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Australian Transport Safety Bureau

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- safety data recording, analysis and research
- fostering safety awareness, knowledge and action.

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ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2010-063
Final

Depressurisation, VH-NGX
120 km NNE Perth Airport, Western Australia
16 August 2010

Abstract

At about 0700 Western Standard Time on 16 August 2010, a Fairchild Industries Inc. SA226-TC (Metro II) aircraft, registered VH-NGX, departed Perth Airport on a charter flight to Fortnam Mine, Western Australia. On board the aircraft were the pilot and 10 passengers.

The aircraft was climbing through flight level 205 when the right cockpit side window suddenly failed and the cabin rapidly depressurised. The pilot put on his oxygen mask, activated the passenger oxygen system and transmitted a distress call to air traffic control. He commenced an emergency descent to 9,000 ft and returned to Perth. There were no reported injuries to the aircraft occupants and the aircraft sustained minor airframe damage as a consequence of the window failure.

The investigation determined that the window failed as a result of cracks that had propagated laterally between the retainer holes along the upper edge of the window and significantly weakened its structural integrity.

Inspection of the aircraft logbooks determined that the failed window was fitted as an outer window in 2006 by the previous aircraft owner. However, the investigation identified that the window was manufactured and supplied as an inner window only, was of reduced material thickness, and was not designed to safely withstand cabin pressurisation loads.

The work practices during the installation of the incorrect window and its reduced material thickness contributed to the window's deterioration and failure under pressurisation loads.

The investigation did not identify any organisational or systemic issues that might adversely affect the future safety of aviation operations. Notwithstanding, the aircraft operator and Civil Aviation Safety Authority initiated proactive safety action to minimise the risk of a recurrence of the window failure.

FACTUAL INFORMATION

Sequence of events

At about 0700 Western Standard Time[1] on 16 August 2010, a Fairchild Industries Inc. SA226-TC (Metro II) aircraft, registered VH-NGX, departed Perth Airport on a charter flight to Fortnam Mine, Western Australia. The aircraft was being operated under the instrument flight rules and was climbing to an altitude of flight level (FL) 210[2] with the pilot and 10 passengers on board.

The aircraft was about 120 km (65 NM) north-north-east of Perth and climbing through FL 205 when the pilot heard a loud bang followed immediately by wind noise. The pilot saw that the

1 The 24-hour clock is used in this report to describe the local time of day, Western Standard Time (WST), as particular events occurred. Western Standard Time was Coordinated Universal Time (UTC) + 8 hours.

2 Level of constant atmospheric pressure related to the datum of 1013.25 hPa, expressed in hundreds of feet. FL 210 equated to 21,000 ft above mean sea level (AMSL).

right cockpit side window had failed and noted that the cabin had depressurised.

The pilot recalled that he put on his oxygen mask and activated the passenger oxygen supply. He then reduced the engine power to flight idle, commenced an emergency descent and transmitted a distress call to air traffic control.

The pilot said that he used the aircraft's public address system to instruct the passengers to put on their oxygen masks. In addition, because of the wind noise from the failed window, he also gestured to the front row of passengers by pointing to his own oxygen mask, which ensured that they understood the requirement to use oxygen.

The pilot descended the aircraft to 9,000 ft and indicated to the passengers that oxygen was no longer required. He established that the aircraft was controllable and decided to return to Perth, requesting that the airport emergency services be placed on 'local standby'[3] for their arrival.

Damage to the aircraft

Damage to the aircraft was confined to the right cockpit side window and the cabin trim and fittings in the immediate vicinity (Figure 1). That included the oxygen mask that was stowed adjacent the right (copilot) seat.

Figure 1: Right cockpit side window

Several other items were lost overboard during the depressurisation, including the aircraft's quick reference handbook, a personal distress beacon (EPIRB), the aircraft's maintenance release/technical log, and a number of navigation charts.

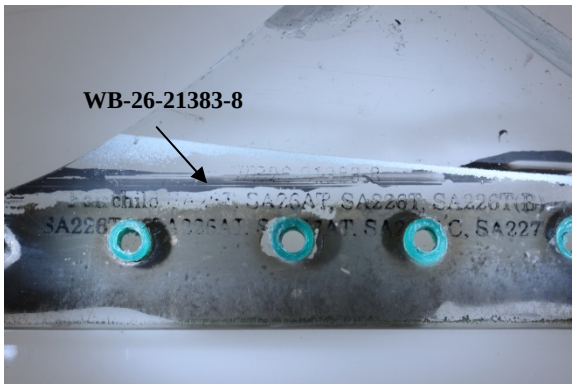
There was no evidence that any debris struck the airframe or right propeller or engine.

Aircraft information

The aircraft was fitted with single-pane acrylic cockpit side windows at the time of manufacture. Dual-pane acrylic cockpit side windows were available as an optional installation on the Metro II. In that configuration, the inner pane was installed to provide a quieter cabin and the outer pane was sealed and stressed to retain cabin pressure. The inner pane could also be fitted to the aircraft as an aftermarket addition, supplementing the original single-pane installation. The aircraft did not have the optional inner panes fitted.

Examination of the aircraft's maintenance records indicated that the right cockpit side window was replaced due to crazing[4] in July 2006, when the aircraft was being maintained and operated by its previous owner. The replacement window was identified by part number as a right cockpit side window inner-pane and was accompanied by an authorised release certificate identifying it as such (Figure 2). However, that window was fitted as a replacement for an outer pane.

Figure 2: Window fragment with part number



The aircraft had flown about 1,800 hours and accumulated an additional 1,700 pressurisation cycles since the installation of that window as an outer pane.

3 Local standby activated the airport-based emergency response agencies in accordance with the aerodrome emergency plan.

4 Small cracks in the surface that reduces the transparency of the window.

A service bulletin issued by the aircraft manufacturer required the recurrent inspection of the acrylic cockpit outer panes to ensure their ongoing structural integrity. That included the requirement to use an 'inspecting prism' to check for the propagation of cracks between the retainer holes in the pane. The completion of that inspection was mandated by an airworthiness directive that was issued by the Civil Aviation Safety Authority.

The aircraft's maintenance logbooks recorded the completion of the required inspections in April 2010, about 360 flight hours prior to the failure of the cockpit side window. No defects were found at that time.

The aircraft manufacturer reported that the specified thickness for the single-pane (outer) cockpit side window was 0.250 in. (6.35 mm). The specified thickness for the inner-pane that was used in the dual-pane installation was 0.188 in. (4.78 mm). A manufacturing tolerance of +/-0.02 in. (0.51 mm) applied to those measurements.

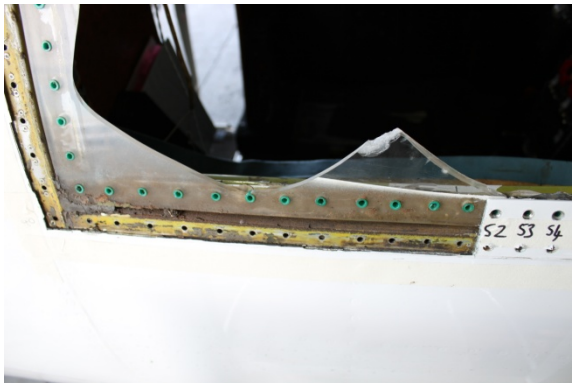
The aircraft manufacturer published comprehensive instructions for the correct fitting of the aircraft's cockpit windows. Those instructions included the option of using the old window as a template to determine the position of the window retaining holes. In that case, it was important to ensure that the template, which was developed from the old window, was placed centrally on the new window to ensure that equal edge distances were maintained from the retaining holes. Adhering to those instructions assured the structural integrity of the fitted window, and included procedures to correctly trim the replacement acrylic sheet to size, to properly locate the window centrally within the frame, and to drill and prepare the retainer holes.

Bushings were to be fitted to each retainer hole and trimmed flush with each side of the window.

Technical examination

Remnants from the right cockpit side window (Figure 3), together with the retaining skins were removed from the airframe under the supervision of investigators from the Australian Transport Safety Bureau (ATSB). The intact left cockpit side window was also removed. The left and right cockpit side windows were sent to the ATSB's facilities in Canberra for technical examination.

Figure 3: Remnant fragments, right side window



The thickness of the acrylic fragments that were recovered from the right cockpit side window was between 0.194 and 0.198 in. (4.93 and 5.03 mm). The upper edge of the window had the least acrylic material remaining. Every retaining hole examined had a combination of cracks running from the hole to the edge of the pane, and cracks running laterally between the holes. The lateral cracks along the upper edge of the window had conjoined to form a continuous crack.

Examination of fragments from the right cockpit side window found that the upper retaining holes were closer to the edge of the pane than was stipulated by the aircraft manufacturer. The reduced hole-to-edge dimension increased the stress on the acrylic pane and made it more susceptible to in-service, hole-to-edge cracking. The hole-to-edge cracks along the upper edge of the pane were each single events. That is, they had each propagated from hole-to-edge in one step.

The aircraft manufacturer required the retaining holes in the acrylic window to be drilled undersize and then correctly-sized using a counterbore from each side of the pane. Examination of the retainer holes indicated that they had been drilled from one side using a large-diameter twist drill. In addition, a twist drill had been used to roughly chamfer the edges of the holes, in contrast to being sanded or countersunk as specified by the manufacturer.

The incorrect preparation of the retaining holes created additional stress raisers, with resultant cracking detected in some of the retaining holes. Chamfer-initiated lateral cracking was evident in the retainer holes along the upper edge of the window, which had in many cases progressed as a series of radiating steps.

The bushings that were fitted to the retaining holes were oversize and had not been trimmed flush with the edges of the acrylic pane. Clamping forces from the mounting screws had forced the bushings into the chamfers, creating a 'bobbin' effect, acting as additional stress raisers in the acrylic pane. Bushing material and sealant extruded into some cracks and was evidence that some of the lateral cracks were created during the installation of the window. There was also evidence that one bushing was not fitted when the window was installed.

ANALYSIS

The aircraft cabin rapidly depressurised when the right cockpit side window suddenly failed. The pilot's immediate use of oxygen and emergency descent ensured the continued safe operation of the aircraft.

The incorrect installation in July 2006 of a right cockpit side window inner pane as a single outer, pressurisation-load-carrying window was consistent with the measured thickness of the remnants from the right cockpit side window. That thickness corresponded with the manufacturer's specification for the thinner inner pane, which was not designed or stressed to take cabin pressurisation loads.

The investigation was unable to establish the circumstances surrounding the incorrect window installation, which was not in accordance with the manufacturer's requirements. Had the manufacturer's procedures been applied, it is likely that the cracks at installation and other stress raisers, including the reduced minimum hole-to-edge distances, would not have occurred.

The window failed as a consequence of cracks that propagated from the retainer holes to the upper edge of the pane. That edge cracking, combined with the additional lateral cracking between the retainer holes, significantly weakened the window's structural integrity.

The Civil Aviation Safety Authority-mandated inspection of the window retainer holes was a response to the risk of lateral cracking between those holes in acrylic panes. Although there was evidence that some lateral cracks had been present since installation, and that the chamfer-initiated cracks had progressed as a series of radiating steps, it was not possible to establish the extent of the lateral cracks at the last inspection, and therefore, whether they would have been detectable at that time.

The hole-to-edge cracking on the failed right cockpit side window would have been obscured by the bushing and mounting screws. Consequently, it was unlikely that any hole-to-edge cracking could have been detected when completing the stipulated inspection procedure.

FINDINGS

From the evidence available, the following findings are made with respect to the failure of the right cockpit side window and subsequent depressurisation that occurred 120 km north-north-east of Perth Airport, Western Australia on 16 August 2010 and involved Fairchild Industries Inc. SA226-TC aircraft, registered VH-NGX. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The right cockpit side window was an inner pane that was not designed for use as an outer, pressurisation-load carrying window.
- The incorrect installation of the right cockpit side window introduced cracks and stress raisers that weakened the window's structural integrity.
- The structural integrity of the right cockpit side window was significantly weakened by cracks that propagated from the retainer holes to the upper edge of the pane, before combining with additional lateral cracking between those holes.

SAFETY ACTION

Whereas an investigation may not identify any organisational or systemic issues that might adversely affect the future safety of aviation operations, relevant organisation(s) may proactively initiate safety action in order to further reduce their safety risk.

A discussion of proactive safety action in response to this occurrence by a number of the parties to the investigation follows.

Aircraft operator

In response to this occurrence, the aircraft operator audited the aircraft's documentation to verify the remaining window installation. As the aircraft was the only one purchased from the organisation that fitted the failed right cockpit side window, the operator considered the audit as terminating action.

Civil Aviation Safety Authority

In response to this occurrence, the Civil Aviation Safety Authority (CASA) initiated its own investigation into the maintenance practices of the organisation that fitted the failed window.

Subsequent to that investigation, CASA resolved any possible airworthiness issues affecting another similar aircraft that was maintained by the organisation that installed the window, and initiated action to address the fitting of the failed window.

SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

- Civil Aviation Safety Authority (CASA)
- owner/operator of the aircraft
- current maintenance organisation for the aircraft
- maintenance organisation that installed the window
- pilot of the aircraft
- aircraft manufacturer and type certificate holder.

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 CASA, the owner/operator and maintenance organisation for the aircraft and the previous owner/operator and maintenance organisation for the aircraft.

Submissions were received from CASA and the maintenance organisation that installed the window. The submissions were reviewed and, where considered appropriate, the text of the draft report was amended accordingly.