Australian Government
Australian Transport Safety Bureau

Speed control during landing Bombardier DHC-8-102, VH-QQA

Cairns Airport, Queensland | 30 December 2011

Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2012-005
Final

Australian Government

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ATSB TRANSPORT SAFETY REPORT

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SAFETY SUMMARY

What happened

On 30 December 2011, a Bombardier DHC-8-102 aircraft, registered VH-QQA, was being operated on a scheduled passenger service to Cairns, Queensland. During the landing, the crew perceived that the aircraft decelerated much quicker than they expected given that reverse thrust and landing gear brakes had not been selected. A subsequent inspection of the aircraft found nothing to explain the perceived problem, and a review of the flight recorder data indicated that there was no abnormal operation of the engines or propellers, and that reverse thrust had not been used.

What the ATSB found

Although unrelated to the reported occurrence, subsequent inspection of the aircraft identified a design problem within the aircraft's power lever control quadrant. The problem related to the friction device within the power levers and its interaction with the flight idle gate, which was designed to prevent the power levers from going into the ground range in flight. When the friction knob was wound to the full out (friction off) position, the flight idle gate was lifted by contact between the friction device and the flight idle gate. That action rendered the flight idle gate inoperative.

The design problem only applied to the first 39 DHC-8-100 aircraft that were manufactured; subsequent aircraft were manufactured with a modified design. The aircraft manufacturer introduced a service bulletin requirement in 1986 to retrospectively modify these 39 aircraft, but the service bulletin omitted a requirement to modify or replace a specific part, which resulted in the bulletin being ineffective.

What has been done to fix it

Once informed of the design problem, the aircraft manufacturer took prompt action to address the issue. It issued a service bulletin to modify the relevant part, and this action was subsequently mandated by Transport Canada and the Civil Aviation Safety Authority of Australia.

Safety message

This investigation highlights the importance of crews reporting occurrences and other perceived problems. Although in this case the actual event reported by the crew was not serious, and no problems relating to the aircraft or crew performance leading to the perceived event were identified, the subsequent investigation did identify a safety issue in the design of the aircraft.

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Figure 2, 5 & 6: Provided by Skytrans
Figure 3 & 4: Provided by Bombardier

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

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 appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

FACTUAL INFORMATION

History of flight

On 30 December 2011, a Bombardier de Havilland DHC-8-102 (DHC-8-100) aircraft, registered VH-QQA, was being operated by Skytrans on a flight from Normanton to Cairns, Queensland. The first officer was the flying pilot. The aircraft landed at Cairns Airport at about 1430 Eastern Standard Time.[1]

During the landing, the captain felt that the aircraft slowed down quicker than usual. He discussed the issue with the first officer, who agreed the aircraft had slowed down quite quickly, considering that the landing gear brakes and reverse thrust had not been selected and there was not a strong headwind at the time.

The captain believed that the aircraft's propellers may have inadvertently gone into reverse during the landing roll even though reverse thrust had not been selected. He spoke to the operator's engineers about the potential problem, but the operator's subsequent engineering inspection did not identify any anomaly with the aircraft that would have caused it to slow down faster than normal on the ground.

The captain stated that after the event and upon reflection he felt that the aircraft may have slowed down faster than normal due to the aircraft's relatively light weight on that sector.

Recorded information

A copy of the aircraft's relevant flight data recorder load information was obtained by the Australian Transport Safety Bureau (ATSB) for analysis. Recorded engine parameters were examined for the landing at Cairns. The characteristics of engine operation during the landing were compared with engine operation during the three previous landings and a landing where reverse thrust was utilised.

It was found that the propeller speed recorded remained within normal operating limits and no significant variations were observed. The values of the engine parameters recorded during the landing at Cairns indicated that reverse thrust was not activated.

Aircraft information

The DHC-8-100 is a high-wing, pressurised, aircraft with a seating capacity of 36 passengers. It is powered by two turboprop engines driving two four-blade constant speed propellers. The serial number of the aircraft being investigated was 005; it was manufactured in1984 and first registered in Australia in 1995. The aircraft had accumulated 45,228 flight hours and 41,046 cycles since being introduced into service.

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

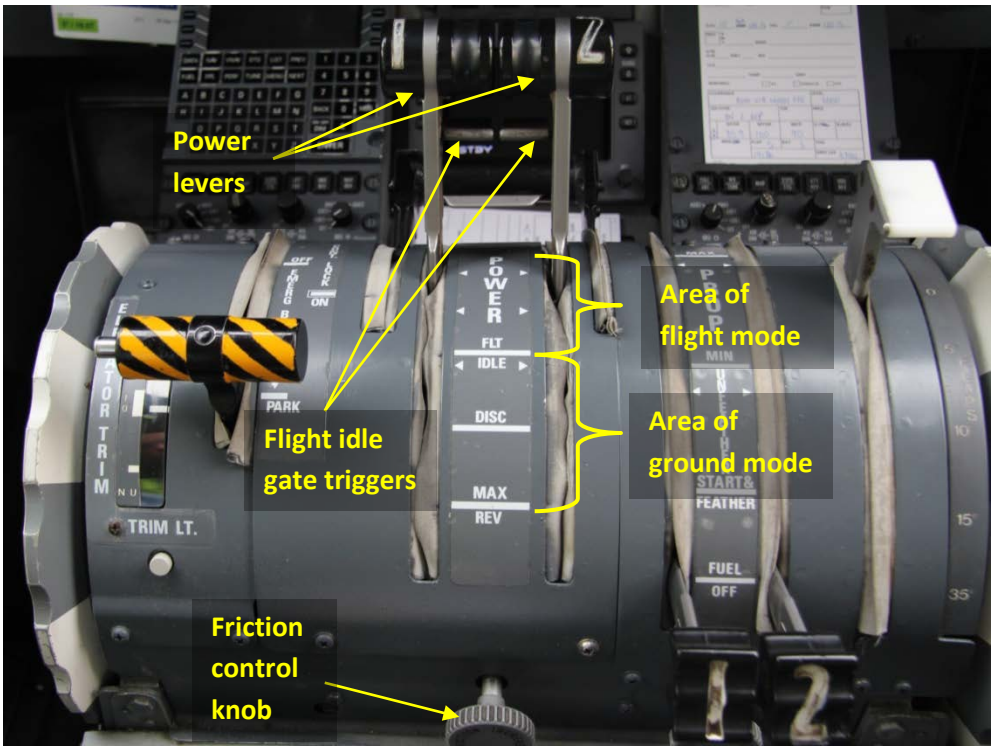
Power lever controls

The aircraft is fitted with two power levers, one for each engine. The levers have two modes of operation: flight mode and ground (or beta) mode. In flight mode the power levers control engine speed between flight idle and take-off power. In ground mode the power levers control engine speed and propeller RPM in a range from below flight idle to maximum reverse (Figure 1).

Ground mode is available for slowing the aircraft after landing by changing the pitch of the propellers to create aerodynamic drag loads. It can also provide a considerable amount of reverse thrust if required. Ground mode is also used to provide limited power for taxiing the aircraft as required.

The power lever quadrant includes a mechanical stop, called the flight idle gate, to assist with preventing movement of the power levers below flight idle in flight. Each power lever grip incorporates a flight idle gate release trigger that has to be lifted in order for the power levers to bypass the flight idle gate and enter the ground mode. In normal operation the pilot raises the flight idle gate release triggers after landing to bypass the flight idle gate and use ground mode as required.

Figure 1: Exemplar picture of the DHC-8 power lever controls



Power lever friction knob

The power levers have an adjustable friction device that increases or decreases the amount of force required to move the power levers. The friction device is actuated by turning a knob in or out to adjust the pressure applied to a leaf spring and pad, which comes in contact with the lower part of the power lever quadrant.

Figure 2 shows the aircraft's power levers, flight idle gate and power lever friction adjustment mechanism with the dust cover removed. The power levers are in the flight idle position.

Figure 2: Power lever controls with the dust cover removed

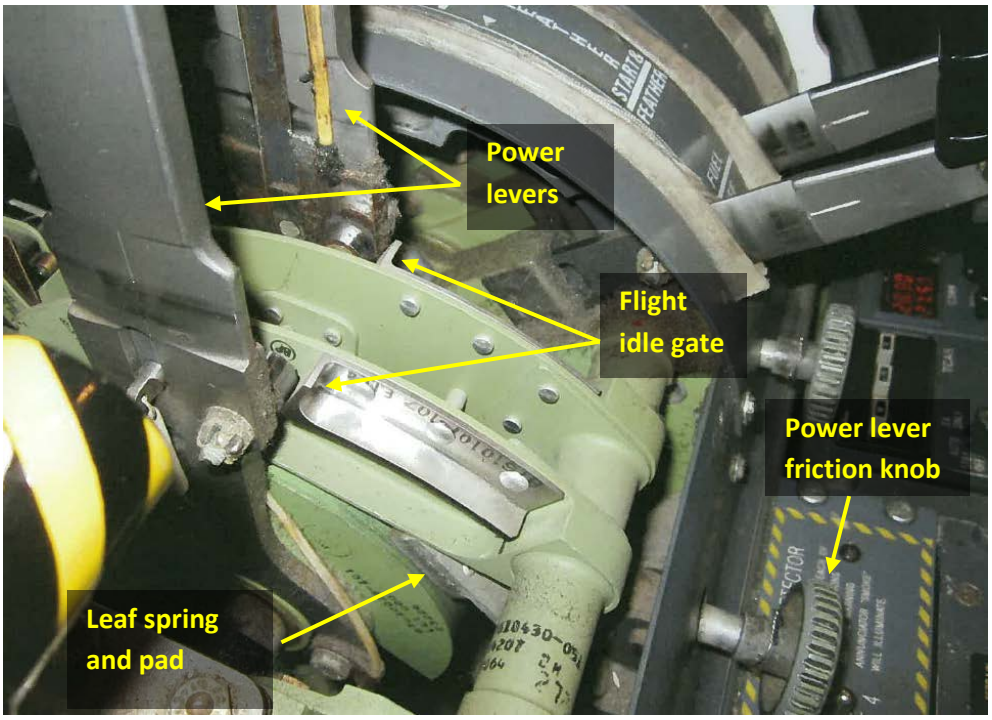


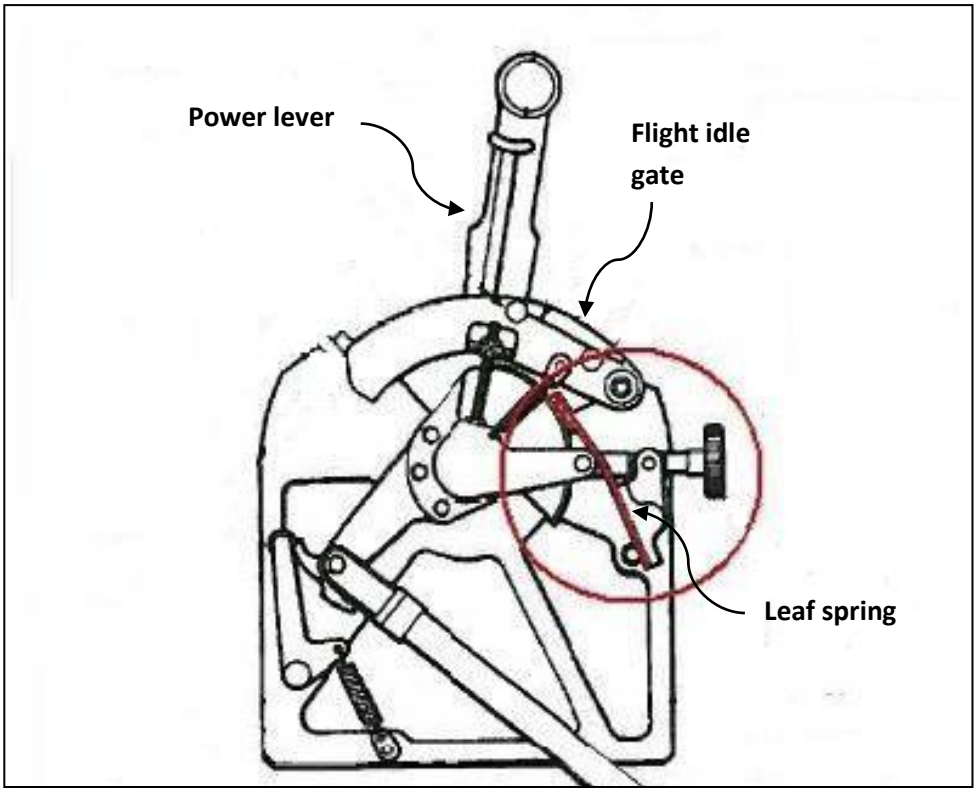
Figure 3 shows the power lever, flight idle gate and power lever friction mechanism with the friction leaf spring highlighted in red.

Flight manual warning

Section 2.5.8 of the *Aircraft Flight Manual* stated:

> In-flight operation of the power levers aft of the FLT IDLE gate is prohibited. Failure to observe this limitation will cause propeller overspeed, possible engine failure and may result in loss of control.

Figure 3: Power lever and friction adjustment mechanism



Aircraft inspection

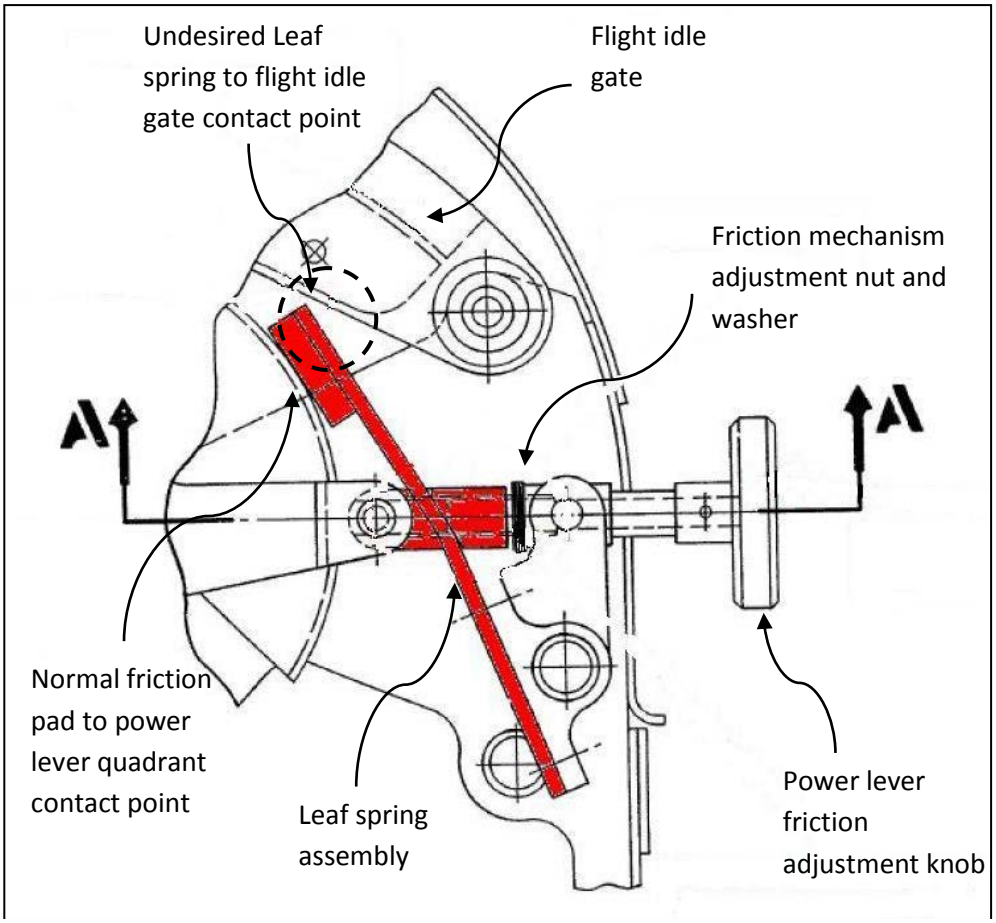
As noted above, the operator's engineers identified no problems with the aircraft that could explain the reportedly excessive deceleration after landing. However, they discovered two areas of concern within the power lever control system. The first was a problem with the friction lever pad, which had become partially unsecured due to a broken fastener. This was repaired before the aircraft was returned to service.

The second and more serious issue was an underlying design problem within the power lever control system. It was discovered that if the engine power lever friction adjustment knob was wound completely out (friction off) then the forward upper edge of the leaf spring would come in contact with the lower part of the flight idle gate (Figure 4). The flight idle gate could be raised by the leaf spring a sufficient amount so that the power levers could bypass the flight idle gate without the flight idle gate release triggers being lifted. In effect the flight idle gate could be rendered ineffective at protecting the propeller system against inadvertent activation of propeller ground beta range in flight.

If the power levers were moved into the ground beta range inflight, the propeller speed would no longer be controlled by the propeller systems, leaving the propellers susceptible to an overspeed condition that could rapidly lead to engine damage and, in the worst case, engine failure.

The operator conducted a fleet wide inspection of its 13 DHC-8 aircraft, three of which had the same design problem. These aircraft were DHC-8-100 aircraft with serial numbers 008, 014, and 036.

Figure 4: Friction adjustment mechanism



Aircraft type modification history

In January 1986, the aircraft manufacturer introduced non-mandatory service bulletin (SB) No. 8-76-2 for all DHC-8 aircraft between serial numbers 001 to 039 to be modified by the incorporation of a new stop on the power lever friction adjusting screw. The purpose of the modification was to prevent contact between the friction lever and the flight idle stop when the friction adjustment was in the fully out position.

The service bulletin was also incorporated into all aircraft that were manufactured after serial number 039. The newer aircraft were also fitted with a modified type of leaf spring, which replaced the initial design with a chamfer at the end of the leaf spring so that the spring would not make contact with the flight idle gate (Figures 5 and 6). The modified leaf spring had an identical part number to the unmodified version.

Figure 5: Initial leaf spring

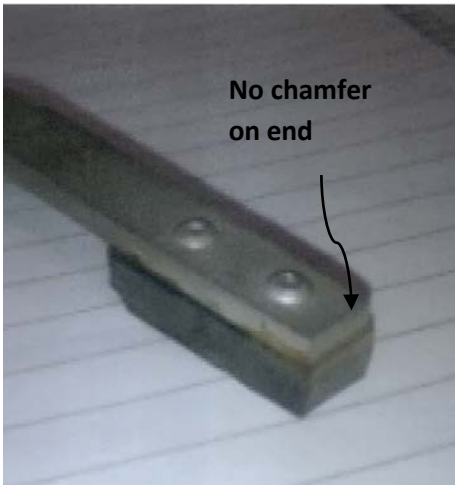
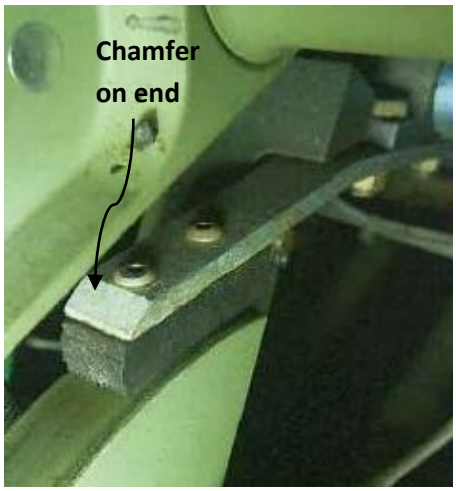


Figure 6: Modified leaf spring



Even though all aircraft after serial number 039 were fitted with the new leaf spring, the service bulletin did not mention the modification or replacement of the leaf spring to incorporate the chamfered end. As a result, aircraft with serial numbers 001 to 039 did not have a leaf spring with a chamfered end fitted. The manufacturer confirmed that the leaf spring fitted to VH-QQA was the pre-modification part that did not include a chamfered end.

The aircraft operator confirmed that SB 8-76-2 had been incorporated into VH-QQA and that it was ineffective at preventing contact between the friction leaf spring and the flight idle gate without the leaf spring chamfer modification. That meant that the service bulletin was ineffective at preventing leaf spring to flight idle gate contact in all aircraft that did not have a post-modification leaf spring with a chamfered end.

The ATSB asked the aircraft manufacturer why the friction lever chamfer modification had not been incorporated on aircraft from serial number 001 to 039. The manufacturer stated:

> De Havilland modification, (8/0443), addressed aircraft 40 and subsequent during production build-up by adding a chamfer to the leaf spring and also increasing the width of the friction lock nut brake. In order to address aircraft 1 - 39, which had already been delivered, de Havilland issued SB 8-76-02 (mod 8/0443), and current records do not identify why this bulletin only addressed the friction lock nut; however, the current change-management system that is in place at Bombardier would have identified this and aircraft 1 - 39 would have had been fully modified in accordance with modification 8/0443. It should be noted, that Airworthiness Directive CF-2012-08 was issued in January of 2012 to address this issue with corrective actions of the omitted requirements in the original issue of SB 8-76-02.

Previous occurrences

There have been several occurrences where pilots have inadvertently placed the power levers below flight idle in flight on DHC-8 and other turboprop aircraft, and some of these had serious consequences such as propeller overspeed and engine

failure.[2] However, there were no known incidents associated with the leaf spring design problem on DHC-8 aircraft with serial number 001 to 039, even though these 39 aircraft had accumulated extensive flight hours since their manufacture in the mid 1980s.

In terms of assessing the potential risk associated with the design problem, the ATSB noted:

- There is no operational reason for the friction device to be wound to the fully out (friction off) position during flight.
- Some of the aircraft in the serial number range 001 to 039 would have had the leaf spring replaced during unscheduled maintenance. For example, of the five aircraft operating in Australia with a serial number in that range, one had been modified.
- Since 2001, all DHC-8-100 aircraft were required to have a beta warning horn installed. The horn would activate if the flight idle gate release triggers were lifted in flight. In addition, if the friction device had been wound to the fully out position prior to flight, the horn would activate immediately after takeoff.
- Since 2002, all DHC-8-100 aircraft operating in the United States were required to have a beta lockout system[3] fitted, reducing the risk of the consequences of ground beta operation in flight.

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[2] For examples, see (a) the Accident Investigation Board Norway report SL 2012/05, *Report on serious incident during descent to Sørkjosen Airport, Norway on 21 February 2006 with Bombardier DHC-8-103, LN-WIE operated by Widerøes Flyveselskap AS*; (b) US National Transportation Safety Board report AAR-94/06, *Overspeed and loss of power on both engines during descent and power-off emergency landing, Simmons Airlines, Inc, American Eagle Flight 3461, N349SB, False River Air Park, New Roads, Louisiana, February 1, 1994, involving a Saab 340B aircraft.*

[3] The beta lockout system is a modification to the propeller system design that prevents propeller overspeed in the event of a power lever selection below flight idle in flight. The system is a mandatory modification in the US and Papua New Guinea. On 19 June 2012, the manufacturer issued an All Operator Message advising that Transport Canada had indicated its intention to issue an AD to require the fitment of a beta lockout modification for all DHC-8 aircraft. As Canada is the State of Design, such a modification would become mandatory in other countries, including Australia. Further details of beta lockout systems and related occurrences are provided in ATSB investigation report AO-2011-159.

ANALYSIS

During the landing at Cairns, the crew perceived that the aircraft decelerated much quicker than they expected given that reverse thrust and landing gear brakes had not been selected. A subsequent inspection of the aircraft found nothing to explain the perceived problem, and a review of the flight recorder data indicated that there was no abnormal operation of the engines or propellers, and that reverse thrust had not been used. There was little if any risk associated with the event.

Although no problems were found to explain the crew's perceived event, inspection of the aircraft revealed a design problem with the engine power lever friction adjustment mechanism. It was discovered that the flight idle gate could be rendered ineffective at protecting the propeller system against inadvertent activation of propellers in the ground range in flight if the power lever friction device was wound to the full out (friction off) position. The first 39 DHC-8 aircraft manufactured had the same underlying problem.

The manufacturer had identified the design problem in 1986 and modified all subsequent aircraft. It issued a service bulletin to modify the first 39 aircraft, however the bulletin omitted the replacement or modification of a specific part, the leaf spring, which resulted in the modification of those aircraft being ineffective. The exact reasons for the omission in the service bulletin could not be determined, but the manufacturer advised that such omissions would not occur with their current change management process.

The Australian Transport Safety Bureau (ATSB) considered that the likelihood of the design issue leading to an accident was very low, taking into account that it would be very rare for the aircraft to be operated with the power lever friction device in the fully wound out (friction off) position. Evidence of this can be seen by the fact that it took 28 years for the ineffectiveness of the service bulletin to address the design issue to be identified. That said, the in-flight operation of the power levers in ground mode can have serious consequences; therefore the ATSB considered the problem to be a safety issue.

After the operator identified the problem with the original service bulletin, the aircraft manufacturer was very proactive at working with the regulators, aircraft operators and the ATSB to rectify the situation. The *Safety action* section of this report describes that rectification.

FINDINGS

Context

From the evidence available, the following findings are made with respect to the perceived speed control occurrence involving the Bombardier DHC-8 aircraft, registered VH-QQA, which occurred on landing at Cairns, Queensland on 30 December 2011. The findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

Based on the available evidence, the investigation could not identify any specific safety factors had contributed to the reported event.

Other safety factors

- The first 39 manufactured DHC-8-100 aircraft had a design problem such that, if the friction control was wound to the full out (friction off) position, the flight idle gate was ineffective in reducing the likelihood of pilots inadvertently moving the power levers below flight idle in flight. *[Minor safety issue]*
- Although the DHC-8 manufacturer had identified a problem in 1986 with the friction control mechanism that could render the flight idle gate to be ineffective, its service bulletin to fix the first 39 DHC-8-100 aircraft omitted the replacement or modification of the leaf spring, which resulted in the bulletin being ineffective.

Other key findings

- Although the crew were concerned that there may have been an uncommanded reverse pitch of the propellers during the landing roll, an examination of the flight data showed that this did not occur.
- The design issue was identified by the operator's engineering personnel during an unscheduled maintenance inspection.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety 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 responsible organisations for the safety issues identified during this investigation were given 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.

Power lever quadrant design issue

Minor safety issue

The first 39 manufactured DHC-8-100 aircraft had a design problem such that, if the friction control was wound to the full out (friction off) position, the flight idle gate was ineffective in reducing the likelihood of pilots inadvertently moving the power levers below flight idle in flight.

Action taken by Bombardier Inc.

In response to this design problem, Bombardier Inc. issued an alert Service Bulletin A8-76-32 on 24 January 2012, which recommended the modification of the friction lever spring on all aircraft between serial number 001 thru 039 in order to prevent contact between the friction lever spring and the flight idle gate.

Action taken by Transport Canada

Transport Canada mandated the alert service bulletin with Airworthiness Directive (AD) CF-2012-08 *Power lever Friction Brake Assembly Discrepancy* on 30 January 2012. That AD mandated compliance with the aircraft manufacturer's service bulletin.

Action taken by the Civil Aviation Safety Authority

The Civil Aviation Safety Authority (CASA) issued Airworthiness Bulletin (AWB) 61-009 on 12 January 2012 to inform Australian operators of DHC-8 100-300 series aircraft about the design issue. The AWB recommended an inspection of the power lever quadrant in order to ascertain the ongoing serviceability of the aircraft.

Under Civil Aviation Regulations, CASA mandates all ADs from the State of Design. Accordingly, CF-2012-08 became a mandatory requirement for Australian operators on 30 January 2012.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of information

The sources of information during the investigation included:

- the flight crew of VH-QQA
- the aircraft operator
- the aircraft manufacturer
- Transport Canada (TC)
- the Transportation Safety Board of Canada (TSB)
- and the Civil Aviation Safety Authority (CASA).

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (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 flight crew of VH-QQA, the aircraft operator, the aircraft manufacturer, TC, the TSB and CASA.

Submissions were received from the aircraft operator, the aircraft manufacturer, TC, the TSB and CASA. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

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Investigation

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