Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Aviation Occurrence Report – 200404589
Final

Aircraft Loss of Control
Lake George, NSW
21 November 2004
VH-TAG
Fairchild Industries SA227-AC Metro III

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CONTENTS

THE AUSTRALIAN TRANSPORT SAFETY BUREAU vii

FACTUAL INFORMATION 1

Sequence of Events 1

Aircraft Systems Information 3

Previous Occurrences Involving Use of Beta Mode in Flight 5

Personnel Information 7

Organisational Information 9

Other Factual Information 11

ANALYSIS 13

FINDINGS 17

Contributing Safety Factors 17

Other Safety Factors 17

Other Key Findings 18

SAFETY ACTIONS 19

Aircraft Operator 19

Civil Aviation Safety Authority 19

Australian Transport Safety Bureau 20

Safety Recommendation 20

DOCUMENT RETRIEVAL INFORMATION

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Aircraft Loss of Control - Lake George – 21 November 2004

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Abstract

On 21 November 2004, the crew of a Fairchild Industries SA227-AC Metro III aircraft, registered VH-TAG, was conducting an endorsement training flight near Lake George, 33 km north-east of Canberra Airport. The flight included a planned in-flight engine shutdown and restart, conducted at an altitude below 4,500 ft (about 2,200 ft above ground level (AGL)). During the engine restart preparation, the instructor departed from the published procedure by moving the power lever for the left engine into the beta range and directing the pilot to select the unfeather test switch. These actions were appropriate to prepare an engine for start on the ground with a feathered propeller, but not during an airstart. As a result, the propeller on the left engine became fixed in the start-locks position. The crew lost control of the aircraft and it descended 1,000 ft, to about 450 ft AGL, before they regained control. The crew could not diagnose the source of the loss of control and proceeded to start the left engine while the propeller was fixed on the start-locks. As a result, the crew lost control of the aircraft for a second time and it descended 1,300 ft, to about 300 ft AGL, before they regained control. The SA226 / SA227 aircraft contain no lockout system to prevent pilots from intentionally moving the power lever into the beta range during flight. It was the first time the instructor had given a Metro endorsement and he was subject to time pressure to complete the endorsement. His ongoing difficulties in adapting to his employment tasks were not successfully dealt with by the operator. He had a limited understanding of the aircraft's engine and propeller systems, and had not practiced an airstart for 8 years as the CASA check and training approval did not include an assessment of all flight critical exercises.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

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. Accordingly, the ATSB also conducts investigations and studies of the transport system to identify underlying factors and trends that have the potential to adversely affect safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and, where applicable, relevant international agreements. The object of a safety investigation is to determine the circumstances to prevent other similar events. The results of these determinations form the basis for safety action, including recommendations where necessary. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations.

It is not the object of an investigation to determine blame or liability. However, it should be recognised that an investigation report must include factual material of sufficient weight to support the analysis and findings. That material will at times contain information reflecting on the performance of individuals and organisations, and how their actions may have contributed to the outcomes of the matter under investigation. 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.

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. While the Bureau issues recommendations to regulatory authorities, industry, or other agencies in order to address safety issues, its preference is for organisations to make safety enhancements during the course of an investigation. The Bureau is pleased to report positive safety action in its final reports rather than make formal recommendations. Recommendations may be issued in conjunction with ATSB reports or independently. A safety issue may lead to a number of similar recommendations, each issued to a different agency.

The ATSB does not have the resources to carry out a full cost-benefit analysis of each safety recommendation. The cost of a recommendation must be balanced against its benefits to safety, and transport safety involves the whole community. Such analysis is a matter for the body to which the recommendation is addressed (for example, the relevant regulatory authority in aviation, marine or rail in consultation with the industry).

FACTUAL INFORMATION[1]

On 21 November 2004, the crew of a Fairchild Industries SA227-AC Metro III (Metro) aircraft[2], registered VH-TAG, was conducting a training flight near Lake George, 33 km north-east of Canberra Airport. The pilot under training (pilot) was seated in the left seat and an instructor pilot (instructor) was seated in the right seat. The training was to provide the pilot with a command endorsement on the Metro. Successful completion of this flight would have completed the endorsement requirements. The intended activities for the flight included a planned in-flight engine shutdown and restart. At about 1431 Eastern Daylight-saving Time[3], during the left engine restart exercise, the crew had difficulty controlling the aircraft and experienced an unplanned descent to about 300 ft above ground level (AGL).

The aircraft was fitted with a cockpit voice recorder (CVR) and a flight data recorder (FDR). Data from both recorders and voice and radar data from The Australian Advanced Air Traffic Control System (TAAATS) were obtained by the ATSB. The recorded parameters of altitude and airspeed from the FDR were unable to be interpreted, and consequently all altitudes in this report are based on TAAATS information, which is accurate to the nearest 100 ft.

Sequence of Events

The pilot reported that he arrived at Canberra Airport soon after 1200 and commenced reviewing engine shutdown and startup procedures. The instructor was completing some training with another pilot. When the instructor had completed that task, he met the pilot and informed him that he had already conducted the pre-flight acceptance check and asked the pilot to board the aircraft. The pilot asked the instructor if they were going to conduct a briefing on the engine shutdown exercise, but the instructor said that they would brief the exercises on the way to the training area.

After some initial pre-flight endorsement exercises in the aircraft, they commenced flying training at 1340 and the pilot conducted several circuits. At 1415, the instructor requested clearance from the Canberra Aerodrome Controller (ADC) for the aircraft to track to the Lake George area at an altitude of 4,500 ft above mean sea level (AMSL) to conduct airwork. The ADC cleared the crew to track to Lake George and to operate not above 4,500 ft. At 1419, the instructor reported to the controller that the aircraft was established in the Lake George area and they commenced the one-engine inoperative training by shutting down the left engine. The radar data showed that the aircraft was at 4,300 ft AMSL at that time. No briefing of the exercise took place prior to commencing the in-flight engine shutdown procedure.

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1 Only those investigation areas identified by the headings and subheadings were considered to be relevant to the circumstances of the occurrence.

2 SA227 aircraft have the common name ‘Metro’. SA226 aircraft also share the common name ‘Metro’ with the later (and larger) models of the SA227.

3 The 24-hour clock is used in this report to describe the local time of day, Eastern Daylight-saving Time (EDT), as particular events occurred. Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.

The Metro was normally operated on regular public transport (RPT) flights with two pilots. During those flights, cockpit functions and roles were shared between the pilot flying and the pilot not flying. During the training flight, the pilot was responsible for the pilot flying roles and the instructor was responsible for the pilot not flying roles. During the engine shutdown, the instructor read the relevant items from the operator's quick reference handbook. The crew reported that, after the instructor read each item, the pilot touched the relevant control, the instructor confirmed that he had selected the correct control, and then the pilot actioned the item. At 1422, the left engine was shut down and the propeller was feathered[4].

At 1423, the crew commenced the procedure to restart the left engine. The instructor reported that he identified the 'Pre Planned Engine Airstart - SRL[5] On' procedure in the quick reference handbook, and then commenced to read the items for that procedure to guide the actions of the pilot. Item 14 required that the start button be pressed. The CVR data indicated that, instead of reading that item, the instructor departed from the procedure and moved the power lever for the left engine rearwards of the flight idle gate stating 'let's bring this back there'. He then departed from the procedure again by telling the pilot to 'hit the unfeather test switch' to the left position while he waited for the propeller to commence windmilling significantly. Those actions, combined with the low rotational speed of the engine, resulted in the left propeller blades moving to the start-locks position (perpendicular to the line of flight). The pilot was watching the propeller and saw it accelerate rapidly. As the propeller accelerated, the aircraft developed significant asymmetric drag, became difficult to control, and the pilot was unable to maintain altitude.

The radar data showed that at about 1425, soon after the left propeller moved onto the start-locks, the aircraft began to descend. Ten seconds after this descent started, the pilot asked the instructor if the unfeathered test switch should be still in the left position and then quickly returned it to zero. After the aircraft had descended 600 ft, the instructor took control of the aircraft. He asked the pilot to contact the ADC to request an immediate return to Canberra, which was approved. The aircraft descended a further 400 ft to an altitude of about 3,300 ft AMSL, equivalent to about 450 ft AGL, before the instructor stopped the descent.

From 1427 to 1430, the aircraft was climbed to an altitude of 4,300 ft AMSL. During the climb, the crew discussed the situation and attempted to diagnose the problem. Although they realised they could not return the left propeller to the feathered position, they did not recognise that this was because the propeller was fixed in the start-locks position.

At 1429, the instructor advised the ADC that the aircraft was remaining over the Lake George area. The ADC asked whether operations were normal and the instructor replied 'at this stage'. The crew then reviewed the 'Pre Planned Engine Airstart – SRL On' procedure from the beginning, with the pilot reading the items and the instructor confirming that the actions had been completed. When they

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4 Feathering the propeller positioned the blades parallel with the line of flight to minimise drag.

5 'SRL' means 'single red line computer', which refers to a part of the engine power management system that is normally switched on, but the aircraft can continue to operate with the SRL computer switched off, if different procedures are used.

reached item 14 (start button), the pilot depressed the start button on the instructor's command.

After the left engine started, the aircraft immediately rolled to the left and altitude could not be maintained at a safe airspeed. The radar data showed that the aircraft descended at a rate of 1,600 ft/min. The instructor reported that all he could do during the descent was try to keep the airspeed above the minimum take-off safe flying speed with a nose-down attitude and not banking. After about 40 seconds, the crew used the left engine stop and feather knob to shut down the left engine. The propeller did not revert to the feathered position, but the engine decelerated, reducing aerodynamic drag. Immediately following the engine shutdown, the stall warning horn sounded for 5 seconds. The aircraft had descended below 3,000 ft AMSL before the descent was stopped. The ground proximity warning system (GPWS) alert then sounded for 18 seconds. At its lowest altitude of 2,900 ft AMSL, equivalent to about 300 ft AGL, the aircraft was 1.1 km east of Governors Hill, which has an elevation of 2,959 ft.

At 1432, after the second descent had been stopped, the instructor informed the ADC that they were orbiting over Lake George to gain some height, and that they would be returning to Canberra shortly. The aircraft was climbed to 4,300 ft before commencing the return. During the return to Canberra, the instructor handed control of the aircraft to the pilot for 6 minutes in order to rest. At 1447, the instructor landed the aircraft at Canberra airport.

Aircraft Systems Information

The aircraft was fitted with two Allied Signal TPE 331–11U turbine engines driving four bladed constant speed propellers. The propellers had a variable pitch angle range of -5.0 to 88.9 degrees. In the feathered position of 88.9 degrees, the propeller blades were parallel to the line of flight to minimise drag. The propeller hub contained springs that provided a positive force on the propeller blades toward the fully feathered position. In flight, a constant engine speed was maintained by the propeller governor, which used engine oil pressure to adjust the propeller blade pitch angle.

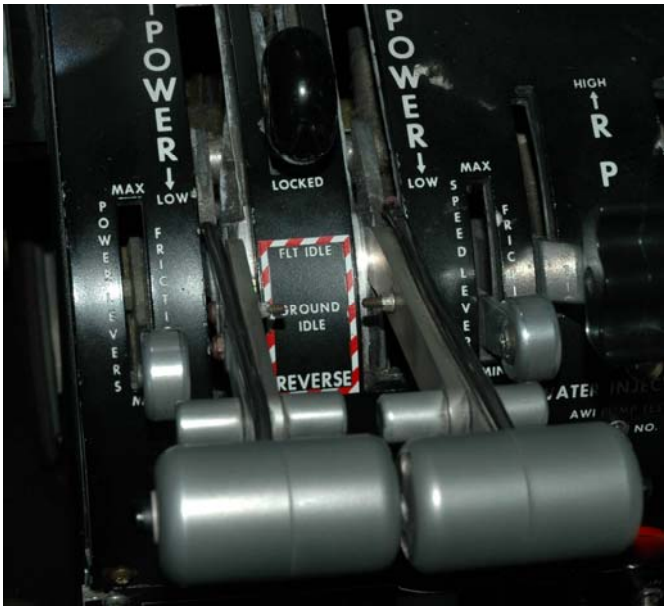
The power levers in the cockpit had two ranges: flight range from flight idle to maximum power; and beta range (for ground operations) from flight idle to ground idle then further rearward to reverse thrust (Figure 1). In the flight range, the power lever controlled the engine fuel and the speed lever controlled the propeller governor. However, in beta range, the propeller blade pitch angle was directly controlled by the power lever. Between the flight idle and ground idle setting, only minimal forward thrust could be obtained. Moving the power lever further rearwards of ground idle induced reverse thrust as a negative propeller blade angle of up to -5 degrees was created. At the 9 degrees (start-locks) position, the propeller blades were almost perpendicular to the line of flight, providing virtually no forward thrust and considerable aerodynamic drag to any forward motion.

To start an engine on the ground required that the propeller was in the start-locks position. This minimised the rotational resistance and assisted spin up while the engine and propeller were being rotated by the starter generator. Therefore, when engines were shut down on the ground, it was normal practice to move the blades to the start-locks as the engine slowed. Movement of the blades to the start-locks

position was accomplished by moving the power lever rearward of the flight idle position, approximately half way into the beta range.

At low engine speeds, or when the engine was stopped, either on the ground or in-flight, the unfeather pump provided oil pressure to change the propeller pitch toward the start-locks position. When on the ground, the unfeather pump was operated by selection of the unfeather test switch. The switch displayed selections LEFT-OFF-RIGHT. Once selected to a desired position, the switch remained there until de-selected, as was standard on Metro III aircraft.

Figure 1: Power levers and markings



In-flight engine shut-down procedures required that the propeller blades be moved to the feathered pitch position to reduce drag and allow the engine to spool down. That would be achieved by selecting the stop and feather knob, which ports oil away from the propeller, allowing spring pressure to move them to feather. During an in-flight restart, due to the air load that would be present from rotating propeller blades in the feathered position, the blades must be moved from the feathered position to enable windmilling before the engine could start. That would be accomplished through the operation of the unfeather pump, which was automatically activated with the selection of the engine start button.

The engine incorporated a negative torque sensing (NTS) system that, under normal in-flight operation, modulated the propeller blade pitch to ensure that the engine maintained positive drive of the propeller. The NTS system only moved the blades in the direction toward the feather position. However, movement of the power lever into the beta range disables the NTS system, allowing movement of the propeller blades away from feather and toward low angle pitch if sufficient oil pressure exists, or unfeather pump pressure is applied.

The manufacturer stated that, although it had not been tested, it was theoretically possible to position the propeller blades onto the start-locks in flight if the engine speed was low and the power lever was moved into the beta range with the unfeather pump operating.

The aircraft flight manual specifically warned that the power levers must not be selected rearwards of flight idle (into beta range) in flight as this may lead to a loss of aircraft control or an engine overspeed condition and consequent loss of engine power.

Once fixed on the start-locks, the propeller blades could only be released by the movement of the power lever further rearward within the beta range toward the full reverse pitch. The rotational speed of the engine then needed to be increased. As the engine speed increased, centrifugal force retracted the start-locks allowing the blades to move to forward thrust settings.

In order to prevent inadvertent selection of beta range in flight, the power levers were fitted with a supplemental latch mechanism that required the lifting of toggles (located below the power lever handle) to allow the lever to move through a detent from flight idle into the beta range.

Placing the power lever at the flight idle position with the landing gear retracted activated the 'landing gear warning' horn. No additional auditory warning was provided if the power lever was moved further rearward of the flight idle gate into the beta range. The 'Pre Planned Engine Airstart – SRL On' procedure called for the power lever to be brought back to the flight idle gate and then moved forward about ¼ inch until the landing gear warning horn was silenced. The CVR data indicated that the landing gear warning horn sounded four times during the occurrence sequence; the first time (lasting 14 seconds) was when the instructor initially brought the left engine power lever into the beta range.

Following the occurrence, the left propeller was found to be fixed in the 9 degree start-locks position. After release of the start-locks, the left engine and propeller operated normally during all ground testing and a subsequent in-flight engine shutdown and airstart. No problems were identified with the detent on the power lever between the flight idle and beta range.

Previous Occurrences Involving Use of Beta Mode in Flight

A review of the Australian aviation occurrence database and the United States (US) National Transportation Safety Board (NTSB) database identified no previous occurrences involving SA226 or SA227 aircraft where a propeller had been fixed on the start-locks in flight. The manufacturer reported that it was unaware of any such occurrences.

In the 1980s, there were at least three accidents involving SA226 and SA227 aircraft in the US where a power lever was inadvertently pulled back into the beta range in flight. Investigations revealed that the flight idle gates in these aircraft were worn, meaning that the power levers could be pulled back into the beta range without lifting the toggles over the detent. Following a recommendation from the NTSB, the US Federal Aviation Administration (FAA) issued an airworthiness directive (AD92-18-07) to modify the power lever detent arms and cover assemblies on SA226 and SA227 aircraft.

In 1996, a single engine Ayres Thrush aircraft with a newly installed Garrett turbine engine inadvertently had its propeller placed on the start locks in flight after the pilot attempted to restore power to the failed engine using the ground start

procedure. The flight was a training flight over Lake George at an altitude of 6,500 ft AMSL. As a result of the start locks being engage in-flight, the pilot had difficulty controlling the aircraft and collided with the ground, resulting in both occupants receiving serious injuries and substantial damage to the aircraft.[6]

Following a series of accidents and incidents in the 1980s and early 1990s involving intentional and inadvertent selection of beta mode in flight in other types of turbo-prop aircraft, the NTSB issued several recommendations to the FAA. Of these accidents, one accident involved a SAAB 340 aircraft in 1994, for which the NTSB issued the following recommendations to the FAA:

> NTSB Recommendation #A-94-062: The NTSB recommends that the Federal Aviation Administration: revise Title 14 Code of Federal Regulations, Parts 25.1155 and 23.1155 to require a positive means to prevent operation of the propeller in the beta mode while in flight, unless the airplane is certified for such use.
>
> NTSB Recommendation #A-94-063: The NTSB recommends that the Federal Aviation Administration: Review all other turbopropeller airplane designs to determine whether in-flight engine operation in the beta range should be prohibited. Issue appropriate airworthiness directives applicable to those airplanes to install a system to prevent movement of power levers into the beta range, and require appropriate warnings in airplane operating manuals and on cockpit placards to warn pilots not to move power levers into the beta range in flight, unless the airplane is certificated for such use.

As a result of the NTSB recommendations, the FAA issued requirements for many aircraft flight manuals to be modified to include specific warnings to prohibit the use of beta mode in flight. It also introduced a series of airworthiness directives for beta lockout systems on specific types of turbo-prop aircraft to prevent power levers from moving into the beta range in flight. The directives for beta lockout systems were issued for the CASA C-212 (AD 91-03-10), the Embraer EMB-120 (AD 90-17-12), the SAAB 340 (AD 96-18-03) and the De Havilland DHC-8 (AD 2000-02-13). These aircraft types were certified under Part 25 of the US Federal Aviation Regulations (for transport category aircraft), whereas the SA227 was certified under Part 23 (for utility, acrobatic, and commuter category aircraft).

The FAA concluded that there was no requirement to introduce beta lockout devices for smaller aircraft, based on a lack of documented occurrences in these aircraft. No changes were made to the certification requirements. The NTSB classified the FAA's response to recommendation 94-063 as 'Closed - Acceptable Action' (11 May 2000), and classified recommendation 94-062 as 'Closed – Unacceptable Action' (18 July 2002).

As of October 2005, there were 61 SA227 aircraft and 11 SA226 aircraft on the Australian civil aircraft register. Many of these aircraft were engaged in regular public transport (RPT) operations. At the same time, there were 47 DHC-8 aircraft, 27 SAAB 340 aircraft, 19 EMB-120 aircraft and 3 CASA 212 aircraft on the register.

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6 Australian Transport Safety Bureau investigation report BO/199600323.

Personnel Information

Instructor

Both the instructor and the pilot were employees of an RPT operator. The instructor was employed by the operator in July 2004 (four months prior to the incident) as the Metro Fleet Manager and a Check and Training Captain. The person previously in this role handed over the job, and evaluated the instructor as suitable for the positions through conducting a line check[7], base check[8] and route check[9], in three days before leaving the operator's employment. Prior to this employment, the instructor had been operating Metro aircraft on freight and RPT operations for about 8 years. He had a total of 5,388 hours on type, including 3,397 hours in command. In the 30 days prior to the incident, he recorded 49 hours flight time, and 159 hours flight time in the previous 90 days.

The instructor's duties included conducting base checks on the operator's existing Metro pilots and conducting endorsements for new Metro pilots. He held a Grade 1 instructor rating, but had no previous experience as a supervisory or check and training captain, and had not previously conducted any endorsement training on the Metro. In order to be appointed as a check and training pilot under the operator's check and training system, he was required to be approved by the Civil Aviation Safety Authority (CASA).

The CASA approval process for the instructor involved assessing his instructional techniques and his suitability to be an airline check and training pilot. It was not feasible to conduct a systematic assessment of his entire aircraft systems knowledge. Rather, the CASA flying operations inspector (FOI) had to rely on samples of the instructor's knowledge and his operational experience to make the judgement that he was suitable for the role. Further, although the instructor was required to be able to teach all of the Metro ground school, he was only required to teach a portion of the syllabus to gain his CASA check and training approvals.

The operator and the CASA FOI both reported that the approval process was more thorough than normal and included four check flights. Those flights involved base checks and instrument renewal. However, although the process did include a training room discussion of an in-flight engine shutdown and startup, it did not include an assessment during a check flight of an in-flight engine shutdown and startup. The CASA Air Operator Certification Manual, Section 7.12 stated that:

> The flight check should encompass, at a minimum, demonstrations of all asymmetric operations and any critical manoeuvres applicable to the aircraft type.

During the approval process, difficulties were identified with the instructor's instructional skills. Following feedback and further observation, he satisfied the necessary requirements to be approved as a check and training pilot several weeks

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7 Line check is a test of proficiency of a pilot qualified on the aircraft type during a normal revenue flight. The test involves an assessment of all phases of flight except emergency procedures.

8 Base check is a test of proficiency of a qualified pilot in both normal procedures and emergency or abnormal operations of the aircraft's systems during a non-revenue flight.

9 Route check ensures that a qualified pilot has adequate knowledge of the route being flown.

prior to the occurrence. However, CASA had not formally issued him with the relevant legal instrument to permit him to conduct endorsement training on behalf of the operator. As the operator required two of its pilots to be endorsed on the aircraft in order to commence line operations, it directed the instructor to start conducting the endorsement training on 20 November as a private operation, and informed CASA of that decision.[10]

The instructor stated that, prior to the occurrence flight, he had not conducted an engine airstart since he had been endorsed on the Metro about 8 years earlier. He had been aware from previous flying in Metro aircraft that the propeller must be unfeathered to facilitate engine acceleration, but was unaware that the start button would automatically operate the unfeather pump. Consequently, he revealed that he knowingly departed from the procedure and instructed the use of the unfeather test switch to unfeather the propeller to reduce the strain on the starter generator. Although he had reviewed and presented material on most of the aircraft's systems for ground school training about 3 months prior to the occurrence, he was not the instructor responsible for teaching the module on the engine and propeller systems. Consequently, he had not reviewed those systems in detail prior to the occurrence flight.

Following the occurrence, the instructor could not recall placing the power lever in the beta range during the flight. He stated that he was very much aware that this action should not be conducted in flight. The pilot said that the Metro ground school had included instructions not to place the power lever in the beta range in flight. The pilot also recalled that, on the day before the occurrence, he had placed the power levers in the beta range just prior to touching down during circuit training, and the instructor had told him not to do so.

The instructor also remarked that he had demonstrated ground restart procedures on the morning of the occurrence and on the previous day, including starting the engine on the ground when the propeller was feathered. These restarts involved using the unfeather test switch, with the power lever in the beta range, to place the propeller on the start-locks prior to starting the engine.

The instructor indicated that his overall workload over the four months of his employment, including CASA approval requirements and the operator's requirements for check and training and line flying, was considerable. As a result, his preparation for the ground school lessons and some other work were conducted out of scheduled work hours at night and on rostered days off. This out-of-hours work was not reflected in his flight and duty times he recorded for the operator. The instructor also stated that he had been experiencing personal life stressors in the months leading up to the occurrence.

The operator's management and the CASA FOI indicated that the instructor had often commented to them that he was tired and had been working late into the night. The operator reported that it had rostered the instructor for less line flying duties than other pilots to help ensure he could complete his training duties. According to the operator's management, they had advised the instructor several times to not work outside of normal work hours. The operator also noted that the instructor did not appear to be able to develop training materials efficiently due to his

10 As the instructor held a Grade 1 instructor rating and a command endorsement on the aircraft type, he was legally entitled to conduct endorsements as a private operation.

unfamiliarity with the computer software, and they had arranged work-around alternatives so that he would not need to learn the software in the short-term. Several counselling sessions with the chief pilot were conducted to try to assist the instructor to understand how to undertake his roles in an appropriate way, and he was also coached by management as to how to prioritise his tasks. However, the instructor continued to struggle with his workload, and his comments about being tired and working from home continued throughout the four months of his employment.

The instructor stated that he read the operator's training manual until 2200 on 19 November in preparation for the training. On 20 November, endorsement training involving two trainee pilots occurred between 1000 and 2145. Although the instructor and both endorsement pilots were tired by the end of the day, neither of the trainee pilots recalled that the instructor appeared tired on the following day. On 21 November, the aircraft had to be returned from training by 1500 so that it could be prepared for an RPT flight. The instructor conducted some training with the second endorsement pilot during the morning, because the pilot for the occurrence flight was not available until after 1200. The endorsement exercises completed with the second pilot did not include an engine shutdown.

Pilot

The pilot had 1,648 hours flight experience, with 4.5 hours on the Metro. He was originally employed by the operator to fly single pilot operations in the Piper PA-31 Chieftain aircraft. In the 30 days prior to the incident, the pilot recorded 38 hours flight time, and 60 hours flight time in the previous 90 days. The Metro endorsement was his first involvement with turbo-prop aircraft and formal two-pilot operations.

Organisational Information

The operator commenced RPT operations in Metro aircraft in February 2004. Prior to that, the operator had experience in RPT operations with single pilot piston-engine aircraft. At the time of the occurrence, only one Metro was in service, but a second aircraft was due to start on a different route on 29 November. The expanding Metro operations required the endorsement of two additional pilots to enable them to be employed as first officers. The operator originally directed the instructor to complete the two endorsements by the end of 21 November. On 19 November, the instructor informed the operator that there would be insufficient time to complete the second endorsement, so it was agreed that this endorsement would be completed later.

Within six weeks of the instructor commencing employment, all three senior management pilots, including the chief pilot, a Metro supervisory pilot, and the former Metro fleet manager and check and training captain, left the operator to commence positions with high capacity RPT operators. The short-term replacement chief pilot at the time of the incident was endorsed as a copilot on the Metro but was not an experienced Metro pilot. At the time of the incident, the deputy chief pilot was receiving Metro check and training approvals from CASA and was to become the chief pilot once he had accrued 400 hours in two-pilot operations.

The operator stated that it had wanted to employ a person for the Metro fleet manager and check and training positions with prior experience in supervisory and check and training roles, but there was a lack of pilots with such experience available, and none had applied for the position. As a result of this and the loss of the operator's former Metro management pilots, the operator had no one qualified to give Metro endorsements until such time as the instructor received his CASA approvals. Furthermore, the operator had no one in a position to provide it with an internal assessment of the instructor's suitability to endorse their Metro pilots. They were required by CASA to have two positions with check and training approvals (the instructor and the deputy chief pilot) in order to provide the capacity for an internal quality assurance process within their Metro check and training system. However, this system was not in place at the time of the incident.

The operator's check and training manual stated that asymmetric power exercises, including engine shutdown and airstarts, were to be conducted at or above 6,000 ft. It did not state a height reference of either AMSL or AGL. The Lake George area is about 2,300 ft in elevation, with spot heights to 2,959 ft. The instructor could not recall why he chose 4,500 ft to conduct the exercise. He recalled that he may have been thinking 4,500 ft AGL at the time. The lower limit of controlled airspace in the area was also 4,500 ft, and the weather report included scattered cloud at 4,500 ft. Other pilots who were experienced in turbo-prop operations and the check and training role indicated to the investigation that they would perform such training at a greater height and generally above 10,000 ft. The pilot reported that when he heard the instructor request 4,500 ft, he had thought that it was too low for the exercise and had considered asking the instructor to reconsider the altitude. However, they had received their clearance from the ADC before he could decide whether to express his concerns. He then considered the altitude choice to be fixed, so did not speak about the issue.

The operator's Metro endorsement program did not include a crew resource management training program to enhance safety in two-pilot operations. The operator reported that crew resource management instruction was given informally while flying on the line under supervision once an endorsement was finished. The operator's Metro pilots included a mix of pilots with previous experience in two-pilot operations with other operators, and pilots with no previous experience in two-pilot operations.

All of the operator's manuals for the Metro aircraft were written by the former fleet manager who was replaced by the instructor. The CASA FOI and the instructor both reported that they thought the normal procedures checklists contained in the operations manual were unnecessarily long. These checklists were, however, issued by the aircraft manufacturer. The instructor had wanted to rework this manual on several occasions but the chief pilot and deputy chief pilot continually directed him not to spend time on the manuals until after all of the required endorsements were finished. In addition to this disagreement, there were several other disagreements resulting from differences between how management wanted the instructor to operate in his role as fleet manager and how the instructor was operating.

The asymmetric flight training syllabus in the operator's check and training manual included: '1. Engine shutdown, 2. Use of un-feather pump'. The deputy chief pilot reported that the unfeather pump item was included in the syllabus to reflect a checklist item contained in the Fairchild 227 Aircraft Flight Manual. The aircraft flight manual further explained that if the exhaust gas temperature was more than 200°C when the propeller feathered and stopped rotation, the unfeather test switch

should be used intermittently to keep the propeller windmilling slowly until the temperature stabilised below 200°C.

Other Factual Information

At the time of the occurrence, the reported weather conditions at Canberra Airport were a wind direction of 320 degrees (M), a wind speed of 8 kts, visibility greater than 10 km and scattered[11] cloud at 4,500 ft.

The cockpit voice recorder (CVR) data indicated that, when the instructor read both the engine shutdown and engine airstart procedures, several items were missed and the after shutdown clean up section was not completed. Items were read aloud quickly by the instructor and very few remarks were heard from the pilot on the CVR. After item 12 on the 'Pre Planned Engine Airstart – SRL On' procedure, the instructor read an item, 'speed select switch', which was not on this checklist but on a subsequent checklist (Pre Planned Engine Airstart – SRL Off). The operations manual required the pilot reading a checklist to read aloud the procedure's title at the start of each procedure. However, this was not heard on the CVR.

On the way to the Lake George area, the ADC asked the pilots to monitor the radio signal from the radio distress frequency 121.5 MHz. That beacon could be heard on the CVR throughout the flight. During the first uncontrolled descent while the instructor was trying to re-establish control, the ADC asked them if the beacon had been continuous and the instructor replied 'yes'.

The CVR contained four recorded audio tracks: pilot headphone, copilot headphone, cockpit area microphone, and a spare track. The sound quality and volume was only adequate on the pilot headphone track. During the download of the flight data recorder (FDR) the data was found to be of a poor quality. Additionally, the operator was unable to provide the ATSB with the data conversion algorithms for the aircraft/recorder configuration. Shortly after the occurrence, when the FDR was refitted to the aircraft, it displayed a fault light. The recorder was returned to a maintenance organisation which found that both of the recorder's two recording heads were out of alignment and needed to be replaced. The combination of poor quality data and the lack of decoding documentation precluded a reliable interpretation of the airspeed and altitude parameters for the occurrence flight.

11 Scattered: 3 to 4 eights of the sky obscured by cloud. Clear intervals between clouds predominate.

ANALYSIS

The crew initially lost control of the aircraft when the left propeller became fixed in the start-locks position, creating no forward thrust and considerable aerodynamic drag. The propeller became fixed on the start-locks as a result of the instructor placing the left power lever into the beta range while directing the pilot to select the unfeather test switch during the preparation for restarting the engine. When the crew recovered control of the aircraft and regained altitude, they repeatedly, but unsuccessfully tried to feather the propeller, but neither pilot realised that the propeller was on the start-locks. Subsequently, the crew started the engine while the propeller was still in the start-locks position, resulting in a second unplanned loss of altitude with more drag and a more rapid descent than on the first occasion.

The instruction to use the unfeather test switch was a deliberate departure from the published procedure which resulted from the instructor's inadequate systems knowledge. That decision may have been influenced by the inclusion of the item 'use of un-feather pump' in the asymmetric training syllabus. The instructor was attempting to increase the windmilling rate of the propeller in order to reduce the load on the starter motor. It is possible that he thought that the unfeather test switch was spring loaded so that the switch would return to the off position when he instructed the pilot to 'hit' the switch. As it was not spring loaded, the switch remained in the left position long enough for the propeller to move to the start locks. However, he also did not realise that simply pressing the start button, as required by the procedure, would have automatically unfeathered the propeller enough to increase the windmilling rate. The instructor did not fully understand the start button function prior to his employment with the operator, and his systems knowledge was not comprehensively assessed as part of his CASA approval. Further, he had only studied the modules of the ground school course that he had taught by the time of the occurrence. That may have been partially influenced by the workload that he felt he was under during the four months of his employment with the airline.

The instructor was not required to demonstrate the in-flight restart exercise during his CASA approval, so had not completed an in-flight engine start since his own endorsement. Due to the instructor's eight years of experience as a Metro pilot, the operator had expected him to be both current and proficient on the Metro. The previous person in the instructor's position also confirmed that the instructor was at the operator's standard through his initial base, line and route checks. However, the operator relied on the assessment by CASA as their assurance that he was suitable for the check and training roles within their company. Neither the chief pilot nor the deputy chief pilot were considered to be in a position to oversight the instructor's technical handling of Metro endorsements. However, the CASA process was designed to be a final check of a prospective training captain prepared for the role by his or her company, and not a comprehensive evaluation of the endorsement process.

The operator's intended quality assurance of their check and training system was to have two check and training captains who could assess each other. However, as the previous three Metro captains with training, checking and supervisory qualifications had left the operator within 6 weeks of the instructor starting, the operator was left with no qualified and experienced check and training captains and had to build up the qualifications for both positions. As the deputy chief pilot was still in the

process of gaining his CASA approvals at the time of the incident, the operator's long-term Metro check and training assurance system was not yet in place when they tasked the instructor to start endorsing pilots.

The instructor had no experience in airline management or as a check and training pilot, so many of his employment tasks were new to him and therefore required additional preparation time. Due to this increased workload, he often worked extended hours. It was clear to the operator's management that the instructor was having difficulty adjusting to his new employment roles. Although the operator took some steps to reduce his workload, including reducing his line flying duties, the instructor still had difficulty managing his tasks during normal office hours. There was no evidence that the operator took adequate steps to ensure that a senior pilot operating endorsement and RPT flights was not fatigued or stressed, nor adequately pursue alternative methods of providing endorsement training for their Metro pilots. Due to his difficulties with his new roles and the personal life stressors he had been subject to, the instructor was probably experiencing chronic fatigue[12] at the time of the occurrence.

Moving the power lever into the beta range in flight is a high risk action, and the instructor was aware that it must not be done. However, on the ground, moving the power lever into the beta range was an appropriate step to prepare the propeller for an engine start when the propeller was feathered. He was familiar with the ground start actions and had recently practiced them, but he had not conducted an airstart for eight years. Such errors, where familiar actions are performed in an inappropriate situation, usually occur when the person's attention is not fully dedicated to the task at hand.[13] This is consistent with the time pressure the instructor was experiencing on the day of the occurrence.

Metro aircraft did not have a beta lockout system to prevent pilots moving the power lever into the beta range in flight, nor was any such system required to be fitted under the relevant certification requirements. Such a device would have prevented this occurrence, and would also prevent a range of other types of occurrences where pilots intentionally but mistakenly placed the power levers in beta mode in flight. Although no other occurrences have been recorded involving Metro aircraft, they have been recorded for a number of other types of turbo-prop aircraft. In recent years, the United States (US) Federal Aviation Administration (FAA) has required that beta lockout systems be introduced to a range of other, larger turbo-prop aircraft. However, given the number of Metro (and similarly equipped US FAR 23) aircraft in service, the possibility of future accidents related to a lack of a beta lockout system remains.

On both occasions when the crew temporarily lost control of the aircraft, the chance of a collision with the ground was substantially increased due to the instructor's decision to conduct the exercise at an altitude below 4,500 ft. The investigation could not establish the reason for this decision. However, had the instructor conducted a pre-flight briefing for the exercise, using the check and training manual, the crew would probably have noted that the exercise was not to be conducted below 6,000 ft. The lack of a pre-flight briefing appeared to be due to the time pressure the instructor was experiencing on the day.

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12 Chronic fatigue refers to continual and long-term fatigue.

13 Reason, J., Human error, New York, Cambridge University Press, 1990.

The pilot had little opportunity to question the instructor's decision to conduct the exercise below 4,500 ft as the first knowledge he had of this was when the instructor requested their altitude clearance from the Canberra aerodrome controller. In addition, any in-flight decision made by the instructor would probably have been difficult to question due to the steep trans-cockpit authority gradient[14] resulting from the instructor-trainee relationship. The pilot had also received no training from the operator in crew resource management and, specifically, in effective communication skills and techniques for managing upwards in two-pilot operations. Appropriate training and management strategies have been found to mitigate the potential for ineffective cross-crew communication.

The instructor's time pressure arose because the operator required additional pilots to staff a new Metro service. The training was commenced as a private operation due to delays in the instructor's formal approval as a check and training pilot. There was limited aircraft availability on the day of the occurrence, and the pilot was not available until 1200 of the day on the occurrence. Although the timeframe to conduct the endorsement training was limited, there was no evidence to suggest that the time to prepare for the training was limited.

After the propeller was fixed in the start-locks position, there would have been significantly high drag on the left side of the aircraft, resulting in it being extremely difficult to maintain the aircraft's altitude and direction. The instructor displayed exceptional aircraft handling skill to be able to regain control of the aircraft and to return to Canberra airport for an uneventful landing.

14 A steep trans-cockpit authority gradient results in junior crewmembers being less likely to voice concerns to senior crewmembers, and senior crewmembers less likely to seek and incorporate a junior crewmember's opinions or concerns.

FINDINGS

Contributing Safety Factors

- The instructor did not brief the pilot about the engine shutdown and restart exercises prior to starting the exercises.
- The instructor elected to conduct the engine shutdown and restart exercises at an altitude below 4,500 ft (about 2,200 ft AGL).
- The instructor departed from the published procedure for conducting an engine start in flight by moving the power lever for the left engine into the beta range and directing the pilot to select the unfeather test switch. These actions were appropriate for preparing an engine for start on the ground with a feathered propeller, but were not appropriate when conducting an airstart.
- The propeller on the left engine became fixed in the start-locks position.
- The crew lost control of the aircraft and it descended 1,000 ft to about 450 ft AGL before they regained control.
- The crew could not diagnose the source of the initial loss of control and proceeded to start the left engine in flight while the propeller was fixed on the start-locks.
- The crew lost control of the aircraft for a second time and the aircraft descended 1,300 ft to about 300 ft AGL before they regained control.
- The instructor was subject to time pressure to complete the training exercises.
- The instructor had a limited understanding of the aircraft's engine and propeller systems, and had not practiced an airstart since his own endorsement eight years before the incident.
- The SA226 / SA227 aircraft contain no positive lockout system to prevent pilots from intentionally moving the power lever into the beta range during flight.
- The operator did not have a crew resource management training program for two-crew operations.
- The operator recognised the instructor's continual difficulties in adapting to his new employment roles, but its responses to this did not successfully resolve these difficulties.
- The Civil Aviation Safety Authority did not mandate an assessment of the instruction and demonstration of all flight critical exercises in their assessment of all prospective training pilots.
- The operator did not properly assess the suitability of the CASA check and training approval process to determine its adequacy as an indicator of the instructor's ability to endorse their Metro pilots.

Other Safety Factors

- In addition to the actions leading to the propeller being fixed on the start-locks, the instructor made a series of errors and omissions during the process of shutting down and restarting the left engine.

- The instructor was probably suffering from chronic fatigue.
- The crew did not communicate the nature and magnitude of the problems they were experiencing to air traffic control in a timely manner.
- The operator's check and training manual stated that asymmetric exercises, including engine shutdown and airstarts, should be conducted at or above 6,000 ft. However, a higher altitude would be more appropriate. The manual also did not state if the specified height was above mean sea level or above ground level.

Other Key Findings

- The instructor displayed exceptional aircraft handling skill to be able to regain control of the aircraft, and return it for landing, with one propeller on the start-locks.
- There were significant problems with the availability and quality of the data obtained from the aircraft's CVR and FDR.

SAFETY ACTIONS

Aircraft Operator

As a result of this occurrence, the aircraft operator has taken the following actions:

- Made changes to its Check and Training Manual for asymmetric training to require engine shutdown exercises to be conducted at or above 10,000 ft above ground level in the Metro aircraft:

  > The minimum safe height for practicing exercises involving engine shutdown is 3000ft AGL for piston engine aircraft and 10000ft AGL for turbine aircraft.

- Changed the asymmetric training syllabus item ‘use of un-feather pump’ in its Check and Training manual to reflect the intent of the Aircraft Flight Manual that the unfeather pump should be discussed after an engine shutdown, but not necessarily used:

  > Whilst the engine is shutdown, discuss the use of the un-feather pump.

- Initiated a crew resource management training program for its pilots and operational ground staff
- Is in the final stages of obtaining CASA approval for all Metro endorsements (for both check and training captains and for line pilots) to be completed at a Metro simulator centre. As such, asymmetric training, including engine airstarts, will be trained in the safe environment of a simulator rather than in an aircraft
- Undertaken repairs to the flight data recorders from both SA227-AC Metro III aircraft owned by the operator
- Attempted to ascertain the appropriate data conversion algorithms for the flight data recorder for the SA227-AC Metro III fleet. A download of the recorders was conducted by Australian Transport Safety Bureau staff in January 2006 to assist this procedure and further cooperation with the ATSB is continuing
- Advised that it will undertake a functional check of the audio quality from all channels of the cockpit voice recorder fitted to VH-TAG to determine if any maintenance action on the aircraft or recorder is required.

Civil Aviation Safety Authority

As a result of this occurrence, the Civil Aviation Safety Authority (CASA) has advised the ATSB that they intend to take the following actions:

> CASA will ensure that an assessment of the pilot's instructional ability is conducted and that all critical flight sequences are assessed. However, it is not practical to assess every possible combination of events and sequences, and as such assessments of this kind are ordered according to a candidate's capability.
>
> CASA will ensure that the company operations manuals require training to be conducted in accordance with published checklists. Practical assessment must ensure that this is an integral part of any ground and in-flight assessment.

Australian Transport Safety Bureau

On 10 February 2006, the Australian Transport Safety Bureau issued the following two recommendations to address deficiencies in the maintenance and associated legislation of on-board recorders:

R20060005

> The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority review the maintenance requirements for cockpit voice recording systems and flight data recording systems against international standards such as EUROCAE ED-112 and ICAO Annex 6 with the aim of improving their reliability and increasing the availability of data to investigators.

Background information to this safety recommendation can be found at http://www.atsb.gov.au/aviation/av_rec20060005.aspx

R20060006

> The Australian Transport Safety Bureau recommends that the Department of Transport and Regional Services, with the assistance of the Civil Aviation Safety Authority, pursues further the development of proposals to amend the provisions of Part IIIB of the Civil Aviation Act 1988. While recognising the need to have protections to prevent inappropriate disclosure and use of Cockpit Voice Recorder information, the proposals to amend the CA Act should take into account the need to enable approved maintenance organisations to replay in-flight Cockpit Voice Recorder data for legitimate maintenance and testing purposes.

Background information to this safety recommendation can be found at http://www.atsb.gov.au/aviation/R20060006.aspx

Safety Recommendation

As a result of this occurrence, the Australian Transport Safety Bureau issues the following safety recommendation:

R20060017

The Australian Transport Safety Bureau recommends that the United States Federal Aviation Administration consider revising Title 14 Code of the Federal Regulations, Part 23.1155, to require a positive means to prevent operation of the propeller in the beta mode while in flight (regardless of pilot action), unless the aircraft is certified for such use.