

AVIATION INVESTIGATION REPORT

A00H0007

GEAR-UP LANDING

DEPARTMENT OF TRANSPORT AIRCRAFT SERVICES

BEECHCRAFT KING AIR A100 C-FDOU

OTTAWA/GATINEAU AIRPORT, QUEBEC

04 DECEMBER 2000

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

## Aviation Investigation Report

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### *Summary*

A Transport Canada Beechcraft King Air A100, serial number B-112, with two pilots on board, departed from the Ottawa/McDonald-Cartier International Airport, Ontario, on a visual flight rules training flight. The aircraft proceeded to Ottawa/Gatineau Airport, Quebec, to conduct practice visual approaches and landings. At approximately 1430 eastern standard time, a visual circuit and approach to runway 27 was flown with the left engine at low power, simulating an engine failure. The landing gear was not lowered before landing, and the aft fuselage and both propellers contacted the runway surface. The captain initiated a successful go-around, declared an emergency, and subsequently landed the aircraft at Ottawa/McDonald-Cartier International Airport. There were no injuries. The aircraft was substantially damaged.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

The purpose of the flight was to conduct recurrent training for the co-pilot, who was occupying the left seat as the pilot flying and who was not current. The pilot-in-command (PIC), a Transport Canada training pilot, was occupying the right seat as the pilot not flying. The Gatineau weather was as follows: wind 230 degrees magnetic at 5 knots, overcast clouds at 24 000 feet above ground level, and visibility 15 statute miles.

Following a touch-and-go landing on runway 27 at Ottawa/Gatineau Airport, the aircraft was climbing through approximately 500 feet above ground level when the left throttle was retarded to simulate a left engine failure. The landing gear warning horn sounded and was immediately silenced. Silencing the horn during flapless configurations when throttles are retarded is a normal procedure to avoid distracting or adversely affecting crew members while communicating or performing other cockpit duties during critical phases of flight. The emergency checklist procedure for an engine failure in flight (simulated) was completed, and the aircraft remained in the circuit for runway 27. The PIC then directed that a flapless touch-and-go landing be completed, with a simulated left engine failure; both engines were to be used for the subsequent take-off. Neither pilot called for the Before Landing checklist, and neither pilot noticed that the landing gear had not been lowered. As the aircraft contacted the runway, the PIC advanced both throttles and commanded a go-around. The aircraft continued along the runway for approximately 1400 feet before taking off. Once airborne, moderate airframe vibrations were apparent, but the aircraft was controllable.

Standard operating procedures (SOPs) are developed, in part, to reduce memory and attention errors by establishing consistent patterns of behaviour. The Transport Canada *King Air A100 Standard Operating Procedures*, dated July 1998, include separate sections for normal and emergency procedures. The normal procedures section contains a Before Landing checklist with the line item "Landing Gear - Down/3 Green". The diagram accompanying this section indicates that the checklist should be completed as the aircraft turns onto base leg. The emergency procedures section of the SOPs includes a Single-Engine Approach and Landing checklist with the line item "Landing Gear - Down for Landing". This checklist states that, during a single-engine, visual flight rules (VFR) circuit, the landing gear should normally be lowered when commencing an uninterrupted descent to landing. The SOPs do not indicate when the Single-Engine Approach and Landing checklist should be carried out. However, it is typically not consulted during single-engine VFR approaches and landings, even though the checklist twice refers to VFR circuits. The Before Landing and Single-Engine Approach and Landing checklists are similar but not identical. Although landing gear and flaps are common to both checklists, the line items airspeed, propeller rpm (revolutions per minute), and landing lights are unique to one checklist or the other. The King Air SOPs do not contain any other before landing checklist procedures.

The King Air A100 is equipped with a landing gear warning system, comprising a horn and a light in the landing gear handle. Three switches are used to activate the horn: one switch is attached to each of the two power levers and another is attached to the flap lever. When either or both power levers are retarded below an engine setting sufficient to maintain flight, with the gear not down and locked, a warning horn will sound intermittently. During operation with power retarded, the horn can be silenced, as long as the flaps are up, by pressing the HORN SILENCE button; however, the light will remain on in the landing gear handle. The horn will reactivate if the flaps are lowered or if the power lever that triggered the horn is advanced and either power lever is subsequently retarded. If the horn is silenced and the power lever that caused the horn to activate is not advanced above the trigger position, retarding the second power lever will not activate the horn. The *King Air A100 Pilot's Operating Manual* (POM) describes the operation of the landing gear warning system; however, the POM does not clearly describe how the system functions when the power levers are sequentially retarded.

Inspection and testing after the accident showed that the aircraft's landing gear system, including the associated warning system, operated as it was designed to operate. The light in the handle illuminated, as required, during the tests. It was found that, in daylight conditions, the light in the landing gear handle is not bright enough to attract a pilot's attention unless the pilot is looking at the light.

Recurrent flight training requirements for Transport Canada King Air pilots include flapless landings and single-engine landings. Transport Canada publishes safe training practices for the King Air in the Aircraft Services Directorate (ASD) operations manual. The ASD safe training practices place no restriction on the conduct of combined flapless and single-engine landings.

Transport Canada holds an operating certificate issued under Part VII of the *Canadian Aviation Regulations* (CARs), Commercial Air Services. Paragraph 700.16 of the CARs stipulates the maximum flight duty time and minimum rest period criteria for Part VII aircrew. Section 3 of the ASD operations manual reiterates these criteria and expands the definition of flight duty time to include office or inspection duties. The PIC had worked 26.5 hours of overtime in the month before the occurrence and 295.3 hours of overtime since January 2000. On 24 November 2000, the PIC expressed concern to ASD management about his high workload and associated fatigue. The PIC did not request time off, and he continued to work. After the occurrence, the PIC was seen by a physician and placed on medical leave for a period of one month, to recover from stress resulting from this occurrence. The PIC's work schedule for the five-week period before the occurrence was reviewed and found to comply with the applicable flight duty time and rest period criteria. A detailed analysis of factors affecting the PIC's fatigue state was completed. The pilot's work and sleep history for the 72-hour period before the occurrence was not indicative of acute fatigue. However, the analysis was inconclusive regarding chronic fatigue.

The King Air A100 is certified under Part 23 of the United States *Federal Aviation Regulations*, which requires that single-engine climb performance be demonstrated in a low drag (gear and flaps retracted) aircraft configuration. With the landing gear or flaps extended and one engine inoperative, the remaining engine may not develop sufficient power to achieve a positive rate of climb. The King Air SOPs' Single-Engine Go-Around checklist includes the following warning: "The aircraft will NOT assume a positive rate of climb until excess drag is eliminated."

## *Analysis*

The landing gear warning light is not bright enough to reliably capture a pilot's attention in daylight conditions. The warning horn is readily apparent in most situations and is a more reliable defence against gear-up landings. The operation of the King Air landing gear warning system, when the power levers are sequentially retarded, is not clearly described in the POM. As a result, it was not universally known that the landing gear horn, once silenced, does not activate if the second power lever is subsequently retarded. The PIC's decision to silence the landing gear warning horn was predicated, in part, on an incorrect understanding of the landing gear warning system functionality.

Since the aircraft's single-engine climb performance is not assured when the flaps are extended, carrying out a flapless approach where one engine has failed is a prudent thing to do, in recognition that a single-engine missed approach may be required. To practise for this eventuality, simulated single-engine approaches and landings are routinely carried out with no flap selected. This procedure effectively disables the aural defences associated with the King Air landing gear warning system.

The Before Landing check was forgotten; the landing gear was not lowered, and the crew did not note the status of the landing gear warning light. The current SOPs do not require any further checks of the landing gear status after the Before Landing check is carried out.

The King Air SOPs' Before Landing checklist and Single-Engine Approach and Landing checklist are similar but not identical. Both checklists should be completed to cover all items at least once, a procedure that would also ensure a redundant check of the flaps and the landing gear. When conducting a single-engine approach, there is no requirement to complete both the normal and single-engine landing checklists. The SOPs provide no specific guidance about when to complete the Single-Engine Approach and Landing checklist. This list is typically not consulted during single-engine VFR approaches and landings, even though the checklist twice refers to VFR circuits.

In the 11 months before the occurrence, the PIC had worked approximately 8 weeks of overtime. Although he had recently expressed concern to ASD management about his workload and associated fatigue, he voluntarily continued to work. Despite the PIC's considerable overtime, his work schedule complied with the CARs flight duty time and rest period criteria. A detailed review of factors influencing the fatigue state of the PIC was not indicative of acute fatigue and was inconclusive regarding chronic fatigue.

### *Findings as to Causes and Contributing Factors*

- a. A simulated single-engine, flapless landing was conducted in a Transport Canada King Air aircraft, with its landing gear warning horn silenced.
- b. The King Air standard operating procedures do not require a redundant check of the landing gear status during single-engine approach and landing exercises.
- c. The crew forgot to complete the Before Landing check and did not lower the landing gear before landing. With the landing gear warning horn effectively disabled, there was no aural warning that the landing gear was not extended, although the gear warning light was most probably illuminated.

### *Findings as to Risk*

1. The functionality of the King Air A100 landing gear warning system is not clearly described in the pilot's operating manual.
2. The King Air standard operating procedures provide no specific guidance about when to complete the Single-Engine Approach and Landing checklist.

### *Safety Action*

After the occurrence, Transport Canada, Aircraft Services Directorate (ASD), distributed Pilot Information File 04/2001 to all pilots of ASD King Air aircraft. The Pilot Information File clarified the functionality of the landing gear warning system on all models of the King Air that ASD currently operates.

ASD is revising the King Air Single-Engine Approach and Landing checklist with a view to requiring its exclusive use by all pilots of ASD King Air aircraft in all single-engine landing scenarios.

ASD is amending all its King Air standard operating procedures (SOPs)—except for the King Air A100 SOPs, which are being phased out—to include a redundant challenge/response verification of the landing gear position before landing.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 31 October 2001.*