

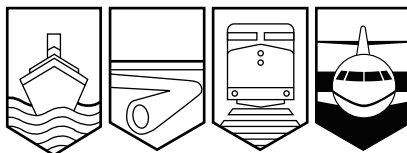
Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

AVIATION INVESTIGATION REPORT

A00Q0043



INCORRECT ASSEMBLY OF AILERON CONTROL SYSTEM

CESSNA 172L C-FAXL

MANIWAKI, QUEBEC

11 APRIL 2000

Canada

The Transportation Safety Board (TSB) of Canada 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

The pilot owner of the Cessna 172 C-FAXL, serial number 17259357, was making a visual flight rules flight between the airport at Saint-Bruno-de-Guigues, Quebec, and the airport at Trois-Rivières. The aircraft was carrying four persons. When the aircraft was 70 nautical miles from Maniwaki, at an altitude of 5500 feet above sea level, the right-hand aileron yoke assembly came apart, and the pilot lost lateral control. He immediately declared an emergency on the 121.5 megahertz frequency and was guided by the control centre to the Maniwaki airport, where the emergency services were standing by. The elevator was functioning normally, but the pilot used it as little as possible for fear that the flight controls might jam completely. He successfully landed at Maniwaki without incident. No one was injured.

Ce rapport est également disponible en français.

Other Factual Information

On 07 April 2000, after the annual inspection of his aircraft, the pilot of C-FAXL left the airport at Amos, Quebec, at about 1645 eastern daylight time (EDT).¹ When the aircraft was 13 nautical miles from the airport, at an altitude of 2700 feet, the pilot noticed that the aileron control was no longer responding. Using the elevator, its trim tab, and the rudder, the pilot managed to turn back and set the aircraft down on the runway. The landing proceeded without incident, and the pilot did not declare an emergency.

When the pilot arrived at the hangar, the employees had all left the premises except for the maintenance manager. The maintenance manager checked the malfunction and found that the right-hand aileron yoke assembly had come apart and that some parts had fallen onto the floor of the aircraft. He redid the work himself. The pilot's lack of a night rating put additional pressure on the maintenance manager, who rushed to complete the work before it began to turn dark. He put the universal joint back in place, checked the operation again, and returned the aircraft to service without making any technical entry and without asking anyone else to perform an independent inspection. He did not submit a service difficulty report (SDR) after the occurrence although he should have. The pilot took off again at about 1825, and the flight proceeded without incident to the Saint-Bruno-de-Guigues airport. This occurrence was not reported to the TSB, nor was it required to be.

Four days later, on 11 April 2000, the pilot took off again for Trois-Rivières with a stop at Mont-Laurier. About 70 nautical miles from Maniwaki, the right-hand aileron yoke assembly came apart again. The aileron and the elevator mechanisms are linked; the elevator responded normally, but the left aileron had a tendency to ride up and destabilize the aircraft. For that reason, the pilot used the elevator as little as possible, employing the elevator trim tab and the rudder instead. He landed at Maniwaki, where emergency services were standing by.

The maintenance manager who was involved in the work was a licensed aircraft maintenance engineer (AME). He had over 20 years' experience in aircraft maintenance and founded the company Avionnerie Amos in 1983. The company also has another AME on call who supervises and certifies specialized maintenance, performs independent inspections, and provides the appropriate signatures. Five apprentice technicians maintain aircraft, but only one apprentice technician is a graduate in aircraft maintenance from a recognized school.

The *Canadian Aviation Regulations* (CARs) require an independent inspection because of the potential serious consequences of maintenance on flight or engine controls. The regulations require that work that disturbs engine or flight controls be inspected for correct assembly, locking, and sense of operation by at least two persons and that the technical record contain the signatures of both persons. One of the signatures may be that of the person who has signed the maintenance release. Section 4.4.2 of the *Avionnerie Amos Maintenance Policy Manual* sets forth the procedures for the independent inspection. The requirement for a second person to inspect the work performed is intended to prevent an aircraft from being returned to service with defective controls. During the 07 April 2000 annual inspection, an apprentice technician had taken part in the installation of the aileron control system, and the maintenance manager had checked the work. Yet the aircraft had been returned to service with the aileron yoke assembly incorrectly installed.

¹ All times are EDT (Coordinated Universal Time [UTC] minus four hours).

No standards or regulations prohibit apprentice technicians from performing maintenance work, however complex, on an aircraft. However, the responsibility of the AME who certifies the work remains; the AME must ensure that the work is performed completely in accordance with the applicable airworthiness standards and that the aircraft is airworthy.

The work on the yoke involved rotating two identical parts from one side to the other of the flight control. The two mechanisms were similar, but access to the right side was restricted by the presence of the radio equipment and the card box. This work was simple enough for the maintenance manager to entrust to an apprentice technician with only one year's experience, in the first occurrence, without constant supervision. The apprentice technician was, however, supervised by an experienced apprentice technician. For economic reasons, the maintenance manager had suggested to the aircraft's owner that the universal joints be rotated instead of just replacing the left joint. By so doing, he increased his maintenance staff's workload and the risk of error, without, however, contravening the regulations.

The work involved sliding the universal joint (part number [P/N] 0411257) into the sprocket (P/N 0511785-1), then pushing the shaft (P/N 0511788-1) into place and aligning it to install the bolt. The bolt would thus hold all the parts together. In the second occurrence, the maintenance manager had trouble aligning and inserting the universal joint in the sprocket. To ensure the integrity of the assembly, the manufacturer had added a note specifying that washers (P/N AN960-816L) were to be installed on the shaft to limit the distance between the shaft and the bearing (P/N S1004-43A) to 0.005 inch. (See Appendix A for a diagram of the aileron control system.) The Cessna 172 maintenance manual contains no specific instructions for removing and installing the universal joints. The manual describes, rather, the procedure for removing and installing the control as a whole. For a better view of the right-hand installation, the technician could have accessed all the parts by removing the card box, but he did not do so. The technician therefore had to work by feel in a more confined space.

The universal joint was held in place by the pressure exerted by the nut, even though the nut was not in the right place. Consequently, the abnormality could not be detected in the ground test of the controls. Removing the card box would have simplified access and would have helped to visually confirm the incorrect assembly. The time required to remove and replace the card box was a determining factor in this maintenance operation. The distance between the shaft and the bearing was nearly 0.500 inch, whereas it should have been 0.005 inch. Even an inspection by touch would have been able to detect this abnormality.

Private aircraft inspection forms are used to detail the work to be done in annual inspections for private aircraft. The approved maintenance organization held up-to-date maintenance manuals and microfiches for all the aircraft maintained at this base. The maintenance work is recorded on a worksheet, which, once completed, is attached to the inspection sheets. In both occurrences, the work of rotating the universal joints was not recorded in the aircraft journey log or in the technical logs.

The pilot was present during the inspection of his aircraft in both occurrences. He remained in the hangar throughout the work and knew that the two universal joints had undergone maintenance work. Under existing regulations, he could have been asked to take part in the independent inspection following the maintenance work, but he was not. He did, however, perform a pre-flight check, and all the flight systems were functioning normally.

Aeronautical maintenance professionals require a number of skills and are subject to a variety

of pressures. Among other things, they have to keep aircraft airworthy, perform maintenance on an ageing fleet, and cope with other stress factors that affect their performance. The serious consequences of a flight or engine control installation or adjustment error are well known to the industry and to Transport Canada. That is why engine and flight control maintenance is treated differently from other maintenance work in that an independent inspection is required on completion of such maintenance work. In both occurrences, no entry certifying that an independent inspection had been done was made in either the aircraft journey log or any other technical log.

Under CAR 573.12, an approved maintenance organization certificate holder is to report to the Minister any service difficulty relating to the aeronautical products being maintained. Appendix C of the *Airworthiness Manual*, Chapter 591, gives examples of defects requiring submission of an SDR. Among other things, part (3)(b) indicates that incorrect assembly of components is one of the defects requiring submission of an SDR. The first occurrence was not reported to Transport Canada. The second occurrence was reported to the TSB by the control centre through the Aviation Occurrence Reporting Service. CAR 591.01(2) stipulates that an SDR is not required if the service difficulty has already been reported by another person or organization.

Analysis

The investigation revealed that, in both occurrences, the aileron control system had been incorrectly installed, resulting in loss of lateral control of the aircraft in flight. The manufacturer's maintenance manual does not give any specific instructions concerning this installation; rather, the instructions are general, and the technicians have to show judgement when performing this maintenance operation. Removing the card box, however, would have afforded better access to the aileron control system not only to perform the work but also to check for correct system installation.

By suggesting rotating the universal joints to the aircraft's owner, instead of replacing the defective joint, the maintenance manager increased the amount of work and the level of difficulty of installation for his staff and himself.

In both occurrences, the maintenance manager did not notice that the system was incorrectly installed, and the required independent inspection was not performed. In the first occurrence, the maintenance manager checked the apprentice technician's work and thus carried out the first level of inspection. The maintenance manager did not, however, ensure the integrity of the control system by performing an independent inspection as the regulations require. In the second occurrence, the maintenance manager did the installation alone. No other inspection was done by either an AME or the aircraft's pilot.

The work of rotating the universal joints was not recorded in the aircraft journey log or the technical logs, although this is required by the regulations.

In the first occurrence, an SDR should have been submitted to Transport Canada. The maintenance manager did not make a report, although this is required by the regulations. In the second occurrence, the maintenance manager was not required to submit such a report because the TSB had already been informed of the situation.

Findings as to Causes and Contributing Factors

1. The aircraft was returned to service twice with the aileron control system incorrectly installed, resulting in loss of lateral control of the aircraft.
2. An independent inspection was not performed in either occurrence. Such an inspection could have revealed the incorrect assembly.
3. The card box was not removed in either occurrence. Such removal would have provided better access to the aileron control system and facilitated detection of the incorrect installation.

Findings as to Risk

1. Rotating the universal joints instead of replacing the defective joint increased the difficulty of installation, thereby increasing the risk of error.

Other Findings

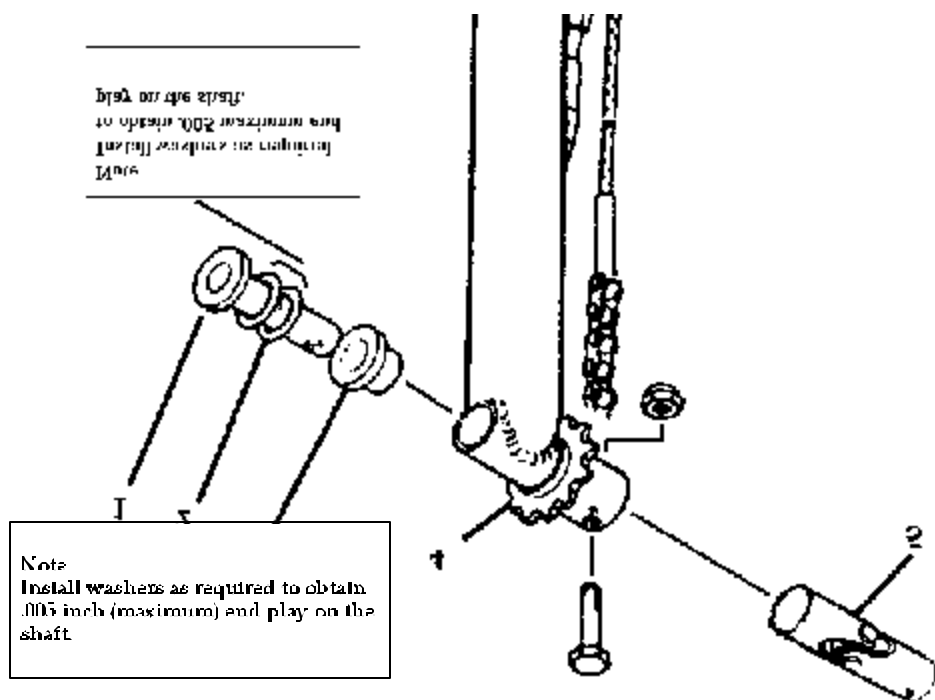
1. The work performed on the universal joints was not recorded in the aircraft journey log or the technical logs. Regulations required this work to be recorded.
2. After the first occurrence, no service difficulty report was submitted to Transport Canada to report the difficulties encountered.

Safety Action

On 05 October 2000, Transport Canada issued *Service Difficulty Advisory* No. AV-2000-05. The advisory relates the circumstances of the incident and gives details about inspection and procedures when work is done on the aileron control yoke sprocket.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 18 October 2001.

Appendix A—Aileron Control System



Legend

1. Shaft
2. Washer
3. Bearing
4. Sprocket
5. Universal joint