

AVIATION OCCURRENCE REPORT

A9800184

MAIN LANDING GEAR COLLAPSED

TRANSPORT CANADA

BEECH A100 KING AIR C-FDOR

OTTAWA MACDONALD-CARTIER INTERNATIONAL AIRPORT,

ONTARIO

16 JULY 1998

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 Occurrence Report

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### *Summary*

The Beech A100 King Air, serial number B-103, departed Ottawa MacDonald-Cartier International Airport at 0830 eastern daylight saving time on an instrument flight rules (IFR) training flight to North Bay, Ontario, with two flight crew on board. At North Bay, the crew conducted a radar-vectored back-course approach to runway 26 with a touch-and-go landing followed by two visual flight rules touch-and-go landings, then a full-stop landing. The flight crew switched seat positions in the aircraft and departed on a return IFR flight to Ottawa. At Ottawa, when the landing gear was selected down, the crew observed an unsafe landing gear indication in the cockpit and requested and received overshoot instructions from air traffic control. Visual observation from the ground during the overshoot confirmed the landing gear was not extended. The flight crew carried out the emergency landing gear extension procedure, but still observed an unsafe landing gear position indication for the right main landing gear; however, the landing gear appeared to be extended when observed from the ground. The flight crew discussed how the landing would be carried out, requested emergency rescue services for the landing, and proceeded to land on runway 25. On the landing roll, the right main landing gear collapsed and the aircraft went off the right side of the runway. There were no injuries. The accident occurred during the hours of daylight in visual meteorological conditions.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

As the aircraft decelerated on the landing roll and the supported weight of the aircraft transferred from the wings to the landing gear, the right main landing gear began to collapse. The number two engine propeller, right wing trailing edge flap, and right wing tip contacted the ground when the landing gear fully collapsed. The aircraft veered to the right, went off the right side of the runway onto the grass infield area of the airport, and came to rest on a northerly heading, 3 000 feet from the threshold of runway 25. The runway, an asphalt surface 8 000 feet long by 200 feet wide, was bare and dry at the time.

The weather at the time of the occurrence was scattered cloud at 25 000 feet , a visibility of five miles in haze, with a temperature of 29 degrees Celsius, and a dew point of 22 degrees Celsius. The wind was from 210 degrees magnetic at eight knots.

The flight crew was certified and qualified in accordance with existing regulations to conduct the flight. The pilot in command had flown 20 hours and the co-pilot 15 hours in the last 90 days, all on type.

Aircraft records indicated the aircraft was certified and equipped in accordance with existing regulations and approved procedures.

The aircraft was originally equipped with an electrically-operated landing gear retraction and extension system. The circuit breaker used to protect the electric motor that operated the electric landing gear system was a 120-amp circuit breaker. As a result of reported electrical fires associated with the electric motor, Airworthiness Directive 95-13-03 was issued instructing operators of the aircraft to replace the 120-amp circuit breaker with a 60-amp breaker. Aviadesign Incorporated, an American company, developed and had approved a supplemental type certificate (STC), SA 4013WE, to allow the landing gear on the Beech A100 aircraft to be modified from electric operation to hydraulic operation. In February 1996, the occurrence aircraft was modified in accordance with the STC, using the same type of electric motor and the same rated 60-amp circuit breaker to operate the hydraulic pump. An STC does not require consultation with or endorsement by the aircraft manufacturer.

During normal operation of aircraft equipped with Aviadesign STC hydraulic landing gear, the nose and main landing gear are retracted and extended by hydraulic actuators, which receive hydraulic fluid under pressure from an electrically-driven pump. The electric motor for the hydraulic pump is protected by a 60-amp circuit breaker located on the aircraft cockpit floor between the pilot seats. On the accident aircraft, the 60-amp circuit breaker was located on the floor at the front of the aircraft passenger cabin, recessed for protection, and not accessible by the pilots from the cockpit. (The Transport Canada, Aircraft Services Directorate (ASD), standard operating procedures (SOPs) for the Beech A100 King Air aircraft generally do not permit pilots in flight to reset circuit breakers with values as high as 60 amps.) System pressure is maintained by a pressure switch, which cycles the electric motor on and off via a relay. The hydraulic system incorporates a nitrogen-charged accumulator to prevent spike pressures and to provide a hydraulic cushion within the system. An amber light in the cockpit illuminates and remains illuminated when electric power is applied to the hydraulic pump motor. All three landing gear are held in the retracted position by system hydraulic pressure.

A red light in the landing gear selector handle is illuminated any time the landing gear is in transit. Extinguishing of the red light with the landing gear selector handle in the gear-up position indicates that the landing gear is fully retracted. The nose landing gear hydraulic actuator has an internal lock that provides a positive downlock for the nose landing gear. Mechanical over-centre downlocks located on the main landing gear drag braces provide downlocks for the main landing gear. Individual green light indicators in the cockpit illuminate when the respective landing gear is fully down and locked. Illumination of all three green lights and

extinguishing of the gear in-transit light with the landing gear selector handle in the down position indicate the landing gear is fully extended and locked in the down position. If the landing gear is not down and locked and either or both engine power levers are retarded below an engine setting sufficient to maintain flight, a warning horn will sound intermittently.

In the event the landing gear fails to extend by the normal method, extension of the landing gear is accomplished by the flight crew actioning the "Landing Gear Emergency Extension Checklist." The checklist instructs the crew to slow the aircraft to 120 knots indicated airspeed, manually open the landing gear relay circuit breaker located in the cockpit, and select the landing gear handle to the landing gear down position. The pilots rotate the manual hydraulic vent valve and the emergency gear extension nitrogen valve<sup>1</sup> to the full open position and check that all three green landing gear lights are illuminated.

The manual hydraulic vent and nitrogen valves are located on the aircraft cockpit floor between the two pilot seats. Several counterclockwise rotations are required to fully open each valve. The valves rotate with little or no resistance. When the hydraulic vent valve is fully open, all three landing gear free fall to the extended position. When the nitrogen valve is fully open, pressure from a nitrogen bottle forces the main landing gear beyond the over-centre locks to lock the landing gear in the down position. Maximum pressure in a fully charged nitrogen bottle is 1 500 pounds per square inch (psi). The normal landing gear extension system cannot be operated after the emergency system has been activated until the landing gear system has been returned to normal by maintenance personnel on the ground.

When the aircraft was examined at the accident site, the landing gear handle was in the down position, the landing gear relay circuit breaker was open, and both the hydraulic landing gear vent and the nitrogen valves were in the full open position. The nitrogen gauge was indicating 800 psi, which would be normal following bottle use. The 60-amp circuit breaker for the landing gear hydraulic pump electric motor was open. As the right wing of the aircraft was raised off the ground during recovery after the accident, the right main landing gear extended and locked in the down position. The aircraft was then towed to the hangar and placed on aircraft jacks.

The landing gear hydraulic and emergency extension systems were returned to normal. The 60-amp hydraulic pump electric motor circuit breaker and the landing gear relay circuit breaker were reset, and the landing gear was cycled in the normal mode several times without malfunction. The 60-amp circuit breaker was then opened, and the landing gear was extended by the emergency extension procedure several times without malfunction. It was determined that the landing gear would not free-fall during the emergency extension procedure until the hydraulic vent valve was in the full open position.

Subsequent to the normal and emergency landing gear extensions in the hangar, the nitrogen charge for the hydraulic system accumulator was found to be depleted. The accumulator was recharged, and after two days the nitrogen charge was found to be depleted again. The accumulator was dismantled and found to be unserviceable. Damaged and deteriorated O-rings were found leaking at both ends of the accumulator. In accordance with the STC, nitrogen pressure was to be checked every 1 000 hours of aircraft operation or during every major inspection; however, the operator routinely checked the pressure every 200 hours. The nitrogen charge for the accumulator is separate from the emergency landing gear extension system. No other defects were found during examination of the landing gear and landing gear retraction and extension systems.

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<sup>1</sup> The nitrogen bottle associated with the emergency landing gear extension system is not associated with the hydraulic system accumulator.

## *Analysis*

The aircraft landing gear did not extend when the flight crew selected it down for landing at Ottawa because the circuit breaker for the electric motor that operated the hydraulic pump had opened. The landing gear will not extend by the normal method without the operation of the electric motor to operate the hydraulic pump.

The depleted nitrogen charge in the landing gear accumulator would result in more frequent cycling of the hydraulic pump motor to maintain system hydraulic pressure. The combination of repeated landing gear cycling at North Bay and more frequent cycling of the electric hydraulic pump motor because of the depleted nitrogen charge in the hydraulic system accumulator likely caused the 60-amp circuit breaker to overheat and open, shutting off electric power to the hydraulic pump motor.

Operation of the emergency landing gear extension system resulted in all three landing gear extending, but the right main landing gear did not lock in the down position and collapsed as the aircraft weight settled on it during the landing roll. It could not be determined why the right main landing gear did not lock in the down position during the emergency extension.

## *Findings*

1. The crew was certified and qualified for the flight.
2. Aircraft records indicated the aircraft was certified and equipped in accordance with existing regulations and approved procedures.
3. The 60-amp circuit breaker for the electric hydraulic pump motor opened, rendering the aircraft normal hydraulic landing gear system inoperable.
4. The aircraft right main landing gear indicator did not indicate the down and locked position following extension of the aircraft landing gear by the emergency method.
5. The aircraft right main landing gear collapsed during the landing roll.
6. The aircraft landing gear hydraulic system accumulator was found defective and would not maintain the required nitrogen charge.
7. The depleted landing gear hydraulic system accumulator should not affect the ability of the landing gear system to actuate in normal or emergency operation.

## *Causes and Contributing Factors*

For undetermined reasons, the right main landing gear did not lock down following extension of the landing gear by the emergency method, causing it to collapse on the landing roll. The normal aircraft hydraulic landing gear extension and retraction system was rendered inoperable when the circuit breaker for the electric hydraulic pump motor opened, likely due to overheating from repeated cycling of the electric motor. A defective landing gear hydraulic system accumulator contributed to the repeated cycling of the electric hydraulic pump motor.

## *Safety Action*

### *Actions Taken*

Since the occurrence Transport Canada, ASD, has taken the following actions:

1. The Beech A100 King Air SOPs have been amended to allow a single, in-flight reset of the electric hydraulic pump motor 60-amp circuit breaker.
2. The 60-amp circuit breaker in the accident aircraft has been relocated to the aircraft cockpit. This location is now the same as on the other Beech King Air aircraft in the ASD fleet that have the Aviadesign STC hydraulic landing gear.
3. A mirror has been installed on the inboard side of the Beech A100 King Air engine cowlings to provide a means for pilots to observe the nose landing gear position from the aircraft cockpit.
4. The ASD *Flight Operations Manual* was amended to read, "where practicable, it is recommended that the pilot contact the applicable ASD operations centre, and state the nature of the problem, the assistance required, and the time remaining before a landing is necessary."

### *Actions Required*

The safety actions taken by Transport Canada, ASD, have possible continuing airworthiness operational implications for the fleet of similar aircraft operating elsewhere in Canada and in other countries. These actions include permitting a single in-flight reset of the electric hydraulic pump motor 60-amp circuit breaker, relocating the 60-amp circuit breaker to the cockpit, and installing a mirror to provide a means for the pilot to observe the nose landing gear position from the cockpit. Dissemination of this information to other King Air operators in Canada and around the world for the purpose of possible similar safety actions by other operators would reduce the risk of similar accidents.

Annex 8, "Airworthiness of Aircraft," to the *Convention on International Civil Aviation* contains provisions urging the State of Registry of an aircraft to notify the State of Design about information that might cause adverse effects on the continuing airworthiness of an aircraft. It seems appropriate that the changes to the configuration and operating procedures for the Transport Canada King Air fleet should be brought to the attention of the Federal Aviation Administration in the United States, the State of Design, for possible fleet-wide safety action. Therefore, the Board recommends that:

The Department of Transport ensure that all Canadian operators of the Beech King Air with the Aviadesign landing gear modification are advised of the circumstances of this accident and the safety actions taken, with the view toward implementing similar changes to prevent a future similar accident.

A00-07

The Department of Transport notify the United States Federal Aviation Administration, in accordance with Annex 8, "Airworthiness of Aircraft," to the *Convention on International Civil Aviation*, about the circumstances of this accident and the safety actions taken, with the view toward wider application of the safety actions.

A00-08

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 1 March 2000.*