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Australian Transport Safety Bureau

Wheels-up landing involving Fairchild SA227-AT Metro III, VH-UZA

Brisbane Airport, Queensland | 15 February 2012

Investigation

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Addendum

Page	Change	Date

Safety summary

What happened

VH-UZA

Source: Toll Aviation Pty Ltd

On 15 February 2012, a Toll Aviation Pty Ltd Fairchild Industries Inc SA227 Metro III aircraft, registered VH-UZA, was being operated on a post-maintenance acceptance flight in the circuit at Brisbane Airport, Queensland with two crew on board. On selection of the landing gear handle to the down position, the landing gear would not extend. After unsuccessful attempts to extend the landing gear in both normal and emergency gear extension modes, the crew decided to conduct a wheels-up landing. At about 0230 Eastern Standard Time the aircraft landed along the centre-line of runway 19. The crew evacuated without injury and the aircraft sustained substantial damage.

What the ATSB found

The ATSB found that an electrical wire to the landing gear selector valve had separated at a connector adjacent to its terminal preventing normal operation of the landing gear to the down position. The investigation also identified an out of rig condition in the landing gear emergency extension system, which prevented correct operation of that system. Factors including the maintenance practices by a number of personnel and inconsistent maintenance documentation contributed to the existence of the defects.

What's been done as a result

The aircraft manufacturer advised that, as a result of this occurrence, re-routing requirements for the landing gear selector valve electrical wiring loom in the Metro aircraft have been distributed to all Metro operators through a *Metro Global* advisory publication.

The operator carried out a fleet-wide check of the landing gear on its Metro aircraft and rectified any defects found. The operator also re-routed the electrical wiring loom to the landing gear selector valve. In addition, the operator amended the pilot's quick reference handbook and the Metro phase inspection worksheets and issued an engineering memorandum to all aircraft maintenance personnel detailing the operator's requirements with regards to following standard procedures and approved data for maintenance tasks.

Safety message

This investigation highlights the importance of operators and approved maintenance organisations having a detailed understanding of the systems installed on the aircraft types that they are authorised to certify and aircraft manufacturers providing clear and concise maintenance procedures in an aircraft's suite of manuals.

Contents

The occurrence

At 0127 Eastern Standard Time[1] on 15 February 2012, the pilot in command (PIC) and a pilot in command under supervision (ICUS) took off from Brisbane Airport, Queensland in a Fairchild Industries Inc[2] SA227-AT Metro III aircraft, registered VH-UZA. The flight, operated by Toll Aviation Pty Ltd, was a short acceptance flight following completion of maintenance on the left engine's fuel flow indication system.

The ICUS pilot was seated in the command (left) seat and the PIC was seated in the copilot (right) seat. The PIC conducted the take-off and manoeuvred the aircraft for an instrument landing system (ILS)[3] approach for runway 19 at Brisbane Airport about 3 minutes later, then handed control to the ICUS pilot.

Upon selection of the landing gear handle to the down position, there were no indications or sounds to indicate that the landing gear had extended. The crew advised air traffic control (ATC) who cleared the crew to hold over water to the east of the airport. The PIC assumed control of the aircraft while the ICUS pilot consulted the quick reference handbook (QRH). In combination, both crew members then carried out procedure *4.5 Landing gear fails to extend*. That action did not result in the landing gear extending.

The crew then commenced QRH procedure *4.6 Landing gear emergency extension* with the ICUS pilot reading out the checklist items and the PIC actioning them. Upon rotation of the emergency release lever, both crew observed the landing gear indication change from no lights (gear up and locked) to three red lights (gear unlocked and in transit). The crew heard an increase in airflow noise, but not the sounds normally heard when the landing gear was fully extended. The crew observed that the three green light indication (landing gear down and locked) did not illuminate.

The emergency extension procedure then required manual actuation of the emergency hand pump. The crew reported significant resistance when operating the hand pump with only a few cycles being accomplished before actuation was no longer possible. Despite the use of the hand pump, the gear did not extend so the crew continued with the QRH *ADDITIONAL PROCEDURE.* This procedure required the crew to reduce airspeed to just above the flight idle stall speed, cycle the gear handle and then return the system to the emergency extension mode. The crew reported that these actions were carried out but the landing gear did not extend.

The crew discussed the situation by radio with the operator's maintenance personnel on the ground and decided to obtain a block altitude level clearance from ATC. They cycled the gear handle while conducting a series of aircraft manoeuvres in an attempt to force the gear to extend due to in-flight loading ('g' manoeuvre), but the landing gear 'unlocked and in transit' indication remained.

The crew requested a missed approach off runway 19 so that their maintenance personnel on the ground could confirm the landing gear status. The aircraft was configured to gear down for the missed approach and the maintenance personnel confirmed that the landing gear had not extended. The crew reported that they reconfigured the landing gear system back to normal mode and the gear handle to up, whereby the red lights (gear unlocked and in transit) extinguished. After making some adjustments in an attempt to lower the gear, and conducting another 'g' manoeuvre, the crew conducted a second missed approach. The maintenance personnel again confirmed that the gear had not extended.

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

2 The current type certificate holder for this aircraft type is Elbit Systems of America.

3 A standard ground aid to landing, comprising two directional radio transmitters: the localizer, which provides direction in the horizontal plane; and the glideslope, for vertical plane direction, usually at an inclination of 3°. Distance measuring equipment or marker beacons along the approach provide distance information.

On receiving confirmation that the landing gear was retracted, the crew elected to conduct a wheels-up landing and ATC cleared the crew to land on runway 19. In compliance with QRH procedure 4.7 *Gear-up landing*, the crew planned a threshold speed of 5-10 kt faster than published for a normal approach. The left engine was shut down and the propeller feathered[4] before the approach was initiated, and the right engine was shut down and feathered when the aircraft was over the runway at about 200 ft before touchdown.

At about 0230 the aircraft initially touched down on two propeller blades from each engine, and skidded on these blades until the tail of the aircraft descended onto the runway. The tail was partially protected by a navigational antenna mounted on the rear of the aircraft.

After the aircraft came to a halt, the crew exited the aircraft without injury via the right over wing emergency exit. The crew had opened the exit before commencing the approach to land in accordance with the QRH guidance, which was consistent with the information provided in the aircraft flight manual.

The local aviation rescue and firefighting (ARFF) service were deployed prior to the aircraft landing. This pre-positioning allowed ARFF to promptly apply foam to the runway and under the aircraft as soon as it came to rest (Figure 1).

Figure 1: VH-UZA on runway 19 following the wheels-up landing

Source: ATSB

[4] The term used to describe rotating the propeller blades to an edge-on angle to the airflow that minimises aircraft drag following an engine failure or shutdown in flight.

Context

Personnel information

Both pilots reported being well rested prior to their duty. Each advised that they were not suffering from the effects of fatigue or illness despite the occurrence taking place toward the end of their shift.

Pilot in command

The pilot in command (PIC) held an Air Transport Pilot (Aeroplane) Licence issued in 2010 and had a current Class 1 Medical Certificate. His total aeronautical experience was about 2,650 flying hours. Since obtaining the Metro endorsement in 2010 he had accumulated about 700 flight hours on the aircraft type. He had recently been approved by the operator to work as a training pilot and had been acting in that role with the pilot in command under supervision (ICUS) on the previous two shifts.

Pilot in command under supervision

The ICUS pilot held a Commercial Pilot (Aeroplane) Licence since 2006 and had a current Class 1 Medical Certificate. He had a total aeronautical experience of about 3,150 flying hours with about 115 flight hours on the Metro. He was endorsed on the aircraft type by the operator in November 2011 and had been flying in command under supervision since, in preparation for being checked to line. Once checked to line, the pilot would be able to fly as PIC.

Aircraft information

General information

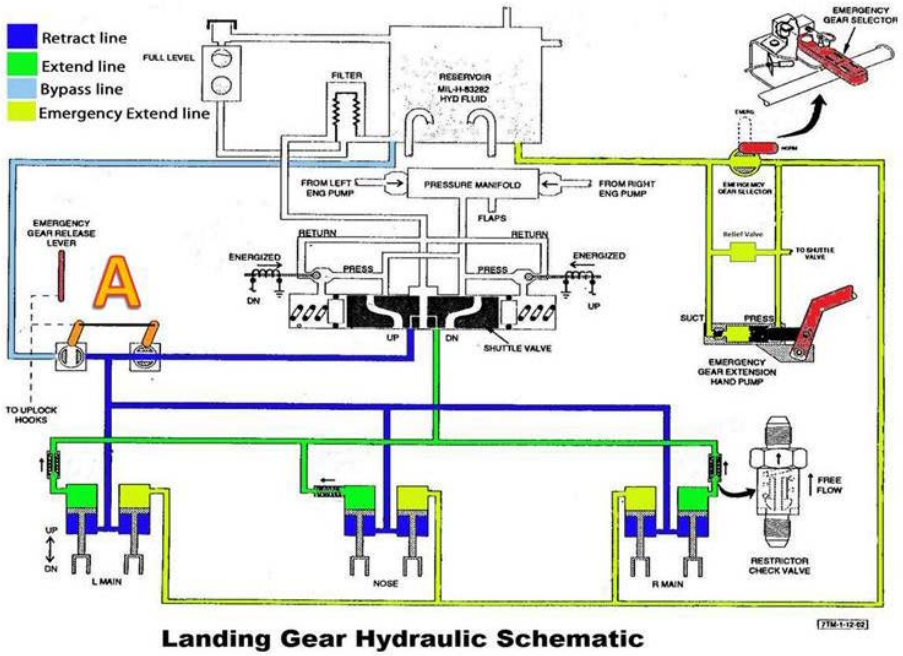
The aircraft, Fairchild Industries Inc[2] SA227-AT (Metro III) serial number AT-502, was manufactured in the United States (US) in 1981, was first registered in Australia on 3 June 1996 and had accrued about 26,290 hours total time in service. It was listed on the certificate of airworthiness (C of A) under the 'normal category' and was being used for freight operations with a payload of up to 2,000 kg. Although certified for single pilot operation, two pilots were on board at the time to allow the second pilot to accumulate ICUS flight time.

Landing gear system

Normal operation

The landing gear was electrically controlled through a selector handle on the centre pedestal and hydraulically powered with each landing gear containing two hydraulic actuators. Both hydraulic actuators were activated for retraction of the gear with only one actuator for each gear used for extension. Movement of the landing gear handle to up or down, energised solenoids on the selector valve, which in turn moved a shuttle valve to port hydraulic fluid under pressure to retract or extend the gear actuators (Figure 2). Once extended, the gear was locked into place mechanically by an over-centre condition of the drag braces. Unlocking the gear from either the retracted or extended position was by movement of the actuators.

Figure 2: Landing gear hydraulic system



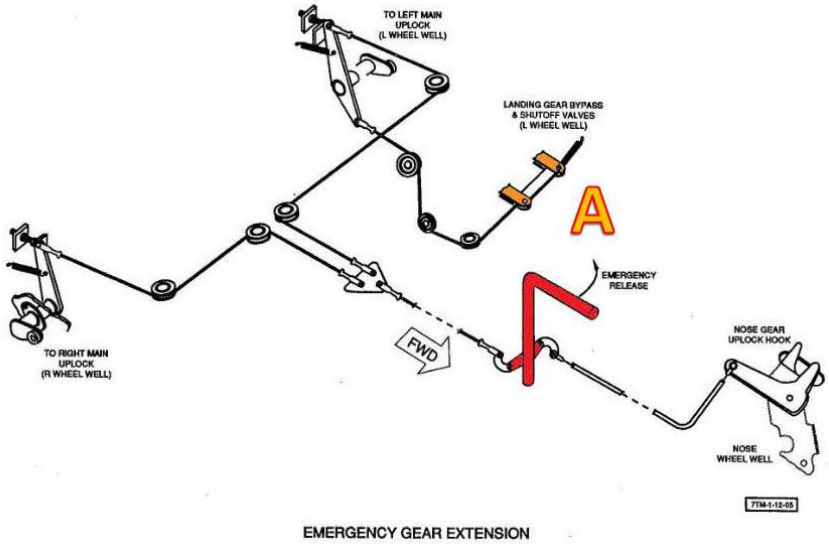
Source: Toll Aviation Pty Ltd (modified by the ATSB)

Emergency extension

In the event that the landing gear failed to extend under normal selection, a provision for emergency extension was available. That system incorporated an emergency release lever, shut-off and bypass valves, an emergency hand pump and an emergency gear selector (referred to in the QRH as the hand pump valve handle).

Rotation of the emergency release lever mechanically released the landing gear up-locks and positioned the shut-off and bypass valves (item 'A' Figures 2 and 3). This isolated the normal selector valve and allowed hydraulic fluid within the retract side of the system to return to the reservoir (Figure 3). Completion of that action should allow the landing gear to gravity freefall. The emergency gear selector, when rotated to the 'emergency gear' position, directed reservoir fluid to the emergency hand pump, which could then be used to increase pressure on the extend side of the landing gear actuators to assist in moving the gear to the fully locked down condition.

Figure 3: Landing gear emergency extension



Source: Toll Aviation Pty Ltd (modified by the ATSB)

Initial examination and testing

Following the occurrence the aircraft was moved to a hanger where it was placed on jacks and examined under the supervision of the Australian Transport Safety Bureau (ATSB). An initial examination of the cockpit revealed that the landing gear handle was in the 'down' position.

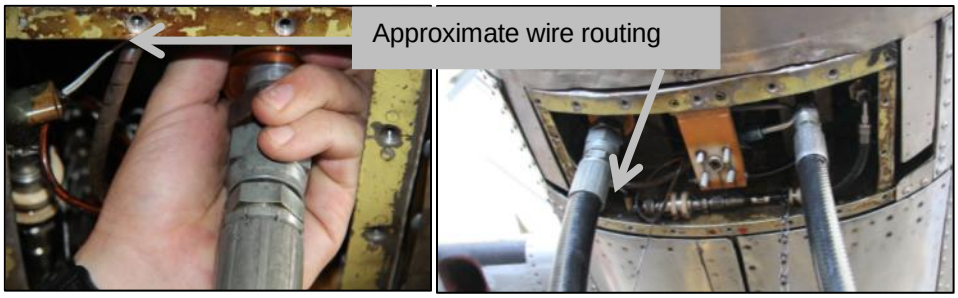
The landing gear system was tested while the aircraft was on the jacks. With electrical and hydraulic power off, the landing gear extended when the emergency release lever was rotated rearward. The nose gear extended to its full lock position; however, the main gears required maintenance personnel to apply a light force to fully lock down, which was considered normal when the gear is extended with no forward airspeed.

The emergency release lever was then stowed and the landing gear handle selected to the 'up' position. On applying electrical and external hydraulic power the gear retracted. The landing gear handle was then selected to the 'down' position but the gear did not extend.

Examination of the aircraft found that an electrical wire to the down selection on the landing gear (normal) selector valve had separated at the connector adjacent to its terminal. Once repaired, normal operation of the landing gear resumed.

The wiring loom that contained the separated wire was located in the vicinity of the external hydraulic connectors in the left engine nacelle below the hydraulic power pack. On examination, it was confirmed that normal connection and disconnection of the external hydraulic rig would have brought the hand of the engineer performing the task in contact with the wiring loom (Figure 4).

Figure 4: Hydraulic rig connection



Source: ATSB

Microscopic examination of the broken wire indicated that its strands contained a combination of low-cycle fatigue and ductile overstress. The low cycle fatigue was consistent with forward and rearward cyclic movement of the wire over time leading to fracturing of the outer strands. The ductile overstress present on the inner core strands was consistent with them having undergone tensile loading such as being wrenched or pulled.

The separated wire should not have prevented the extension of the landing gear in the emergency extension mode. As a result, additional examination and ground testing of the system was conducted to determine why the emergency extension had not functioned in flight.

Further ground testing

Additional ground testing included QRH procedures 4.5 *Landing gear fails to extend*, 4.6 *Landing gear emergency extension* and the *ADDITIONAL PROCEDURE.* During the tests, external electrical and hydraulic power was used with the aircraft configured to simulate as close as possible the in-flight conditions at the time of the occurrence. The separated electrical wire was not repaired prior to these tests.

Completion of QRH procedure 4.5 *Landing gear fails to extend* confirmed that the Gear Control circuit breakers were serviceable and that selection between the left and right essential electrical busbars was operational. QRH procedure 4.6 *Landing gear emergency extension* was completed

and the landing gear released in the emergency extension mode, with a positive down and locked indication achieved after actuation of the emergency hand pump.

As the emergency extension system worked as designed when the QRH procedures were followed, a number of out of sequence procedures were carried out in an attempt to determine whether the in-flight failure may have been due to the actions of the flight crew. These variations incorporated the incorrect positioning of the emergency release lever and the landing gear handle, and the isolation of the left and right landing gear control circuit breakers.

The out of sequence procedures demonstrated that, on the ground using external hydraulic and electrical power, with all circuit breakers closed, the landing gear could be fully extended to the down and locked position whenever the landing gear handle was selected to the 'down' position. In some sequences, use of the emergency hand pump was required to achieve the locked status.

When an out of sequence 'up' selection of the landing gear handle was made, the landing gear was able to be released from its 'up' position. However, it could not subsequently be fully extended or locked in the 'down' position.

With electrical and hydraulic power removed in emergency extension mode, the gear was able to freefall and be pumped to the down and locked position regardless of whether the landing gear handle was selected to the 'up' or 'down' position. It was also determined that the emergency extension functioned correctly when the hydraulic system was depressurised or with electrical power isolated from the system.

Following completion of the additional ground tests, the aircraft maintenance manual (AMM): *Operational Check - Emergency Mode* and the *Functional Test - Emergency Release System* procedures were carried out. Part of those procedures included positioning the landing gear handle to the 'up' position during emergency extension to confirm correct function of the by-pass and shut-off valves. The landing gear failed to extend to the down and locked position during this procedure.

As a result of that failure, a rigging check of the landing gear and emergency extension system was carried out. This revealed an out of limits low tension on the cable between the left up-lock release bell crank and the power pack. The low cable tension did not allow full actuation of the shut-off and by-pass valves, preventing the landing gear actuators up lines from completely depressurising. Therefore, system pressure was still able to be applied to the retract side of landing gear actuators when in the emergency extension mode with the landing gear handle in the 'up' position.

Landing gear maintenance history

The most recent maintenance work on the landing gear was conducted on 5 February 2012, about 20 flight hours before the occurrence. That maintenance formed part of a *Phase 3 – SA227AC* inspection and included functional testing, detailed inspection and service checks of the landing gear. Inspection of the engine nacelles and hydraulic power pack were also incorporated within the maintenance procedures.

During the maintenance, a number of landing gear defects were identified and rectified, including:

- the outboard up-lock switch was found loose and repaired
- replacement of the left main gear down-lock switch and repair of the switch wiring
- the left main landing gear doors were adjusted
- the left and right main landing gear drag brace pins were replaced.

The Phase 3 inspection also included a rigging check of the landing gear and an emergency mode functional test, neither of which resulted in defects being identified. The emergency mode functional test required hydraulic power be applied to the aircraft at the time the emergency release lever was operated to ensure correct bypass and shut-off valve operation. Failure to apply

hydraulic power during the test would prevent diagnosis of an incorrect rigging condition or inadequate operation of the valves.

Previous maintenance on the landing gear emergency extension system was conducted on 1 August 2011 and included the replacement of the selector valve due to leaks from the landing gear handle. That maintenance procedure also required an emergency mode functional check. A table showing maintenance work carried out on the aircraft's landing gear between 13 January 2011 and 5 February 2012 is provided in appendix A.

Previous landing gear incidents involving VH-UZA

On 7 November 2008, the aircraft's landing gear failed to retract after take-off from Brisbane and the crew conducted a low fly-past before electing to return to the airport and landing safely. A subsequent engineering inspection identified a broken wire to the 'up' selection of the landing gear's (normal) selector valve. The broken wire in that instance was situated adjacent to the wire that separated during this occurrence in 2012.

On 19 December 2009, the then crew of the aircraft reported nose gear problems on two consecutive sectors. In both cases, when the landing gear was selected 'up' after take-off, the nose gear failed to fully retract, and the cockpit indication displayed a red transit light. The landing gear was cycled resulting in full retraction. Engineering checks were unable to reproduce the error on the ground and no defects were identified.

Similar incidents involving other Metro aircraft

A review of occurrences reported to the ATSB during the period 1997 to 2013 involving Metro aircraft found no similar incidents.

Operational information

Quick reference handbook

The operator's quick reference handbook (QRH) closely followed the US Federal Aviation Administration (FAA)-approved Airplane Flight Manual (AFM) but also contained a large amount of explanatory information in the form of notes embedded within the checklists. Some checklists required reference to previous steps, which disrupted smooth transition through the process.

QRH procedure 4.5 *Landing Gear Fails to Extend* (refer to appendix B) required the crew to check circuit breakers and electrical bus tie breakers before recycling the normal gear handle to 'down'. If one or more gear remained unlocked (red lights) after recycling, the procedure allowed for one additional cycle of the landing gear handle before continuing on to procedure 4.6 *Emergency Gear Extension*. Procedure 4.6, item 2 required the landing gear handle to remain in the 'down' position before emergency extension was actioned.

If procedure 4.6 did not extend the gear, the QRH provided an *ADDITIONAL PROCEDURE* to extend the gear. If a second application of this procedure was also unsuccessful, several of the checklist items were to be carried out a third time, including selecting the landing gear handle to the 'up' position.

If the landing gear did not fully extend after carrying out this sequence of procedures, the QRH included a 4.7 *Gear-up Landing* procedure. This procedure did not cross reference the landing gear handle, or emergency extension system lever or selector positions (refer appendix B).

The QRH emergency extension procedures did not include actions to isolate electrical power to the selector solenoids, or to remove hydraulic pressure should the emergency extension procedure fail to operate due to hydraulic up line pressure or a hydraulic lock.

Flight operations manual

Part 10 of the operator's Flight Operations Manual related to emergency and abnormal procedures. Chapter 4, procedure10-4-6 *Low Fly-past* stated:

> It is unlikely that a low fly-past of a control tower will add much to the information derived from the flight deck indications. A low fly-past should only be undertaken when there is good reason to believe that knowledge of the state of the undercarriage, wheels, tyres etc can be improved by such a manoeuvre.

Crew resource management

The operator's freight operations were normally conducted by a single pilot. However, the availability of the second pilot on the occurrence flight provided an additional resource to assist in diagnosing the landing gear fault and conduct of the wheels-up landing. While managing the landing gear problem, the crew adopted an effective two crew operation with the PIC assuming control and the ICUS pilot acting in a supportive role.

The benefits of this crew resource management-based approach was demonstrated through the efficient completion of duties including monitoring fuel, completing checklists and preparation of the cabin for the wheels-up landing. The crew worked collaboratively throughout the flight, discussing and determining who would perform which actions during the latter stages of the approach and when the aircraft stopped. The crew also discussed the QRH checklist guidance regarding feathering the propellers and the timing of the engine shut downs, apportioning responsibilities between themselves.

Flight recorders

The aircraft was fitted with a Fairchild model F1000 flight data recorder (FDR) and a Fairchild model A100A cockpit voice recorder (CVR). Each was downloaded by the ATSB.

Flight data recorder

Data relating to the occurrence was not included in the recovered data. During subsequent testing, the FDR was allowed to record for a period of time to establish serviceability and that data was captured. The reason for the lack of occurrence flight data could not be determined; however, it was possible that an in-situ power supply failure had occurred.

Cockpit voice recorder

The occurrence flight audio data was recorded on two of the CVR's four available channels; the pilot's and cockpit area microphone (CAM) channels. The recording was of about 30-minutes duration and commenced after the landing gear failure and the QRH landing gear procedures were underway. This prevented confirmation of the crew's actions prior to their attempts to retract the landing gear as part of the *ADDITIONAL PROCEDURE*.

The CVR recorded the crew undertaking multiple ad hoc attempts to extend the landing gear including discussions to 'leave [the] gear down, put everything else back to normal' and to 'put the handle up and down'. After these unsuccessful attempts, the PIC requested the ICUS pilot to read out the 4.7 *Gear-up landing* procedure, which was actioned by the crew. As that procedure did not include the landing gear handle position, neither crew referred to the handle position while actioning the checklist items.

Organisational and management information

Operator's maintenance procedures and documentation

Aircraft maintenance manual

An internal operator review of the 32-00-00 LANDING GEAR – MAINTENANCE PRACTICES - *Inspection/Check - Landing Gear* procedure found that it contained a number of

inconsistencies. This included the use of differing terminology for equipment and components, which could lead to confusion if maintenance personnel were unfamiliar with the aircraft's landing gear system. The operator also found that some steps of the procedure could not be readily achieved. For example, step 22 of the procedure required personnel to verify that the hydraulic pressure was released from the actuators prior to, or simultaneous with the release of the gear up-locks on rotation the emergency release lever.

Procedural instructions were also found by the operator to be incorrect with regard to the operating sequence of the emergency release lever. In one instance, step 28 required the lever to be rotated completely rearward, whereas the next reference to the lever was step 34, which required it to be rotated to the (rearward) emergency position.

Procedure 32-30-00, LANDING GEAR RETRACTION AND EXTENSION – MAINTENANCE PRACTICES – step F *Emergency release System – Adjustment,* was the only procedure available for rigging the emergency extension system cables. The procedure; however, was not precise in its instruction. For example, while clearance tolerances were provided for certain components in the system, the process for setting up the bypass valves stated that 'With the bypass valve in [the] normal position, adjust cable tension to provide proper operation'.

Phase inspection manual

The ATSB found that there were inconsistencies between the maintenance requirements listed in the manufacturer's Phase Inspection Manual (PIM) checklists and the maintenance procedures detailed within the Aircraft Maintenance Manual (AMM). In one case, the scheduled landing gear checks in the PIM did not directly correlate, either by title or Air Transport Association (ATA) reference and paragraph number, to inspections and procedures listed in the AMM. As a result operators were left to make assumptions as to the level and detail of the required inspection.

Work sheets

The operator's scheduled (phase) maintenance inspection work sheets were based primarily on the manufacturer's PIM with the landing gear inspection and functional checks in the work sheets using identical wording to that in the PIM. Certification of scheduled maintenance was made on separate maintenance and certification work sheets.

Maintenance practices

During an internal investigation by the operator, it became apparent that maintenance documents required to complete scheduled tests and procedures were not immediately available to maintenance personnel and, as a result, they were often not referred to in the work place. Personnel also reported they felt under time pressure to complete maintenance work and had to contend with discontinuity from multiple shift handovers and the use of short-term contracted labour.

When discussing the landing gear function check procedure that was performed as part of the Phase 3 inspection, personnel had no clear recollection of specific check actions carried out. It became apparent to the operator that while familiar with the aircraft systems, the maintenance personnel lacked an understanding of the relevance of the specific steps within the procedures or the underlying purpose of these checks.

As a result of its investigation, the operator checked the landing gear system of its Metro aircraft fleet and found that five out of the eight aircraft contained defects. These defects were readily apparent during functional checks when completed strictly in accordance with the AMM procedure. Despite defects being identified on a number of aircraft, in the interim none of the defects resulted in any of the affected aircraft's landing gear failing to extend.

Regulatory oversight

In 2011 Civil Aviation Safety Authority (CASA) inspectors conducted a routine audit of the operator's maintenance division and made the following finding:

> Issues were found in the areas of Documentation Currency, Maintenance Certification, Maintenance Facilities/Tooling/ Equipment Management & Control, Training and Quality Assurance. In total fifteen findings were issued consisting of seven Requests For Corrective Actions (RCA) and eight Audit Observations. No Safety Alert (SA) was raised…The auditors considered the current maintenance activities conducted by [the operator] to be satisfactory. However, it was noted that similar types of deficiencies particularly in relation to training identified from previous audits was again found at this audit. Analysis of audit data also found "organisational management" types of deficiencies reoccurring.

In September 2012, 7 months after the occurrence involving VH-UZA, CASA inspectors conducted a further routine audit and made the following findings:

> The surveillance team found [the operator] to be running a lean operation, which would sometimes hinder their ability to operate as effectively as desired… The surveillance team also found that many documented processes were either not present or not being followed. Informal processes had been introduced, diverting from the manual requirements as published. This was found in all disciplines audited…
>
> In summary, the inspectors found that while the relevant regulatory requirements were mostly being achieved, Senior Management needed to be more accountable, responsible and proactive in reviewing and supporting infrastructure to ensure ongoing compliance and performance and that necessary improvements were made where required.

At the time of the audits, the class of operation being conducted did not necessitate the operator having a safety management system (SMS) under any regulatory requirements. However, as the operator had an SMS, it became subject to the audits. CASA inspectors found deficiencies in the application of the SMS and a number of non-conformance notices (NCN) were issued that required the operator to take remedial action. The operator subsequently provided evidence to CASA of remedial action to address the RCA's and NCN's, which included greater control of documentation and an improved SMS.

Safety analysis

Introduction

The failure of the landing gear to extend in both normal and emergency modes led to the flight crew having to land the aircraft in a wheels-up configuration on runway 19 at Brisbane Airport. This analysis will examine a number of operational considerations, possible landing gear extension failure scenarios, maintenance issues and organisational factors with the potential to have affected the flight.

Operational considerations

General

The crew were appropriately qualified for the flight and reported that they were not affected by fatigue. They reported following the relevant quick reference handbook (QRH) procedures and, when these procedures failed to extend the landing gear, communicated with company maintenance personnel to determine if there were any additional courses of action that could be taken.

The cockpit voice recorder (CVR) audio commenced part way through the crew's response to the occurrence and showed multiple ad hoc attempts at extending the landing gear, followed by completion of QRH procedure 4.7 *Gear-up Landing.* These actions were interrupted by a number of radio transmissions and other tasks. The CVR data confirmed that the crew cycled the landing gear handle and emergency release lever and that the landing gear handle was in the 'down' position on at least one occasion while the landing gear was in the emergency extension mode. The CVR data also confirmed that the landing gear handle was in the 'down' position for the gear-up landing.

Quick reference handbook procedures

While the crew followed QRH procedure 4.7 *Gear-up Landing*, the lack of reference to checking/confirming the position of the landing gear handle in that procedure placed sole reliance on the preceding *ADDITIONAL PROCEDURE* for ensuring that the selected handle position was correct. The lack of this check in procedure 4.7 was a missed opportunity for the crew to identify that the handle position was in the incorrect ('down') position for the landing.

Crew resource management

During emergency situations, where decision making can determine the outcome of an occurrence, it is essential that those making decisions access and evaluate all available sources of information. While the operator's flight operations manual did not generally advocate a low fly-past of the airfield, that action by the flight crew provided for independent confirmation that the landing gear was stowed with the gear doors closed prior to them committing to the wheels-up landing.

The second pilot, who was acting in command under supervision (ICUS), was effectively utilised during the emergency with both crew working collaboratively to ensure the best result. The well-informed, -planned and -coordinated approach taken by the crew during the latter stages of the flight contributed to a smooth, controlled touchdown and minimal damage to the aircraft.

Maintenance considerations

Phase 3 inspection

The *Phase 3 – SA227* inspection incorporated pressurising the hydraulic system and provided an opportunity to identify the out of rig emergency extension system but this defect was missed by

maintenance personnel. The reason for this omission may have been the lack of clarity in the maintenance manual's rigging procedure, or a combination of a lack of adherence to the maintenance manual landing gear functional check procedure and the limited systems knowledge of the maintenance personnel. Had the maintenance personnel carried out an emergency release functional check during the phase 3 inspection with the hydraulic system pressurised, the incorrect operation of the by-pass and shut-off valves should have been identified. This would have alerted maintenance personnel to the need to rectify the rigging fault and the emergency extension system would likely have operated correctly during the flight.

Selector valve wire

The low-cycle fatigue and ductile overstress failure of the landing gear selector valve electrical wire was consistent with its forward and aft movement and tensile loading. The proximity of the external hydraulic power connector to this wire, and periodic connection/disconnection of the external hydraulic unit within a confined space provided a mechanism for such movement. Once initiated, in-service vibration and flexing could have exacerbated the weakening of the wire, contributing to the eventual failure. This scenario is supported by the November 2008 'up' solenoid wire failure, with that wire in similar proximity to the hydraulic connector points.

The phase 3 zonal and specific inspections in the area of the hydraulic power pack provided an opportunity to examine the area of the failed wire loom in the left nacelle. However, due to the nature and location of the damage to the wire, it was unlikely that the defect would have been detected until separation of the wire.

The operator has since significantly reduced the likelihood of further damage to the landing gear selector valve's electrical harness wires in its Metro aircraft by re-routing the harness to provide greater clearance from the external hydraulic connectors. The aircraft manufacturer also provided guidance to all Metro operators on re-routing the landing gear selector valve electrical harness.

Maintenance culture

The operator conducted interviews with relevant maintenance personnel who reported that they were working under pressure to meet deadlines and that prescribed maintenance procedures were not readily available or utilised. This was supported by the findings of the operator's fleet-wide aircraft check following this occurrence, which indicated a failure to use the appropriate maintenance procedure for the landing gear functional check had been common place. When combined with the maintenance personnel's reported limited understanding of the specifics of the system checks and tests, the likelihood of unserviceable components or inadequate system operation not being identified was increased.

The ATSB found that these practices by a number of maintenance personnel resulted in missed opportunities to identify the out of rig emergency extension system and the incorrect actuation of the by-pass and shut-off valves.

Landing gear system failure

General

An analysis of the landing gear hydraulic and emergency extension system concluded that the landing gear would not fully extend when any of the following conditions existed:

- There was a failure of electrical supply to the landing gear down solenoid when the landing gear handle was in the 'down' position.
- There was incomplete actuation of the emergency gear shut-off and bypass valves on rotation of the emergency release lever to the emergency position.
- Hydraulic pressure was present at the gear–up port of the (normal) selector valve during attempted emergency extension.

Normal operation

The weakened wire to the selector valve that separated sometime during the flight was confirmed to be part of the landing gear down circuit. The resulting loss of electrical power to the down solenoid explained the failure of the landing gear to extend when the crew first selected the landing gear handle to the 'down' position as part of their normal procedures for the approach and landing at Brisbane. This required the crew to revert to the available emergency procedures to extend the gear.

Emergency operation

During ground testing using external electrical and hydraulic power, the landing gear was able to be fully extended and locked down when the QRH emergency procedures were followed or whenever the landing gear handle was placed in the 'down' position with the gear control circuit breakers closed. When the emergency gear extension was activated with the landing gear handle set to the 'up' position, the landing gear only partially extended, irrespective of circuit breaker position.

The ground testing also determined that when electrical or hydraulic power was removed from the aircraft, the landing gear was able to be fully extended and locked with the landing gear handle in either the 'up' or 'down' position. However, the QRH emergency procedures did not include checklist steps for the removal of electrical or hydraulic power.

The out of rig emergency extension system cable resulted in only partial actuation of the shut-off and bypass valves. This resulted in residual hydraulic pressure in the retract side of the landing gear actuators, and restriction of fluid flow through the return lines on emergency extension selection with the landing gear handle in the 'down' position. With the landing gear handle set to the 'up' position during emergency extension, continuous (but restricted) hydraulic pressure would have been applied to the retract side of the actuators, with relief of that pressure being reliant on hydraulic supply and the level of actuation of the by-pass and shut-off valves. In either case, the out of rig emergency extension system cable would have affected the freefall capability of the landing gear. Successful emergency extension of the landing gear relied on this freefall capability.

An additional effect of the partial actuation of the shut-off and bypass valves was a higher level of resistance during operation of the emergency hand pump. This is consistent with the crew report of significant resistance when operating the emergency hand pump during the emergency extension procedure.

The apparent inconsistency between the operation in flight of the emergency extension system and its operation during post-occurrence ground testing was probably due to the aircraft's in-flight configuration, the out of sequence operation of the landing gear handle, or a combination of these factors.

Crew actions

The CVR recorded the crew cycling the landing gear handle during the occurrence. The last CVR-recorded (audible) movement of the landing gear handle was to the 'down' position, which corresponded with the as-found position after landing. Accordingly, the possibility that the landing gear did not extend during the emergency extension procedure due to the handle being in the 'up' position was not a factor in the occurrence. While the reason for the crew's inability to fully extend the gear in-flight could not be positively determined, it most likely would have been a consequence of the partial actuation of the shut-off and bypass valves.

Organisational/manufacturer considerations

The inconsistencies in the operational and maintenance documentation published by the manufacturer increased the potential for error in the application of procedures. Clearer documentation may have increased the correct application by maintenance personnel of the

landing gear functional check and ensured that crews confirmed that the landing gear handle was selected to the ‘up’ position prior to conducting a gear-up landing.

The ground tests conducted after the occurrence indicated that, despite the landing gear handle position or the out of rig condition of the emergency extension system, relieving the hydraulic pressure or isolating electrical power from the selector valve solenoids assisted the freefall of the landing gear. It is likely that the inclusion of additional steps in the relevant QRH procedures to isolate the electrical power and/or hydraulic pressure, would have assisted the successful extension of the landing gear in this occurrence.

Findings

From the evidence available, the following findings are made with respect to the wheels-up landing accident involving Fairchild SA227-AT Metro III aircraft, registered VH-UZA that occurred at Brisbane Airport, Queensland on 15 February 2012 and should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing factors

- **The proximity of the landing gear selector valve electrical wiring loom to the external hydraulic power connectors within the left engine nacelle on Fairchild SA227-AT Metro aircraft resulted in the 'down selection' wire being damaged during routine maintenance activities [Safety issue].**
- The separation of the 'down selection' wire interrupted the supply of electrical power to the down solenoid, preventing extension of the landing gear in the normal operating mode.
- The maintenance practices by a number of personnel prior to the occurrence resulted in missed opportunities to identify an out of rig cable within the landing gear emergency extension system.
- The landing gear did not extend in the emergency extension mode in-flight due to the out of rig cable preventing correct actuation of the by-pass and shut-off valves.
- The flight crew were unable to extend the landing gear using the normal and emergency extension procedures, resulting in the need for a gear-up landing.

Other factors that increased risk

- The manufacturer's operational and maintenance documentation suite contained inconsistencies in some procedures.

Other findings

- The crew conducted the emergency procedures to extend the landing gear in a manner that should have allowed the landing gear to extend.
- The low-level fly-past provided for independent confirmation that the landing gear was fully retracted and the gear doors closed.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and 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 directly involved parties were provided with 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.

Routing of landing gear selector valve electrical harness

Number:	**AO-2012-024-SI-01**
Issue owner:	Elbit Systems of America
Operation type:	Aircraft manufacturer
Who it affects:	All owners and operators of SA227 aircraft

Safety issue description:

The proximity of the landing gear selector valve electrical wiring loom to the external hydraulic power connectors within the left engine nacelle on Fairchild SA227-AT Metro aircraft resulted in the ‘down selection’ wire being damaged during routine maintenance activities.

Proactive safety action taken by: Elbit Systems of America

Action number: AO-2012-024-NSA-036

Elbit Systems of America advised that, as a result of this occurrence, re-routing of the landing gear selector valve electrical wiring loom in the worldwide Metro aircraft fleet has been implemented. A *Metro Global* advisory publication has also been distributed to all Metro operators advising the new routing requirements.

ATSB comment/action in response:

The ATSB welcomes the action by Elbit Systems of America to re-route the landing gear selector valve electrical wiring loom in Metro aircraft and advise operators of this new requirement.

Proactive safety action taken by: Toll Aviation Pty Ltd

Action number: AO-2012-024-NSA-037

As a result of this occurrence, Toll Aviation Pty Ltd re-routed the landing gear selector valve electrical wiring loom within the left nacelle of its Metro III/23 aircraft to minimise the risk of damage to the wires during routine maintenance.

ATSB comment/action in response:

The ATSB acknowledges the action taken by Toll Aviation Pty Ltd to re-route the landing gear selector valve electrical wiring loom within the left nacelle of its Metro III/23 aircraft, reducing the risk of damage to these wires during routine maintenance.

Current status of the safety issue:

Issue status: Adequately addressed.

Justification: The ATSB is satisfied that the action by Elbit Systems of America to re-route the landing gear selector valve electrical wiring loom in the worldwide fleet of Metro aircraft, and advise operators of this new requirement will, when implemented across the fleet, minimise the risk of damage to the wires during routine maintenance. The proactive safety action by Toll Aviation Pty Ltd pre-empts this action.

Additional safety action

Whether or not the ATSB identifies any safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Elbit Systems of America

Elbit Systems of America has advised that it has commenced a review and comparison of the Landing Gear section of the Metro III/23 Aircraft Maintenance Manual (AMM) with the Phase Inspection Manual and other documented engineering procedures. This work is being undertaken to ensure that there are no conflicts in these publications regarding the requirements of the landing gear functional check. Operators will be advised of any amendments to these publications arising from this review.

Toll Aviation Pty Ltd

As a result of its own investigation of this occurrence, Toll Aviation Pty Ltd identified a number of additional deficiencies within the operational and maintenance divisions of the organisation. In response, the following local safety actions were taken:

- The Metro III/23 quick reference handbook procedure *4.7 Gear-up Landing* was reviewed regarding the position of the landing gear handle, the emergency release lever and the emergency gear selector. An amended procedure is planned for incorporation in the quick reference handbook in late 2014.
- The Metro III/23 Phase 3 Check Worksheets were amended to include details of specific inspections to be carried out as part of the landing gear functional check.
- An engineering memorandum was issued to all aircraft maintenance personnel detailing the operator's requirements with regards to following standard procedures and approved data for maintenance tasks.

General details

Occurrence details

Date and time:	15 February 2012 – 0230 EST	
Occurrence category:	Accident	
Primary occurrence type:	Wheels-up landing	
Location:	Brisbane Airport, Queensland	
	Longitude: S 27º 23.05'	Latitude: E 153º 07.05'

Aircraft details

Manufacturer and model:	Fairchild Industries Inc,[2] SA227-AT Metro III	
Registration:	VH-UZA	
Operator:	Toll Aviation Pty Ltd	
Serial number:	AT-502	
Type of operation:	Charter – Test and ferry	
Persons on board:	Crew – 2	Passengers – Nil
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Substantial	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- flight crew
- aircraft operator
- aircraft manufacturer.

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, the aircraft operator, the aircraft manufacturer, the Civil Aviation Safety Authority and the US National Transportation Safety Board. Submissions were received from the flight crew, the aircraft operator and the aircraft manufacturer. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Appendices

Appendix A – VH-UZA previous landing gear maintenance 2011-2012

Date	Total Time In Service	Maintenance completed
13 January 2011	25,187.4 hours	Nose landing gear wound not retract, recycled three times with no effect, checked manual hand pump valve, confirmed fully AFT with no effect. Nose landing gear uplock switch replaced. Aircraft jacked in accordance with (IAW) Aircraft Maintenance Manual (AMM) 07-10-00 for functional check and aircraft de-jacked IAW AMM 07-10-00.
2 February 2011	25,227.6 hours	Main landing gear bell crank bushes and bolts worn excessively, removed and replaced. Right side gear door actuator contacting drag brace, gear door actuator removed and replaced. Inboard right side main landing gear DOWN cable worn, new cable and springs installed. Aircraft jacked IAW AMM 07-10-00 for functional check and aircraft de-jacked IAW AMM 07-10-00.
17 February 2011	25,227.6 hours	Right side main landing gear actuators reinstalled following eddy current inspection. Aircraft jacked IAW AMM 07-10-00 for functional check and aircraft de-jacked IAW AMM 07-10-00.
25 March 2011	25,315.2 hours	All landing gear hydraulic flexible lines and emergency release flexible lines replaced, functional (retraction and extension) and leak check completed.
15 April 2011	25,373.0 hours	Left hand main landing gear outboard downlock switch damaged during sheet metal repairs. Inspection confirmed two wires chaffed through to conductor. Switch S316 replaced, switch adjusted. Aircraft jacked IAW AMM 07-10-00 for functional check and aircraft de-jacked IAW AMM 07-10-00.
16 April 2011	25,373.0 hours	Nose landing gear uplock left side rod upper rod end damaged, rod end replaced. Aircraft jacked IAW AMM 07-10-00 for functional check and aircraft de-jacked IAW AMM 07-10-00.
5 June 2011	25,515.8 hours	Aircraft jacked IAW AMM 07-10-00 for landing gear inspection functional check, and aircraft de-jacked IAW AMM 07-10-00.
1 August 2011	25,664.8 hours	Aircraft jacked IAW AMM 07-10-00 for landing gear inspection and functional check and aircraft de-jacked IAW AMM 07-10-00. Landing gear emergency release lever leaking from selector handle (identified

Date	Total Time In Service	Maintenance completed
		18 July 2012), removed and replaced valve, functional (retraction and extension) and leak check completed.
6 November 2011	25,962.0 hours	Left main landing gear uplock spring cable pulley broken, removed and replaced.
5 February 2012	26,259.8 hours	Main landing gear rigging checked, nil faults found. Outboard uplock switch found loose and repaired. Left side down lock switch replaced. Downlock switch wire repaired. Left side main landing gear doors adjusted. Left and right main landing gear drag brace pins replaced. Aircraft jacked IAW AMM 07-10-00, work completed and aircraft de-jacked IAW AMM 07-10-00.

Appendix B – Quick reference handbook

4.5 Landing gear fails to extend

Condition	Landing gear does not fully extend; one or more red 'in transit' lights remain illuminated.
Objective	Extend landing gear.

■ **No response to gear down selection**

1. Gear Control Circuit Breaker ..... Check
2. Gear Control Bus Tie Switch ..... Select right essential bus

► **If gear now extends**

–End Drill–

► **Gear still does not extend**

1. Emergency Gear Extension (HYDR-8) ..... Complete

■ **One or more gear do not lock down (red lights)**

1. Gear ..... Recycle once only

► **If gear now extends**

–End Drill–

► **Gear still does not extend**

1. Emergency Gear Extension Procedure ..... Complete

End of Drill

Further Actions	**Gear still does not extend**: ► Landing gear emergency extension (HYDR-8)
References	**MIII**: AFM 6-68 to 6-72 **M23:** AFM 6B-30 to 6B-35

4.6 Landing gear emergency extension

Condition	Landing gear does not fully extend using normal procedures.
Objective	Extend the landing gear.

*** Warning ***
Hydraulic pressure to the nose wheel steering system will not be available following landing gear emergency extension required by either hydraulic failures or gear position selector valve electrical failures. Do not arm nose wheel steering .

1. Airspeed ..... 175 KIAS maximum
2. Landing Gear Handle ..... Down
3. Emergency Release Lever ..... Rotate aft
4. Hand Pump Valve Handle ..... Pull pip pin
   ..... rotate valve 90 deg foward

Note:
Strong resistance to pump handle motion gives sufficient pressure (500 to 800 PSI) to insure gear security in addition to the mechanical downlocks.

Note:
If manual extension is used because of a failure in the landing gear electrical control system, the hydraulic pressure gauge will continue to indicate approximately 2,000 PSI system pressure. In this case, the pressure to the gear down actuators can be detected only by the effort required to move the emergency hand pump.

Note:
If a failure at the bottom of the hydraulic pack allows depletion of all hydraulic fluid, the emergency hand pump will not provide pressure. Nevertheless, step 3 above will allow the landing gear to free fall to a safe, down and locked position .

5. Emergency Hand Pump ..... Pump as required
6. Landing Gear Indicator ..... Confirm all down and locked

■ **Gear down (3 green)**

–End Drill–

■ **Gear does not extend after completing emergency extension**
–ADDITIONAL PROCEDURE–

Note:
If the gear does not extend **following the emergency extension procedure**, the following additional procedure **may** allow the gear to extend.

Extending the landing gear in this manner requires that the aircraft be slowed to a minimum safe airspeed. Therefore, this procedure must be performed at high enough altitude to ensure safe flight operation.

1. Gear ..... Retract

► **If the landing gear will not retract**

1. Hand Pump Valve Handle ..... Check normal position
2. Gear Emergency Release Lever . Check normal position

2. Flaps ..... Full down
3. Airspeed ..... Slow the aircraft ..... to just above the flight idle stall speed
4. Landing Gear Handle ..... Down position

► **Gear down (3 green)**

–End Drill–

► **Gear does not extend after additional procedure**

1. Additional Procedure ..... Repeat all steps

► **Gear does not extend after SECOND application of additional procedure**

1. Additional Procedure ..... Complete items 1. to 3.
2. Emergency Release Lever ..... Rotate aft
3. Hand Pump Valve Handle ..... Pull pip pin ..... rotate valve 90 deg foward
4. Emergency Hand Pump ..... Pump as required

Note:
If gear is unable to be extended following completion of this procedure then it is likely that a gear up landing will be required. See (HYDR-10).

End of Drill

Further Actions	**Gear will not extend**: ► Gear up landing (HYDR-10)
References	**MIII**: AFM 6-68 to 6-72 **M23:** AFM 6B-30 to 6B-35

4.7 Gear-up Landing

Condition	The landing gear is still not fully extended after completion of landing gear emergency extension procedure.
Objective	Execute a gear-up landing.

Note:

Historically, aircrafts of this class have received more airframe damage from gear up landings on sod than from landings on smooth, paved surfaces.

Propeller blades contacting the surface while turning under power tend to disintegrate and throw shrapnel which may puncture the fuselage. Blades contacting the surface when feathered, or nearly feathered, will bend slightly and wear away but most likely will not shatter and will aid in holding the wings and nacelles off the runway.

The pilot may choose to feather one propeller early and save the other engine for last minute glide path corrections. During approaches with one main gear up and one down, it is recommended that the propeller on the gear up side be feathered first. When a propeller is feathered with flight idle power set, drag will be reduced and gliding distances increased slightly.

After landing, expect the entrance door to operate normally with the exception that it will not open fully after landings with the nose or left main gear retracted.

■ **Landing with all 3 gear up**

1. Cabin ..... Depressurize
2. Escape Hatches ..... Consider removal
3. Briefing/Evacuation Plan ..... Review
4. Flaps ..... Full
5. Approach Speed ..... Normal **plus 5 to 10 KIAS**
6. Propellers ..... Feather when landing is assured

Note:

Leave electrical power on until just prior to touchdown to allow use of the pitch trim.

Leave batteries on during night landings to permit use of landing lights.

7. Electrical Power ..... Shut off just prior to touchdown
8. Allow aircraft to touch down in a relatively flat attitude and on centreline. Use rudder for directional control

–End Drill–

■ **Landing with nose gear up**

Note:
If the nose gear will not extend, land on the mains.

1. Cabin ..... Depressurize
2. Escape Hatches ..... Consider removal
3. Briefing/Evacuation Plan ..... Review
4. Flaps ..... Normal
5. Approach Speed ..... Normal
6. Propellers ..... Feather
   ..... When main gear has touched the runway

Note:
Leave batteries on during night landings to permit use of landing lights.

7. Electrical Power ..... Shut off
   ..... When main gear has touched the runway
8. Hold the nose of the aircraft off the runway as long as practical, but not so long that pitch control is lost.
   Put nose on runway gently rather than letting it drop to the runway

–End Drill–

■ **Landing with nose gear and one main gear extended**

Note:
If either main gear will not extend, land with all three gear up if possible.

1. Gear ..... Retract

► **Gear retracts**

1. "Landing with all 3 gear up" procedure ..... Perform

► **Gear does not retract normally**

1. Emergency Gear Release Level . Check normal position
2. Hand Pump Valve Handle .....Check normal position
3. Landing Gear Control Circuit Breaker ..... Check

► **Gear is unable to be retracted**

Note:
For a landing with nose gear and one main gear only, select the runway with the fewest obstructions and flattest terrain on the side of the unextended gear.

1. Cabin .....Depressurize
2. Escape Hatches .....Consider removal
3. Briefing/Evacuation Plan .....Review
4. Propellers .....Feather when landing is assured

Note:
Leave electrical power on until just prior to touchdown to allow use of the pitch trim. Leave batteries on during night landings to permit use of landing lights.

5. Electrical Power .....Shut off just prior to touchdown
6. Hold the wing with the unextended gear off the runway as long as possible.
   Expect the aircraft to turn into the low wing

–End Drill–

End of Drill

Further Actions	**Review**: ► Emergency Evacuation Checklist (OTH-9)
References	**MIII**: AFM 6-68 to 6-72 **M23:** AFM 6B-30 to 6B-35

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 it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

Wheels-up landing involving Fairchild SA227-AT Metro III
VH-UZA, Brisbane Airport, Queensland, 15 February 2012

AO-2012-024
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