Australian Government
Australian Transport Safety Bureau

Avionics system event involving Fokker F100, VH-FNR

West Angelas Aerodrome, Western Australia, on 1 September 2020

ATSB Transport Safety Report
Aviation Occurrence Investigation (Short)
AO-2020-046
Final – 22 July 2021

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Publishing information

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, ACT 2601
Telephone: 1800 020 616, from overseas +61 2 6257 2463
Accident and incident notification: 1800 011 034 (24 hours)
Email: atsbinfo@atsb.gov.au
Website: www.atsb.gov.au

Addendum

Page	Change	Date

Safety summary

What happened

On 1 September 2020, a Virgin Australia Regional Airlines Fokker 100 aircraft, registered VH-FNR, was being operated on a scheduled passenger flight from Perth Airport to West Angelas aerodrome, Western Australia. During the landing, the take-off/go-around (TOGA) mode activated, disarming automatic deployment of the lift dumpers. Manual activation of the lift dumpers and reverse thrust did not occur on the first or second attempts by the flight crew. On the third attempt, the lift dumpers and thrust reversers deployed. During the landing roll, an engine speed caution activated as reverse thrust had been selected between the idle and maximum reverse positions.

What the ATSB found

The ATSB found that, during the landing phase, the TOGA mode activated uncommanded for an undetermined reason. This subsequently prevented automatic deployment of the lift dumpers.

It was also established that the aircraft likely landed so softly that the weight on wheels sensors did not immediately activate. This delayed manual activation of the lift dumpers and deployment of reverse thrust.

What has been done as a result

While no faults were found with the TOGA system, the operator has requested that the aircraft manufacturer develop guidance documentation for maintenance of TOGA switch travel and resistance.

Safety message

This incident illustrates that, despite the high reliability of modern flight control systems, flight crews can still be faced with non-normal situations that require their combined judgement and expertise to safely manage.

The investigation

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 investigation was conducted in order to produce a short investigation report, and allow for greater industry awareness of findings that affect safety and potential learning opportunities.

The occurrence

On 1 September 2020, at about 1514 Western Standard Time,[1] a Fokker F28 Mk 0100 (Fokker 100) aircraft, registered VH-FNR and operated by Virgin Australia Regional Airlines departed for a scheduled passenger flight from Perth Airport to West Angelas aerodrome, Western Australia. The first officer (FO) was the pilot flying and the captain was the pilot monitoring.[2]

At about 1642, the flight arrived at West Angelas and the flight crew reported that, after touching down right wheel first, they selected the engine thrust reverser levers to the idle position. However, the reversers did not deploy and the levers returned to the stowed position. The FO selected reverse idle a second time. The captain then noted that the thrust reverser and lift dumper deployed messages did not appear on the multi-function display unit and therefore called 'negative reverse, negative lift dumpers' in accordance with standard procedures. The FO noted that the levers had returned to the stowed position again, and moved the levers beyond reverse idle and applied manual braking. Both thrust reversers and lift dumpers then deployed. The flight crew did not recall any bouncing on landing, which they described as a 'single positive landing'.

Shortly after, an engine speed caution 'N1 in Prohibited Range' activated for the left engine, as reverse thrust had been selected between idle and maximum reverse. The captain took over control of the aircraft and returned the thrust reverser levers to idle. The landing continued normally to the end of the runway.

At the end, the captain observed that the go-around (GA) flight mode was active on the primary flight display, with the associated pitch-up attitude direction on the flight director. The multi-function display unit was also indicating take-off/go-around (TOGA) thrust mode. This confused the flight crew as they had not activated the TOGA triggers and were on the ground. The flight crew notified operations and maintenance staff, then grounded the aircraft.

Context

Take-off/go-around modes

The take-off and go-around modes are selected by pulling two TOGA triggers located on the thrust levers (Figure 1). When pulled in-flight, the go-around mode is selected, and the aircraft will direct a rotation to a safe climb-out pitch attitude and maintain the current heading. The thrust levers are initially advanced to go-around thrust and then managed to maintain a climb rate of 2,000 ft per minute or airspeed of 200 kt. In addition, the speed brake is automatically retracted if it has been extended and the lift dumpers are disarmed.

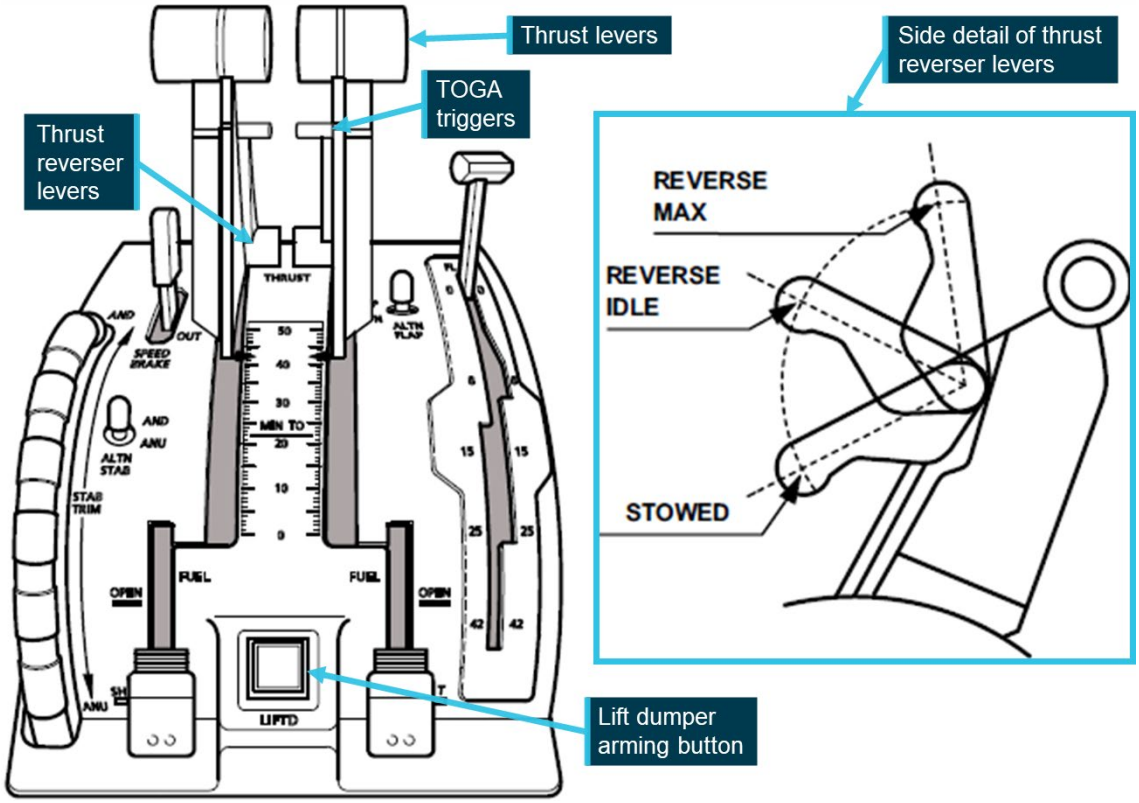
If a performance-decreasing windshear is detected, pulling the TOGA triggers will instead activate the windshear recovery mode.

---

1 Western Standard Time (WST): Coordinated Universal Time (UTC) + 8 hours.

2 Pilot flying (PF) and pilot monitoring (PM): procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances, such as planning for descent, approach and landing. The PM carries out support duties and monitors the PF's actions and the aircraft's flight path.

Figure 1: Fokker 100 throttle quadrant



Source: Fokker 100 Aircraft Operating Manual, annotated by the ATSB

Take-off/go-around triggers

Each TOGA trigger contains three internal switches that are operated simultaneously when the trigger is pulled. One switch is connected to each of the flight control computers, and one energises relays to inhibit the anti-icing system and disarm the lift-dumpers. It is only necessary for a single trigger to be pulled for the aircraft to respond.

If one of the switches connected to the flight control computers malfunctions, or the flight computers receive different signals, a 'no autoland permitted' (NO ALAND) warning and an autothrottle failure alert is generated. The flight crew did not report receiving any NO ALAND warnings. If the third switch fails, only the lift dumper arming system and anti-ice system would be affected.

The flight crew reported that the motion to actuate the TOGA triggers was an intentional movement that they did not believe could happen accidentally. With one hand resting on the thrust levers, the two middle fingers would need to be extended down behind the thrust levers to reach under the TOGA triggers and pull them up.

Reverse thrust

Each engine has a thrust reverser installed that, when deployed, deflects exhaust flow vertically and forward to slow the aircraft. The thrust reversers for each engine operate independently and are deployed by lifting the thrust reverser lever to either the reverse idle or reverse maximum ('max') positions (Figure 1). To lift the thrust reverser lever, the thrust levers must be in the idle position. Thrust reversers will not deploy unless the aircraft is on the ground, as sensed by either of the weight on wheels sensors. More than reverse idle cannot be applied before the reverser doors are completely deployed.

If the engine speed (N1) remains in the restricted reverse range between 57 per cent and 75 per cent for more than 2 seconds, a caution will be presented. After 7 seconds, a warning is presented, and an engine fan inspection is required.

Lift dumpers

The lift dumpers are used to greatly reduce lift and increase braking effectiveness after touchdown. They consist of five hydraulically controlled doors on each wing. The system can be armed to deploy automatically on landing. In this case, the lift dumpers extend when the landing gear wheels spin up on touchdown and the thrust levers are at idle. They retract when the system is disarmed or when thrust levers are advanced. When armed, the system will disarm automatically if the TOGA triggers are activated, or when a thrust lever is advanced to maximum thrust. If the system is not armed, and the aircraft is on the ground, the lift dumpers will extend when reverse thrust is selected.

Weight on wheels sensors

The two main landing gears each have a weight on wheels sensor to detect whether the aircraft is on the ground. Each is a proximity sensor that activates when the landing gear is compressed by at least 20 mm. When the landing gear is compressed, the sensor reads a 'ground' state. When uncompressed, the sensor reads an 'air' state.

Flight data analysis

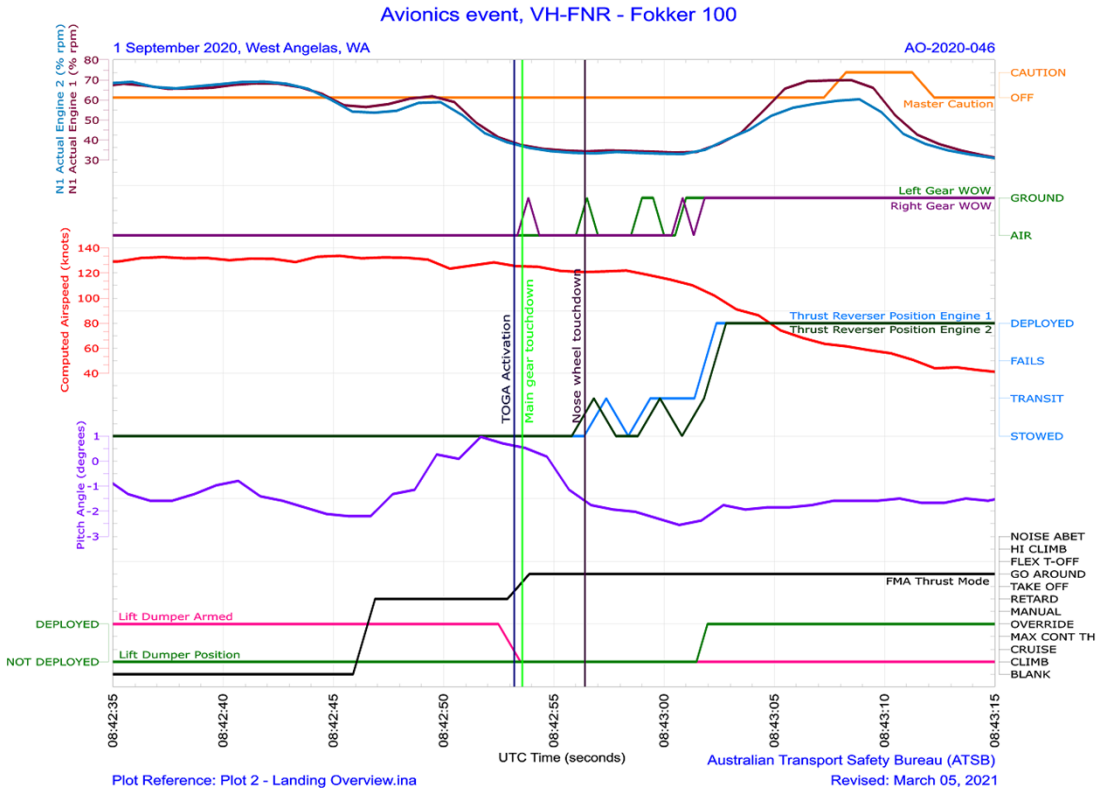
The aircraft was fitted with a flight data recorder and a cockpit voice recorder, which were downloaded by the ATSB. The cockpit voice recorder contained 2 hours of audio from the subsequent flight and none from the incident flight. The flight data recorder contained 500 hours of data, including the incident. The flight data was analysed, and selected timings and parameters are presented in Figure 2 and Figure 3. Of note:

- At the activation of TOGA mode, the aircraft had an airspeed of 126 kt with engines at idle.
- The main landing gear touched down within 0.6 seconds after TOGA mode activation.
- The nose wheel touched down after about 3 seconds, however, it took a further 5 seconds before the aircraft recognised that it was on the ground (had positive weight on wheels), and deployed thrust reversers and lift dumpers.

Figure 2: Landing sequence of events

Source: ATSB

Figure 3: VH-FNR flight data for the landing



Source: ATSB

Maintenance actions

Before returning the aircraft to Perth, the TOGA switches, weight on wheels sensors, lift dumpers, thrust reversers, flight computers, and autothrottle systems were tested by maintenance personnel. No anomaly or unserviceability was found.

After relocating to Perth, the wiring of the TOGA switches and operation of the autothrottle system were tested, with no defects found. The aircraft was then returned to service and at the time of publication of this report, there had been no recurrence.

Landing forces analysis

Accelerometer data from about 200 landings of VH-FNR prior to the incident were aggregated. The maximum G loading, and average between the maximum and minimum G loadings (range) during each landing were calculated. The incident landing had a maximum G loading lighter than about 85 per cent of touchdowns, and range of G loadings during landing smaller than about 90 per cent of touchdowns.

Safety analysis

Activation of TOGA mode

Based on the required hand action and the flight crew's recollection of the incident, the ATSB assessed that the flight crew did not likely activate TOGA mode inadvertently by pulling the TOGA triggers. Rather, the FO's hands would have been in the process of reaching for and lifting the thrust reverser levers.

In addition, no system or mechanical faults were found, and there has been no recurrence of the incident, which indicated there was not a persistent fault. Therefore, the reason for the TOGA mode activation could not be established. However, the activation of the TOGA mode resulted in the disarming of the lift dumpers, preventing automatic deployment on touchdown.

Weight on wheels sensing

The weight on wheels sensors gave an intermittent weight on wheels signal during landing, even after all wheels had touched down. This prevented reverse thrust from being deployed and the lift dumpers from extending manually. While not an issue in this incident, research has shown that a delay in the deployment of reverse thrust and/or lift dumpers have contributed to runway overrun events (Jenkins & Aaron, 2012).

The intermittent signal was most likely due to a softer than typical landing, combined with the lift-dumpers not automatically deploying. Failure of the sensors was unlikely, as the sensors settled to a ground state and no further incidents with the sensors had been recorded at the time of publication of this report.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition, 'other findings' may be included to provide important information about topics other than safety factors.

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

From the evidence available, the following findings are made with respect to the avionics system event involving Fokker F100, VH-FNR, on 1 September 2020.

Contributing factors

- During landing, the take-off/go-around mode activated uncommanded for an undetermined reason, preventing automatic deployment of the lift dumpers.

Other findings

- The aircraft landed so softly that the weight on wheels sensors did not immediately activate, which delayed the deployment of reverse thrust and manual extension of the lift dumpers.

Safety actions

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. All of the directly involved parties are invited to provide submissions to this draft report. As part of that process, each organisation is asked to communicate what safety actions, if any, they have carried out to reduce the risk associated with this type of occurrences in the future. The ATSB has so far been advised of the following proactive safety action in response to this occurrence.

Safety action by Virgin Australia Regional Airlines

While no issue with the TOGA switches were identified, the operator has advised the ATSB that they have contacted the aircraft manufacturer and requested the development of guidance for maintenance of TOGA switch travel and resistance.

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- Virgin Australia Regional Airlines
- flight crew

- Fokker Services.

References

Jenkins, M., & Aaron Jnr, R.F. (2012). Reducing runway landing overruns, *Boeing AERO*, *47*, 15-19. Retrieved from www.boeing.com/commercial/aeromagazine/articles/2012_q3/3/

Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section 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 following directly involved parties:

- Virgin Australia Regional Airlines
- flight crew
- Fokker Services.

Submissions were received from Fokker Services. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

General details

Occurrence details

Date and time:	1 September 2020 – 1647 WST	
Occurrence category:	Incident	
Primary occurrence type:	Avionics system event	
Location:	West Angelas aerodrome, Western Australia	
	Latitude: 23º 7.842' S	Longitude: 118º 42.8' E

Aircraft details

Manufacturer and model:	Fokker F100	
Registration:	VH-FNR	
Operator:	Virgin Australia Regional Airlines	
Serial number:	11488	
Type of operation:	Air transport high capacity - Passenger	
Departure:	Perth, Western Australia	
Destination:	West Angelas, Western Australia	
Persons on board:	Crew – Unknown	Passengers – Unknown
Injuries:	Crew – Nil	Passengers – Nil
Aircraft damage:	None	