Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
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AIRCRAFT CONTROL DIFFICULTY

GOVERNMENT OF CANADA DEPARTMENT OF TRANSPORT
CESSNA TU206G C-FIHV
HAMILTON, ONTARIO
09 JUNE 2005

Canada

Aviation Investigation Report

Aircraft Control Difficulty

Government of Canada Department of Transport
Cessna TU206G C-FIHV
Hamilton, Ontario
09 June 2005

Report Number A05O0120

Summary

The Cessna TU206G (registration C-FIHV, serial number U20606154) was being operated by Transport Canada as flight number TGO954 from Hamilton, Ontario, to Burlington Airpark, Ontario. The aircraft departed from Runway 30 at approximately 1200 eastern daylight time with only the pilot on board. During the take-off rotation and the initial climb, the aircraft had an increasing tendency to pitch nose-up. The pilot applied full nose-down trim, but the aircraft tendency to pitch nose-up continued. Excessive forward pressure on the control wheel was required to maintain an appropriate pitch attitude during the climb-out and subsequent return to the Hamilton Airport. The aircraft was landed without further incident.

Ce rapport est également disponible en français.

Other Factual Information

The occurrence pilot described the control difficulty to the aircraft maintenance engineers (AMEs) following the flight and they in turn investigated the rigging of the trim tab actuator. This was the first flight following the replacement of the elevator trim tab actuator, which had reached its five-year calendar life. It was determined that the actuator was working properly, but the travel limits for the trim tab were incorrect.

The AME who worked on C-FIHV had been licensed for 15 years and worked for Transport Canada for 13 years. The majority of his experience was on large turbine aircraft and small jet aircraft. He also held a private pilot licence.

Removal and installation of the actuator is a multi-step procedure, followed by an additional 11 steps to rig the elevator trim system. The AME had the maintenance manual (Model 206 and T206 Series Service Manual) available during the installation and referred to it as required. Some difficulty was encountered during installation of the trim cables due to the lack of visual access to check the correct cable routing.

There were two areas during the procedure to rig the elevator trim system that also gave the AME some difficulty. The first was determining the correct cable tension. Chapter 9 (Elevator Trim Tab Control System) of the maintenance manual, Section 9-15, describes the rigging procedure and states, "Check cable tension for 10-15 pounds and readjust turnbuckle (16), if necessary." This section also refers to Figure 9.1, which specifies a cable tension of 10 to 15 pounds (at average temperature for the area). He found the reference to "average temperature" to be ambiguous and confusing. Other aircraft manufacturers that he was familiar with provide a graph, specifying a specific tension for a specific temperature. The trim cables were tensioned to 12 pounds.

The second area that created some difficulty was the travel limits for the trim tab. The travel limits were found in a different section of the manual. When the AME read the trim tab travel limits (25° up and 5° down), he misinterpreted these to mean the pitch of the aircraft as seen by the pilot, even though there is a warning on page 9-8 that states, "Be sure trim tab moves in the correct direction when operated by trim control wheel. Nose down trim corresponds to tab up position." The AME adjusted the trim tab actuator so that the trim tab travel was from tab trailing edge 25° down to tab trailing edge 5° up. The final rigging parameter for the trim tab is to set the take-off trim at 10° up. The AME mistakenly set the take-off trim at 10° down (nose-up).

After the elevator trim tab actuator was installed and rigged, a second AME was assigned the task of conducting an independent inspection of the installation and operation of the elevator trim system in accordance with Section 571 of the *Canadian Aviation Regulations* (CARs) and Airworthiness Notice 1 (AN) C010. Before conducting the independent inspection, the second AME was briefed on the installation by the AME who had replaced the actuator.

The briefing included a detailed explanation of what had been taken apart, what difficulties had been encountered, and the maintenance manual reference for the trim tab travel limits. Following the briefing, the two AMEs worked together so that the second AME could inspect

the installation and rigging of the trim tab actuator. The first AME explained the trim tab rigging and the procedure he had used to accomplish it. The second AME inspected the cable run and identified an interference with a cotter pin, which was corrected by re-bending the cotter pin. He then confirmed that the tab was rigged as explained by the first AME.

Before take-off, the pilot set the elevator trim in the take-off position and visually confirmed that the trim tab was moving freely and in the correct direction. There is no indication to the pilot of the normal or expected travel limits of the trim tab. It was not until the take-off rotation and the initial climb that the pilot noted the abnormal forward pressure on the control column required to keep the aircraft from pitching nose-up. To counter the pitch-up tendency, he trimmed the aircraft full nose-down. The amount of forward pressure on the control column continued to increase as the aircraft accelerated. When engine power was reduced to climb power, slightly less forward force was required to hold the proper climb attitude. At circuit altitude, when the pilot reduced engine power to cruise, the proper pitch attitude was relatively easy to maintain. When engine power was reduced to idle for the final approach and landing, full nose-down trim was no longer required. The subsequent flair and landing was uneventful.

Prior Occurrence

In 1998, the Transport Canada maintenance base at Hamilton had dispatched a Beech King Air 90 with a misrigged rudder control. In that occurrence, the pilot, who was attempting to trim out aircraft yaw during the initial climb, found that the out-of-trim condition actually became worse as the rudder trim control knob was turned in the correct direction to counter the yaw. He reversed the trim control input and was able to properly trim out the yaw. After landing at destination, the crew confirmed that the rudder trim was operating backward. About a month before the occurrence, the incident aircraft had undergone scheduled maintenance, which required disassembly of the rudder.

During the re-assembly of the rudder, there was some discussion amongst the AMEs involved concerning which direction the trim tab should move when selected in the cockpit. The maintenance instruction reads, “Visually check the rudder tab movement corresponds to the movements indicated on the tab indicator, Nose Left, tab moves right, Nose Right, tab moves left.” However, on the console in the aircraft cockpit, the marking for the rudder trim tab indicator reads “L <--- RUDDER TAB ---> R” and not nose left or right as described in the maintenance manual.

The AMEs disregarded the maintenance manual and the basic principle that the nose of the aircraft moves in the same direction that the trim control is moved. It is not known why they chose to follow their interpretation of the meaning of the rudder trim indicator rather than the maintenance manual instruction. The AMEs decided that the word “tab” on the indicator meant that the indicator was referring to tab trailing edge movement. They rigged the rudder trim so that the trim tab moved to the left when the tab indicator in the cockpit was moved to the left. The incorrect rigging of the rudder trim tab was not discovered during the required maintenance independent inspection, nor was it discovered during the approximately 15 hours flown since the aircraft was released for service.

An internal maintenance investigation concluded that the cockpit placard referring to RUDDER TAB rather than RUDDER TRIM was misleading, as it suggested that, when the indicator was moved to the left, the rudder tab, rather than the nose of the aircraft, should move to the left. It also determined that the procedure in the maintenance manual, although clear, contributed to the misinterpretation because the wording was not consistent with the wording on the placard. An Aircraft Services Service Bulletin was produced to modify the rudder trim control placard to read "NOSE LEFT < RUDDER TAB > NOSE RIGHT."

AN C010 Edition 2 was published by Transport Canada in October 2001. It is intended to explain the regulations applicable to maintenance performed on engines and flight controls, and the responsibilities of the individuals involved in those maintenance tasks. It is also intended to highlight the significance of these maintenance tasks. The summary at the end of AN C010 states the following:

> While aircraft control systems themselves are often extremely complicated, the kinds of errors in the assembly of these controls that lead to accidents are often extremely simple, so much so that, with hindsight, it can be difficult to see just how the oversight could have occurred. These are simple human errors of the most basic kind, involving poor communication, inattention, distraction, faulty assumptions, and overlooking the obvious. Of all the problems encountered in aviation maintenance, these are among the most avoidable. If all of us involved in the maintenance of control systems were to simply resolve to treat the task with the attention it deserves, regardless of how simple it may appear, control-rigging accidents could be completely eliminated.

Analysis

The job of replacing the elevator trim actuator was completed satisfactorily up to the point of rigging the tab. The AME read the elevator trim tab travel limits but misinterpreted those limits to refer to aircraft pitch rather than elevator tab movement. He rigged the tab so that it moved from 5° up to 25° down, instead of 25° up to 5° down. This resulted in very limited nose-down trim authority. He either did not read or did not note the warning at the end of the rigging instruction.

His misinterpretation of the elevator trim tab travel limits was influenced by the previous incident of the misrigged King Air rudder trim. At the time of that incident, there were numerous informal discussions between the AMEs regarding the wording on the King Air rudder trim control placard, and whether it referred to the position of the rudder tab or the yaw of the aircraft. These discussions, together with the company response of amending the wording on the rudder trim control placard, gave credibility to the argument that the nomenclature referring to the movement of control tabs relates to aircraft response rather than tab deflection.

The Aircraft Services Service Bulletin was an attempt to minimize errors by eliminating the recurrence of a specific active failure identified by the incident investigator. The bulletin only addressed the specific circumstances of the King Air rudder trim rigging error, and not the

possibility that other aircraft may also be subject to rigging errors. Additional organizational error management strategies aimed at training, the procedures and figures in the maintenance control manual, the use of manuals and procedures during normal work activities including the independent inspection, combined with regular procedure reviews after incidents would help prevent a recurrence of these errors.

The maintenance of engine and flying controls have traditionally been treated differently than other maintenance activities due to the consequences of an error when working with these components. AN C010 refers to both the legal requirements of an independent inspection and the philosophy for conducting an independent inspection. It also mentions that it is inadvisable for the AME who completed the maintenance work to be an active participant in the required independent inspection.

In this instance, the AME conducting the independent inspection relied on the explanation of the rigging procedure given by the AME who had accomplished the work, thus undermining the intent of the independent inspection. The independent inspection, which is intended to confirm correct assembly, locking, and sense of operation, failed because the second AME did not assess the rigging limits by himself.

Findings as to Causes and Contributing Factors

1. The aircraft maintenance engineer (AME) misinterpreted the elevator trim tab travel limits and misrigged the elevator trim tab such that limited nose-down trim was available.

2. The second AME did not detect the rigging error during the independent inspection because he relied on the first AME's explanation of the rigging procedure.

Safety Action Taken

In an effort to minimize the risk of a misrigged control system, Transport Canada Aircraft Services included the requirements of Airworthiness Notice (AN) C010 in the maintenance control manual.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 18 April 2007.

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