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Australian Transport Safety Bureau

Runway undershoot involving Fairchild SA226, VH-SSV

Theodore ALA, Queensland, 23 November 2016

ATSB Transport Safety Report

Aviation Occurrence Investigation

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Published by:	Australian Transport Safety Bureau
Postal address:	PO Box 967, Civic Square ACT 2608
Office:	62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone:	1800 020 616, from overseas +61 2 6257 4150 (24 hours)
	Accident and incident notification: 1800 011 034 (24 hours)
Facsimile:	02 6247 3117, from overseas +61 2 6247 3117
Email:	atsbinfo@atsb.gov.au
Internet:	www.atsb.gov.au

Addendum

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Runway undershoot involving Fairchild SA226, VH-SSV

What happened

On 23 November 2016, a Fairchild SA226TC, registered VH-SSV (SSV), departed from Brisbane Airport, Queensland, for a passenger charter flight to the Theodore aircraft landing area (ALA), Queensland. On board the aircraft were the pilot and five passengers.

When SSV arrived at Theodore, the aircraft joined the circuit on the downwind leg for runway 17 at 2,100 ft[1] using the area QNH.[2] The pilot turned the aircraft through the base leg of the circuit, using a constant radius turn, and rolled the aircraft to wings level for the final approach at about 1,400 ft.

In the early stages of the final approach, the pilot noticed the aircraft sink,[3] so they[4] increased power slightly to compensate and by mid final they were satisfied the aircraft was stable on the desired approach path profile. On short final, the pilot checked the airspeed and noted the aircraft was at their calculated airspeed of V_{REF}[5] +2 (111 kt). Shortly after they checked the airspeed, the pilot noticed the aircraft sink, so they pulled back on the elevator control and started to increase power, but the main wheels touched down just prior to the runway threshold. A loud bang was heard within the aircraft and the pilot immediately suspected the aircraft had struck one of the runway 17 threshold solar powered lights.

The landing was completed and after parking the aircraft on the apron, a passenger reported to the pilot that the right wing was leaking fuel. On inspection, the pilot found a puncture to the underside of the right wing, just outboard from the right engine nacelle, which had breached the fuel tank (Figure 1). They concluded it was probably the result of debris from the damaged runway light flicked up by the right main wheel tyre. There were no injuries and the aircraft received minor damage.

Figure 1: Damage to the underside of wing

Source: Pilot

1 The elevation of Theodore ALA is 560 ft.

2 QNH: the altimeter barometric pressure subscale setting used to indicate the height above mean sea level. Forecast Area QNH are considered accurate to within 5 hPa, which equates to a height of about 150 ft.

3 Sink: an increase in rate of descent with little change in the horizontal attitude of the aircraft.

4 Gender-free plural pronouns: may be used throughout the report to refer to an individual (i.e. they, them and their).

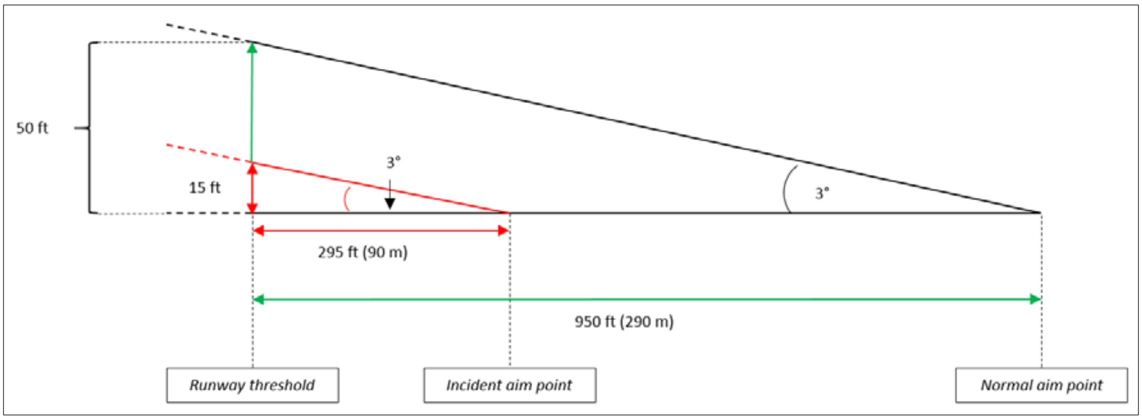
5 V_{REF} is the reference landing speed of an aeroplane which it attains in a specified landing configuration at a height of 50 ft above the runway threshold, and is used to determine the landing distance required.

Landing threshold height

Theodore ALA is situated about 560 km north-west of Brisbane. The ALA has a sealed runway strip surface at an elevation of 560 ft and direction 170-350. The runway length is 1,342 m with a slight down slope to the south (runway 17) and is fitted with low intensity runway lights at the thresholds and at 90 m intervals alongside the runway strip. The pilot used the first row of runway lights from the threshold as their landing aim point.

The landing distance required (LDR) begins at a height of 50 ft from over the runway threshold. The pilot reported flying a standard 3° approach path angle. However, a 3° approach path, with a threshold height of 50 ft is based on a landing aim point about 290 m from the runway threshold. Using the same approach path angle with an aim point 90 m from the runway threshold will reduce the threshold height to about 15 ft (Figure 2).

Figure 2: Runway threshold heights



Source: ATSB (not drawn to scale)

Landing distance performance calculations

Aeroplane flight manual

The pilot used the aeroplane flight manual (AFM) for their performance calculations. The AFM has six sections. The first four sections of the AFM were approved by the United States Federal Aviation Administration (state of manufacture). Section six was manufacturer's data for calculating performance. The manufacturer's data section provided two approach options for calculating LDR. One option was the short field landing approach at V_{REF} 1.1 V_{s0}[6] with full reverse thrust on landing. The other option was the normal approach at V_{REF} 1.3 V_{s0} with no reverse thrust on landing.

The AFM charts are only applicable to level runways. Runway slope is not included as a factor in any of the landing distance charts.

Civil Aviation Order 20.7.4

Civil Aviation Order (CAO) 20.7.4 – *Aeroplane weight and performance limitations – aeroplanes not above 5,700 kg – private, aerial work and charter operations* – paragraph 10 was the CAO for defining how to calculate LDR. Paragraph 10.1 required the calculated LDR to be multiplied by a safety factor, which was 1.43 for SSV. However paragraph 10.1 was subject to paragraph 10.3. Paragraph 10.3 stated:

> Where there is an approved foreign flight manual or a manufacturer's data manual for an aeroplane that sets out the landing distance required for that aeroplane, then that aeroplane must be operated so as to comply with the requirements set out in paragraphs

[6] V_{s0} is the stalling speed with wing flaps in the landing setting and undercarriage extended.

10.1 and 10.2 or the requirements relating to landing distance set out in either of those manuals.[7]

Therefore, CAO 20.7.4 did not require a multiplication factor to be applied if LDR was calculated from either the approved foreign flight manual[8] or manufacturer's data manual.

Company operations manual

The company operations manual for the Fairchild SA226TC provided the following directions to their pilots for performance calculations:

- The pilot-in-command is responsible for ensuring the aircraft is capable of the performance required for the operation. This assessment should include take-off and landing distances, climb performance, and single engine performance.
- Charts supplied in the manufacturer's approved flight manual for this aircraft are American charts and are not factored as required by CAO 20.7.4. Take-off and landing information derived from these charts must be factored to comply with the CAOs, specifically:
    - Take-off distances must be multiplied by a factor of 1.25
    - Landing distances must be multiplied by a factor of 1.43

While the operations manual referenced factoring as a regulatory requirement, it was also company policy to factor landing distances in accordance with CAO 20.7.4 paragraph 10.1, in order to include a safety margin to the flight manual charts, which were un-factored charts.

Pilot calculations

The pilot calculated a short field approach and normal approach LDR with the following results:

- Short field approach V_{REF} 93 kt. Un-factored LDR 590 m; factored LDR 840 m.
- Normal approach V_{REF} 109 kt. Un-factored LDR 1,080 m; factored LDR 1,543 m.

Therefore, for a runway length of 1,342 m, both approaches were suitable un-factored, but only the short field approach was suitable when factored. The calculations did not include a factor for runway slope, but the pilot was aware of a downslope on runway 17 from their previous experience.

Pilot's minimum control speed experience in SA226TC

The pilot noted that the AFM-published V_{MC}[9] for the aeroplane was 94 kt, which was greater than their calculated short field approach V_{REF}, but less than their calculated normal approach V_{REF}.

During the pilot's SA226TC endorsement training in the simulator, the first time they were given an engine failure at V1 they were unable to arrest the yaw and roll in a timely manner and crashed the aircraft (simulator). The SA226TC does not have an auto-feathering[10] propeller mechanism fitted. It is fitted with a negative torque sensing system (NTS system). In the event of an engine failure during flight, the NTS system provides automatic drag reduction by moving the propeller blades towards the feather setting. Once the drag reduces and the negative torque decreases, the feather valve returns to its normal position under the influence of its spring, and the propeller

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7 Paragraph 10.3 includes the following note: The data contained in some manufacturers' data manuals is un-factored and makes no allowance for degraded aircraft performance. Where there is a considerable difference between the data in a manufacturer's data manual and the data in the flight manual for the aeroplane then the manufacturer's data should be treated with caution.

8 An approved foreign flight manual means the flight manual approved by the relevant regulatory aviation authority of the country where the aeroplane is, or was, manufactured.

9 V_{MC} is the lowest airspeed, at which, in the event of the critical power unit suddenly becoming inoperative, it is possible to maintain control of the aeroplane with that engine inoperative, and to maintain straight flight using no more than 5° of bank without a change of heading greater than 20°.

10 Feathering: the rotation of propeller blades to an edge-on angle to the airflow to minimise aircraft drag following an in-flight engine failure or shutdown.

blades move toward the fine (unfeathered) setting. This condition is repetitive until the pilot manually feathers the propeller and is called ‘NTSing.’

The pilot then successfully completed the simulator exercise three more times, completing all drills and feathering the propeller in an appropriate time frame. However, the minimum angle of bank they achieved while regaining control of the aircraft (simulator) was 30°.

From their simulator experiences of the asymmetric handling qualities of the aircraft near V_{MC}, the pilot was uncomfortable conducting approaches at a calculated V_{REF} below or close to V_{MC}.

Approach profile and aim point selection

The pilot reported that they had flown to Theodore numerous times previously, which included 28 times during 2016 in SSV. They did not want to conduct an approach using a V_{REF} less than $V_{MC.}$ Therefore, they employed the normal approach profile with a V_{REF} 1.3 V_{s0}, with the LDR factored in accordance with their operations manual. This produced an LDR greater than landing distance available. In addition, the AFM charts assume a level surface. There is no factor for runway slope and downslope will increase LDR. To minimise the landing distance, the pilot applied full reverse thrust in addition to wheel braking after touchdown for the ground roll when landing at Theodore.

Runway aim point markers, located about 300 m from the threshold on sealed runways, were the standard aim point employed by the pilot. However, unsealed runways, such as Theodore, do not require aim point markers. Consequently the pilot utilised the runway side lights for their aim point. The pilot understood that the landing distance available was between their calculated un-factored and factored LDR for a normal approach using V_{REF} 1.3 V_{s0}, but the downslope on runway 17 would increase their landing distance. This led them to select the first row of runway lights as their aim point in order to maximise the runway distance available for braking. They estimated, from their previous experience, that the normal approach with the use of full reverse thrust on landing would result in a landing distance about 100 m longer than that calculated using a short field approach.

Stabilised approach criteria

The company had a ‘no-fault’ go-around policy and published stabilised approach criteria. For a visual approach the criteria apply from 300 ft above ground level. There were several criteria listed for a stabilised approach, which included:

- The aircraft is on the desired flight path, e.g. established on final/base leg;
- Only small pitch and heading changes are required to maintain the desired flight path;
- For circling approaches, the wings must be level on final not below 300 ft above ground level; indicated airspeed at threshold (50 ft) within tolerance (V_{REF} +5, -0).

During the approach, the aircraft was flown on the pilot’s desired flight path. On short final the pilot checked their airspeed, which was within the threshold stabilised approach criteria and continued the approach. When the aircraft began to sink on short final, the pilot pulled back on the elevator to pitch the aircraft nose upward and applied power in an attempt to avoid an early touchdown, but there was insufficient height to recover.

Convective weather

The pilot reported the incident occurred at about 1657 Eastern Standard Time (EST) and the temperature was about 36 °C. The runway surface is bitumen and the ALA is surrounded by paddocks. On the approach to runway 17, some of the paddocks had been ploughed in preparation for planting and some had light coloured crops. Following discussions between the pilot and their chief pilot, they concluded that because the wind speed in the area at the time was light, the sink may have been the result of local convective currents (known as *thermals*).

Convective currents are the result of uneven surface heating, which sets up areas of local circulation as the air flows from areas of higher pressure towards areas of lower pressure. Ploughed ground and bitumen surfaces, such as sealed runways, absorb and radiate a large amount of heat. If there are neighbouring surfaces, which absorb and radiate less heat, then local updrafts and downdrafts will form, which may strengthen throughout the day.

Further information is available from the United States Federal Aviation Administration's *Pilot's Handbook of Aeronautical Knowledge: chapter 12: weather theory*.

Safety analysis

The pilot considered that a go-around from short final, with an engine failure to be the worst-case scenario when flying the Fairchild SA226TC. The short field approach required a V_{REF} below the published V_{MC} and therefore, when they planned their flight to Theodore, they utilised the normal approach profile speed of V_{REF} 1.3 V_{s0} to provide a safety margin.

The pilot calculated a LDR, from the AFM, for a short field and normal approach, which were both less than the landing distance available. When the pilot applied the factor of 1.43, the normal approach LDR was greater than the landing distance available. The pilot also knew from their previous experience, that there was a downslope on runway 17 at Theodore, which increased their LDR relative to a level runway. Therefore, the pilot always applied full reverse thrust whenever they landed the aircraft on runway 17 at Theodore. Their previous experience of using full reverse thrust on landing from a normal approach, led them to expect an actual landing distance about 100 m longer than required for a short field approach and within the Theodore landing distance available.

The pilot's knowledge of the landing distance required and downslope of runway 17, led them to select the first row of runway lights as their aim point marker, while maintaining a 3° approach path profile. The use of this aim point resulted in the aircraft descending below 50 ft prior to reaching the runway threshold and therefore a low approach path on short final.

The time of the incident was near the end of a hot day with light winds. The pilot did not report that any airspeed fluctuations occurred during the approach, but they experienced sink early on the final approach and again when the incident occurred. Therefore, the runway undershoot was probably the result of a low approach path, which combined with a downdraft from local convective activity to lead to an early touchdown. The early touchdown resulted in the collision with a runway light and subsequent damage to the aircraft wing.

Findings

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

- The pilot flew an approach path with a low runway threshold height, which combined with a downdraft from local convective activity on short final, resulting in a runway undershoot, collision with the runway light and damage to the aircraft wing.

Safety action

Whether or not the ATSB identifies 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.

Operator

As a result of this occurrence, the aircraft operator has advised the ATSB that they have taken the following safety actions:

Internal investigation

The operator conducted an investigation into the incident, where a detailed safety report was produced. The report concluded that 'this incident was a mishandled landing, with the pilots' aiming point and probable thermal activity as contributing factors.'

Training

Prior to further operations in this aircraft type, the incident pilot was retrained on the aircraft type, which involved the following:

- The pilot received a detailed briefing covering aircraft type performance.
- The pilot flew with the type specialist for re-training. These flights involved operations into different airports and runway environments.
- The pilot was returned to duty on charter operations under supervision, and then re-assessed prior to further line flying operations.

Operations manual

The company operations manual for the Fairchild SA226TC shall be amended to reference the factoring of landing distances as a company procedure.

Safety message

This incident highlights the risk of unintended consequences associated with variations from standards. Each change on its own may not lead to an incident or accident, but may increase the likelihood of an incident or accident if combined with an unexpected event(s).

Further general information on calculating landing distances is available from the Flight Safety Foundation *approach and landing accident reduction briefing note 8.3 – landing distances.*

General details

Occurrence details

Date and time:	23 November 2016 – 1657 EST	
Occurrence category:	Serious incident	
Primary occurrence type:	Runway undershoot	
Location:	Theodore ALA, Queensland	
	Latitude: 24° 59.60’ S	Longitude: 150° 05.58’ E

Aircraft details

Manufacturer and model:	Fairchild Industries Incorporated SA226TC	
Registration:	VH-SSV	
Serial number:	TC-383	
Type of operation:	Charter - passenger	
Persons on board:	Crew – 1	Passengers – 5
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Minor	

About the ATSB

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB 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; and 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 operations involving the travelling public.

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.

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.

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.

About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.