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- independent investigation of transport accidents and other safety occurrences
- safety data recording, analysis and research
- fostering safety awareness, knowledge and action.

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ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation A0-2008-009
Final

Runway excursion, VH-UZD

Thangool Aerodrome, Queensland

12 February 2008

Abstract

On 12 February 2008, a Fairchild Industries SA227-AC (Metro III) aircraft, registered VH-UZD, was being operated on a freight service between Emerald and Thangool, Queensland with two pilots. The approach and landing into Thangool was conducted after last light in conditions of scattered low cloud and rain showers. At a speed of about 40 kts after touchdown, the aircraft suddenly veered uncontrollably to the right, departed the runway and became bogged in wet grass.

There was no damage to the aircraft or injuries to the flight crew.

The investigation determined that the runway excursion was probably a result of a directional upset at a time when the nosewheel was in castor mode. The reason for the nosewheel being in the castor mode could not be determined with certainty and may have been the result of an intermittent fault or the inadvertent failure by the flight crew to arm the system.

It was also determined that the aircraft's rate of descent during the latter stages of the approach was significantly higher than for a normal stabilised approach. In addition, the aircraft operator's stabilised approach criteria did not provide flight crew with information on maximum permitted rates of descent. The aircraft operator has advised that, as a result of the investigation, it has redefined its stabilised approach criteria.

FACTUAL INFORMATION

History of the flight

On 12 February 2008, a Fairchild Industries SA227-AC (Metro III) aircraft, registered VH-UZD (UZD), was scheduled to operate on a regular freight service from Brisbane to Emerald via Thangool, Queensland and return. The flight crew comprised a training captain in the left seat, and a line captain who was occupying the right seat. There were no passengers.

Freight services in the Metro III aircraft were normally accomplished with a single pilot. However, on the day of the occurrence, the training captain was onboard the aircraft at the request of the line captain. The intent was for the training captain to assist the line captain prepare for an instrument rating renewal the following day, and in the line captain's preparations to commence supervisory duties.

The aircraft departed Brisbane at about 0530 Eastern Standard Time¹ for the flight to Emerald and Thangool. At about 1800, following an extended period on the ground in Emerald, the aircraft taxied for departure to Thangool. The training captain occupied the left seat and was the pilot flying (PF). The line captain occupied the right seat and was the pilot not flying (PNF). The PNF reported that the nosewheel steering system (NWS) was tested during the taxi and that the test

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

was normal. The PF further stated that it was normal for the test to be carried out before all departures, as it was a temperamental system.

In accordance with the pre-flight briefing, the two pilots switched flying duties about halfway through the flight; the line captain becoming the PF, while the training captain became the PNF and provided support duties.

At about 1902, during the descent into Thangool, the PNF attempted to activate the pilot activated (aerodrome) lighting (PAL)². That action supported the PF, who was preparing to conduct an instrument approach and landing to runway 10 at Thangool.

The PNF made further attempts to activate the aerodrome lighting at 1908 and 1909 respectively; however, it was not until the aircraft was about 1.3 NM (2 km) from touchdown, and at a height of about 650 ft above ground level (AGL), that the lights were finally activated. At that point, the PF did not feel comfortable continuing the approach and handed control over to the training captain. A few seconds later the line captain, who was now the PNF, remarked 'we might have to go around'. The PNF later commented that the reason for making this remark at the time was that he wished to verbalise crew preparedness to conduct a missed approach if it became necessary.

The approach to land was now continued by the flying training captain, during which time the average recorded rate of descent (ROD) was in excess of 1,300 ft/min. A maximum ROD of 1,830 ft/min was recorded as the aircraft descended through about 350 ft AGL. The PNF (line captain) recalled that the approach speed at that time was about 125 kts. Subsequently, the ROD was about 1,200 ft/min at 200 ft AGL.

After the aircraft touched down, the PF (training captain) selected reverse thrust and noticed that the NWS wasn't armed. The PF reported arming it at or about that time. As the aircraft's speed reduced to about 40 kts, and the PF was about to

bring the speed levers to LOW³, the aircraft suddenly veered to the right. The PF reported that in an attempt to regain control, he applied maximum reverse thrust, full left rudder and differential braking. He also re-selected the NWS.

Despite those actions, the aircraft continued to veer to the right, departed the runway and became bogged in wet grass about 15 m to the right of the runway strip.

Personnel information

The training captain held an Air Transport Pilot Licence (ATPL), was a company supervisory captain and had accumulated about 2,000 hours flying experience on the aircraft type. His last flight check was conducted on 11 February 2008.

The line captain held an ATPL and had been operating the aircraft type for about 8 years. His last flight check was conducted on 27 June 2007.

Aircraft information

The aircraft, serial number AC-490, was built in the US in 1982 and was first registered in Australia on 30 March 1995. At the time of the occurrence, the aircraft's total time in service was about 33,660 hours.

Aircraft maintenance history

A review of the aircraft's maintenance documents revealed a history of unscheduled maintenance associated with the NWS. Of particular relevance:

- On 16 July 2007, uncommanded turns were recorded due to a cracked NWS follow-up potentiometer. In response, the potentiometer was replaced.
- On 26 November 2007, intermittent uncommanded turns to maximum right deflection were recorded. Maintenance action in response included the cleaning of the hydraulic unit and a check of the wiring harnesses. No fault was found with the harnesses.

2 The PAL was activated by a series of timed transmissions using the aircraft's very high frequency radio, on either a discreet or the local airport communication frequency.

3 The speed levers limited propeller RPM. They were typically set to the HIGH position for takeoff and landing, an intermediate position for the cruise, and to LOW during ground operations.

Additional unscheduled maintenance on the NWS included the replacement of a number of microswitches that were located on the flight deck, and were associated with system activation.

Following this occurrence, the operator's maintenance department inspected the aircraft prior to its release for further flying operations. That inspection did not identify any faults with the NWS.

Nosewheel steering system

The NWS included a rack-and-pinion nose-steering actuator that was electrically controlled and hydraulically actuated when the landing gear was selected DOWN. Steering input signals were generated by rudder pedal deflection. The normal maximum steering angle was about 12° left or right of centre.

Rudder (control) and nosewheel (monitor) potentiometers provided electrical signals to the NWS. The system monitored the actual and selected position of the aircraft's nosewheel in response to rudder pedal deflection.

After arming, the system was engaged by depressing a button on the left power lever or, by placing the right speed lever fully aft. A green NWS light on the annunciator panel indicated that the system was engaged and operable. Illumination of a flashing NWS FAIL light indicated that the nosewheel had turned more than 3° beyond the angle selected by the rudder pedals. If that condition occurred, the NWS would disengage, and the nosewheel would revert to castor mode.

When the system was not engaged, or in castor mode, the nosewheel was free to castor up to about 63° left or right of centre. As rudder effectiveness was lost as the aircraft's speed decreased through about 60 kts, directional control in castor mode was achieved predominately by asymmetric braking.

Meteorological information

The Thangool aerodrome forecast that was valid for the flight, indicated light to moderate winds from the south-east, overcast conditions with rain

showers, and broken⁴ areas of cloud down to 800 ft above the aerodrome elevation (AAL).

Also forecast for the aircraft's arrival, were periods during which the weather may temporarily deteriorate. Those temporary deteriorations included visibility reducing to 2,000 m in heavy rain showers and broken cloud at 350 ft AAL.

Aerodrome information

Thangool aerodrome was at an elevation of 644 ft above mean sea level and was located less than 1 km to the south of the township. The main runway 10/28 was aligned effectively east to west on a bearing of 102/282° magnetic, had a sealed bitumen surface, and was 1,522 m long and 30 m wide.

Both pilots recalled that, at the time of the occurrence, the runway was wet with areas of standing water (puddles).

Aerodrome lighting was available on runway 10/28, and could be activated on a discrete PAL frequency of 120.6 MHz. Activation of the PAL system was accomplished by transmitting three 3-second pulses (transmissions of between 1 and 5 seconds) with breaks in between of about 1 second on that frequency.

Although not in use at Thangool Aerodrome, a similar PAL system was in use at the time at some other airports that required transmissions on the appropriate aerodrome frequency response unit (AFRU)⁵ frequency. That system, AFRU + PAL, was activated by transmitting on the AFRU frequency with three short transmissions of less than 1 second, including breaks of less than 1 second between each transmission. Following successful activation, the AFRU would transmit a confirmation (or readback) message indicating that the runway lights were ON.

4 Cloud amounts are reported as oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1-2 oktas, scattered = 3 to 4 oktas, broken = 5-7 oktas and overcast = 8 oktas.

5 An AFRU provided an automatic response at non-towered aerodromes when pilots transmitted on the common traffic advisory frequency for the relevant aerodrome.

Flight recorders

The aircraft was fitted with a flight data recorder (FDR) and cockpit voice recorder (CVR).

Examination of the FDR provided information relating to the aircraft's heading, altitude and relative air speed. The aircraft's ROD was established as a function of altitude change over time.

A review of the CVR suggested that, although the correct PAL frequency was selected, the timing used on the first three attempts to activate the lighting was for an AFRU + PAL system. Shortly after the third unsuccessful attempt, and less than 1 minute prior to touchdown, the training captain questioned whether the PAL was a 1-second or 3-second system. The pilot flying line captain replied that it was a 3-second system, and the aerodrome lighting was activated about 10 seconds later.

Organizational and management information

Stabilised approaches

The aircraft operator's operations manual provided guidelines for the conduct of stabilised approaches. Those guidelines in part stated:

An approach is stabilised when the aircraft is lined up with the runway and flown at the prescribed approach speed in the landing configuration maintaining an acceptable rate of descent.

All approaches must be stabilised not later than 300 ft above the runway threshold elevation.

In a separate section, the operations manual further stated:

The support pilot was to advise the flying pilot at 300 ft if the sink rate was in excess of 1000 ft/min.⁶

The operations manual did not contain specific guidance on maximum rates of descent or go-around procedures for application in the case of unstabilised approaches.

Additional information

A review of the Australian Transport Safety Bureau (ATSB) occurrence database identified a number of similar occurrences involving the same type of aircraft that were associated with a loss of directional control.

In particular, UZD was involved in NWS-related occurrences in July and November 2007 (see *Aircraft maintenance history*). In addition, in April 2008, the aircraft was involved in a runway excursion.

Previous occurrences involving UZD

In July 2007, uncommanded turns on landing were reported that were consistent with the identification of a cracked NWS potentiometer.

Similarly, in November 2007, uncommanded turns were reported on landing. However, no faults were identified in that instance.

Runway excursion 21 April 2008

On 21 April 2008, the aircraft was involved in a runway excursion at Bankstown Aerodrome, New South Wales.

That incident occurred after landing, with the speed below 40 kts and at a time when the pilot was changing the speed lever settings from HIGH to LOW. It was reported that the NWS failed to function as selected, resulting in the aircraft veering to the right and departing the runway.

A subsequent inspection of the NWS, by an independent maintenance organisation, found a break in the nosewheel monitor potentiometer wiper wire. That break gave a null reading to the NWS. The NWS would have remained operable with a null reading, provided the position of the rudder pedals and the nosewheel remained the same. Once the pedals were deflected, the computer would receive a disagreement signal in the form of a voltage difference between the control and monitor potentiometers. That disagreement signal would cause the system to enter a fail mode, at which point the nosewheel would default to castor mode.

6 As noted earlier, the Brisbane-Thangool-Emerald freight run was normally a single pilot operation, so this guidance was only relevant to the particular circumstances of the occurrence under investigation.

Stabilised approaches

A number of ATSB and other investigation reports have stressed the importance of a stabilised approach as approach-and-landing risk reduction tools. In particular, ATSB report 200501977 identified 'a lack of clear criteria for conducting stabilised approaches or when to conduct a missed approach' as a contributing factor in the development of the collision with terrain that occurred 11 km north-west of Lockhart River, Queensland on 7 May 2005 and involved a Fairchild Industries SA227-AC (Metro 23) aircraft, registered VH-TFU.

In 2000, the Flight Safety Foundation (FSF)⁷ Approach-and-landing Accident Reduction taskforce published an *Approach-and-landing Accident Reduction (ALAR) Tool Kit and Briefing Notes*. Those notes were designed to address the high proportion of accidents involving aircraft above 5,700 kg during the approach and landing phases, and the incidence of Controlled Flight into Terrain (CFIT).

Included in the ALAR Tool Kit⁸ was *FSF ALAR Briefing Note 7.1 - Stabilised Approach*. That briefing note included recommended maximum rates of descent commensurate with the phase of flight. Unstabilised approaches were identified as frequent factors in approach-and-landing accidents (ALAs), including CFIT. The ATSB draws on this briefing note in considering issues of approach stabilisation.

ANALYSIS

The lack of any identified fault in the aircraft's nosewheel steering system (NWS) that might have contributed to the incident (see *Aircraft maintenance history*) suggested that the runway excursion may have been a consequence of operational factors. This analysis will examine those factors.

Runway excursion

The sudden and uncontrollable turn to the right was consistent with a loss of directional control while the nosewheel was in castor mode. Given the instances of uncommanded turns involving UZD prior and subsequent to this occurrence, the investigation considered the relevance of those events to this incident.

Previous occurrences

The fault finding and corrective maintenance action in response to the July 2007 occurrence suggested that the uncommanded turns in that instance were unrelated to this occurrence. Similarly, given that the uncommanded turns that were reported in November 2007 occurred almost 3 months prior to this occurrence, with no other events recorded in the intervening period, it was considered unlikely that the two events were related.

Subsequent occurrence

Although the April 2008 occurrence was similar to this occurrence (February 2008), and it was possible that these two events were related, it was considered unlikely that the aircraft's NWS would have continued to operate with the same underlying fault, but without incident, during the intervening 2-month period.

Thangool occurrence

The training captain report that the NWS was selected ON prior to the occurrence suggested that the ineffectiveness of the NWS could have been a result of a failure of the NWS. Had such a failure occurred, and there been an upset at a speed less than that required for aerodynamic rudder effectiveness, directional control of the aircraft may not have been assured. An intermittent failure could explain the inability by maintenance to identify a cause for any failure.

Equally, however, had the NWS inadvertently not been armed, the nosewheel would have been free to castor, similarly compromising directional control. In this instance, the difficulties associated with the activation of the aerodrome lights may have distracted the flight crew, with the effect that the NWS was inadvertently not armed at the appropriate time.

⁷ The Flight Safety Foundation was an 'independent, non-profit, international organisation engaged in research, auditing, education, advocacy and publishing to improve aviation safety'.

⁸ Available at http://flightsafety.org/files/alar_bn7-1stabilizedappr.pdf

Given the reported runway surface conditions, there was the potential for the areas of standing water to initiate a directional upset. Had the nosewheel been in castor mode, directional control of the aircraft by asymmetric braking or other means may not have been possible.

The investigation determined that the runway excursion was probably the result of a loss of directional control, at a time when the nosewheel was in castor mode. That mode was a consequence of either a NWS failure, or of an inadvertent failure to arm the system. There was insufficient evidence to determine the reason for the nosewheel being in castor mode.

Stabilised approach criteria

The unsuccessful attempts by the non-flying training captain to activate the Thangool aerodrome lighting were the consequence of an inappropriate activation method. It was not until very late in the approach, and after the appropriate activation method was used, that the runway lights were activated.

By the time the runway lights were activated, the aircraft was only 1.3 NM (2 km) from the aerodrome, and at a height of about 650 ft above ground level (AGL). Given the aircraft's approach speed, this left the pilot only about 35 seconds to re-establish the approach path prior to touchdown. The time available and height loss required meant that a rate of descent (ROD) well in excess of 1,000 ft/min was required to continue the approach. The average ROD in the 30 seconds prior to touchdown, and the maximum ROD during the latter stages of the approach, were well in excess of those recommended in the Flight Safety Foundation's Briefing Note 7.1 - *Stabilised Approach*.

At the time of the occurrence, the aircraft operator's operations manual did not provide specific limitations on the maximum rates of descent permitted during an approach, or guidance on when a missed approach should be initiated in the case of an unstable approach. Had appropriate guidance been provided, it could be expected that a missed approach would have been carried out by the crew.

FINDINGS

From the evidence available, the following findings are made with respect to the runway excursion involving Fairchild Industries SA227-AC (Metro III) aircraft, registered VH-UZD, at Thangool Aerodrome, Queensland on 12 February 2008 and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The runway excursion was probably a result of a loss of directional control at a time when the nosewheel was in castor mode.

Other safety factors

- The aircraft operator's stabilised approach criteria did not provide guidelines on maximum rates of descent permitted during an approach, or when a missed approach should be executed. (*Minor safety issue*)

Other key findings

- There was insufficient evidence to conclusively determine the reason for the nosewheel being in castor mode.
- The late activation of the aerodrome lighting was a result of an inappropriate transmission sequence.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety 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 responsible organisations for the safety issues identified during this investigation were given 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.

Aircraft operator

Safety Issue

The aircraft operator's stabilised approach criteria did not provide guidelines on maximum rates of descent permitted during an approach, or when a missed approach should be executed. (*Minor safety issue*)

Action taken by the aircraft operator

The operator's stabilised approach criteria have been rewritten and incorporated into the operator's Flight Operations Manual. The operator's stabilised approach criteria now states:

A go-around shall be initiated if the approach is not stable by:

1000 ft height above airport (HAA) in instrument meteorological (IMC) conditions or,

500 ft HAA in visual meteorological conditions (VMC).

In addition, the operator re-defined a stabilised approach in terms of meeting a number of criteria, including that:

Sink rate is no greater than 1000 feet per minute below 1000 ft HAA on all approaches (VMC and IMC)

An approach that becomes unstable below 1000 ft IMC or 500 ft VMC requires an immediate go-around.

ATSB assessment of response/action

The ATSB is satisfied that the action taken by the operator adequately addresses the safety issue.

SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

- pilots of VH-UZD
- aircraft operator
- aircraft maintainer
- aircraft's FDR/CVR
- Bureau of Meteorology.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation*

Act 2003, 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 and the Civil Aviation Safety Authority. Submissions were received from the flight crew. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.