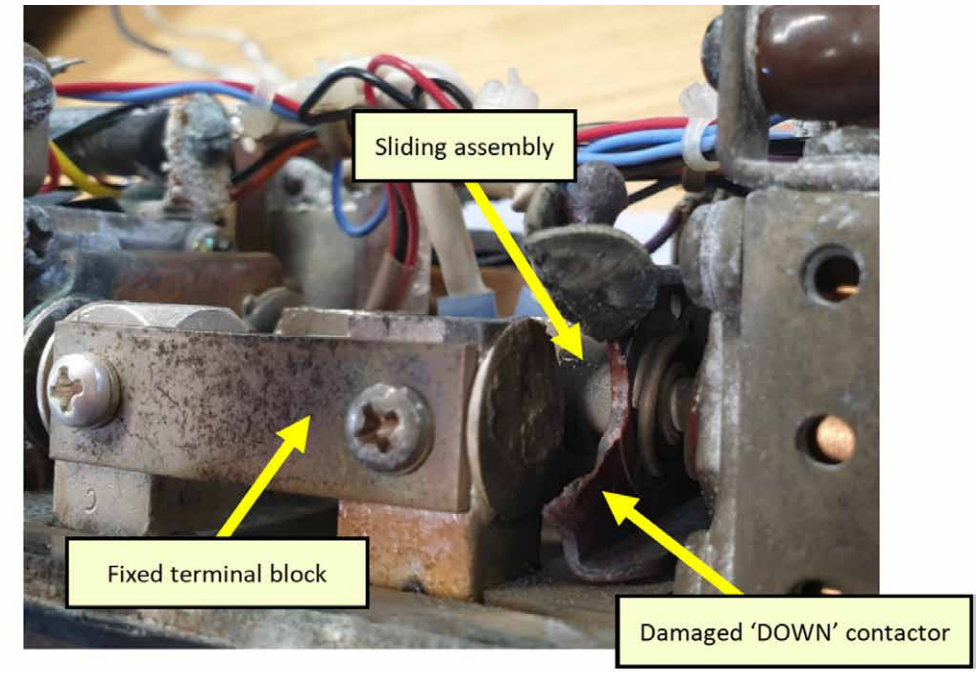

Figure 5
Damaged landing gear contactor

ATC post-occurrence investigation

A post-incident investigation by the ATC Unit found that:

- Traffic levels at the time were of '*moderate intensity and above normal complexity*.'
- The controller had not made a visual check of G-FLYW's landing gear because of '*other activity requiring his attention at the time*.'
- *'Not all of the pieces of information passed to ATC were picked up and understood … which led to … incomplete situational awareness. A report from the 'Checker' vehicle stating "that Beech had his wheels up when he touched the ground" was unacknowledged as it was passed by a UHF radio which broadcasts via a loudspeaker rather than through the controller's headset*.'
- *'The Tower controller was working on the assumption that* [G-FLYW] *had gone around'* and remained unaware that it had suffered a propeller strike.

The report emphasised the high priority that should be afforded to carrying out '*visual checks (including the status of an aircraft's gear)*' before issuing clearances.

The report further stressed the importance of clear and unambiguous radio communication between ATC and pilots.

The report made two recommendations:

- *'That a cross-coupling facility is introduced into the Exeter Tower position as soon as possible to mitigate the risk of safety critical information passed via the UHF radio being missed by the controller*.'
- *'That a list is created which can be quickly accessed … containing aircraft which commonly operate at Exeter whose size category is not immediately apparent*.'

Note: ICAO Doc 4444 PANS-ATM section 7.4.1.7.1 states that *'Whenever an abnormal configuration or condition of an aircraft, including conditions such as landing gear not extended or only partly extended, or unusual smoke emissions from any part of the aircraft, is observed by or reported to the aerodrome controller, the aircraft concerned shall be advised without delay.'* Neither ICAO Doc 4444 PANS-ATM nor the UK's MATS Part 1 (CAP493) make the conduct of a visual check of the status of an aircraft's gear a pre-requisite for the issue of an ATC clearance.

Analysis

G-FLYW's pilots had selected the landing gear down and believed that they had seen three greens indicating that the undercarriage was locked down. They did not see or hear any landing gear unsafe position warnings, but the aircraft arrived at the runway with its gear retracted. An unexpected reduction in the power required to control the aircraft's speed on finals led the pilots to suspect subsequently that the landing gear could have self-retracted. The landing gear handle was in the DOWN position, but the three green indicator lights were not illuminated after the commencement of the go-around.

With approach flap selected and the landing gear up, the King Air undercarriage warning system generates an alert when the power levers' positions are below a '*certain'* level. The landing gear warning lights and horn cannot be cancelled in this configuration. The '*certain power level*' is not specified in the POM. During the go-around the power levers were both fully forward and would have been out of the alert trigger zone.

That there were no warnings evident to the pilots and no fault found during the post-accident engineering investigation, left open the possibility that the power lever position on approach was above the alerting level. Within the bounds of normal human performance, it is also possible that the system generated alerts but that neither of the pilots saw or heard them, perhaps because they were concentrating on the approach. The pilots considered it most unlikely that the power levers would have been above the alert trigger level or that they would not have heard the landing gear warning horn if it had sounded.

A last-chance check of the undercarriage position lights prior to the landing flare may have revealed the unsafe gear position in time for a normal go-around. However, the quick

response by the pilots to the sound of the propellers striking the runway enabled them to fly away, thus avoiding further damage to the aircraft.

The ATCO was not required to visually confirm the status of G-FLYW's landing gear before issuing landing clearance.

Post-accident engineering diagnosis confirmed a fault in the undercarriage electrical control system that prevented the landing gear from lowering when selected DOWN. Once the faulty component had been replaced the landing gear worked correctly. The electrical control unit design isolates the opposite actuator circuit when the landing gear operating lever is in the UP or DOWN detent and the sliding assembly is in the matched position. It was not possible to establish how landing gear self-retraction could have occurred when system design prevents it with the landing gear handle in the DOWN position. No fault was found with the undercarriage warning system.

Communications challenges resulted in incomplete situational awareness and a degree of confusion amongst some of the personnel involved. Clear and unambiguous radio calls could have helped generate greater mutual understanding of the situation as it developed.

Observations

The pilots recalled seeing three greens, did not hear any warnings and wondered whether the landing gear raised itself. The AAIB found no evidence that the landing gear had done so before. With the landing gear selected down, the UP-circuit is isolated, meaning that the gear cannot subsequently raise itself, and the sliding contactor mechanism was working when tested after the accident. The landing gear DOWN selection was found on inspection not to work, and it was therefore concluded that when the pilots selected the gear down it probably did not lower.

It was considered possible that the pilots' recollection was incorrect because it is known that pilots sometimes see three green lights when that is what they are expecting to see, and miss aural warnings when they are working hard, in this case on a check flight.

Although the discussion above is a plausible explanation of this event, the pilots were confident in their recollection, and without recorded data it was not possible to provide a definitive account of what happened.

Conclusion

It could not be positively determined how the landing gear came to be up when G-FLYW touched down at Exeter Airport. 'Wheels up landings' are a known hazard for aircraft equipped with retractable landing gear and a final check of landing gear position approaching the touchdown committal point is seldom wasted. When things do go wrong, accurate and effective communication is an important tool for boosting mutual understanding and situational awareness.