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Australian Transport Safety Bureau

Emergency evacuation involving Fokker F28, VH-NHY

Perth Airport, Western Australia, 23 September 2016

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Addendum

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Emergency evacuation involving Fokker F28, VH-NHY

What happened

On 23 September 2016, a Network Aviation Fokker F28 MK 100 aircraft, registered VH-NHY, departed Newman Airport, Western Australia (WA), on flight 1623 to Perth Airport, WA. On board were two flight crew, three cabin crew and 97 passengers.

About 550 km north of Perth, at 1048 Western Standard Time (WST), the flight crew were alerted to a caution for low quantity in hydraulic system 1. The flight crew completed the checklist actions, which included selecting the hydraulic system 1 pumps off. The loss of hydraulic system 1 results in the loss of the following systems:

- normal landing gear extension (alternate gravity landing gear extension required)
- normal flap extension (electric power used to extend flaps)
- nose-wheel steering, speed brakes and thrust reversers.

The flight crew notified air traffic control (ATC) of the fault and discussed the implications of the failure. Without nose-wheel steering, they planned to land the aircraft on runway 21 at Perth Airport and roll through to the end of the runway, where a pre-positioned tug would connect to the aircraft and tow it to the allocated gate for passenger disembarkation. Rather than use the engines for electrical power and air-conditioning during the aircraft tow, the captain elected to start the auxiliary power unit (APU) during the approach. The APU would then supply air for the air-conditioning system after landing and electrical power after the engines were shut down.

The flight crew discussed the issue with the cabin crew manager (CCM), advised them of the implications of the fault and their plan for when the aircraft landed. The flight crew subsequently advised the company of their plan and made a PAN[1] call to ATC with their landing intentions. They started the APU and then configured the aircraft early for the approach and landing. The aircraft landed without further incident and rolled through to the end of runway 21.

Figure 1: Emergency evacuation of VH-NHY

Source: Airport operator

At the end of runway 21, the flight crew could not see a tug waiting for the aircraft, so they used differential braking to turn the aircraft off the runway and onto the taxiway before stopping. The first officer completed the after landing checks, while the captain called the CCM to explain the

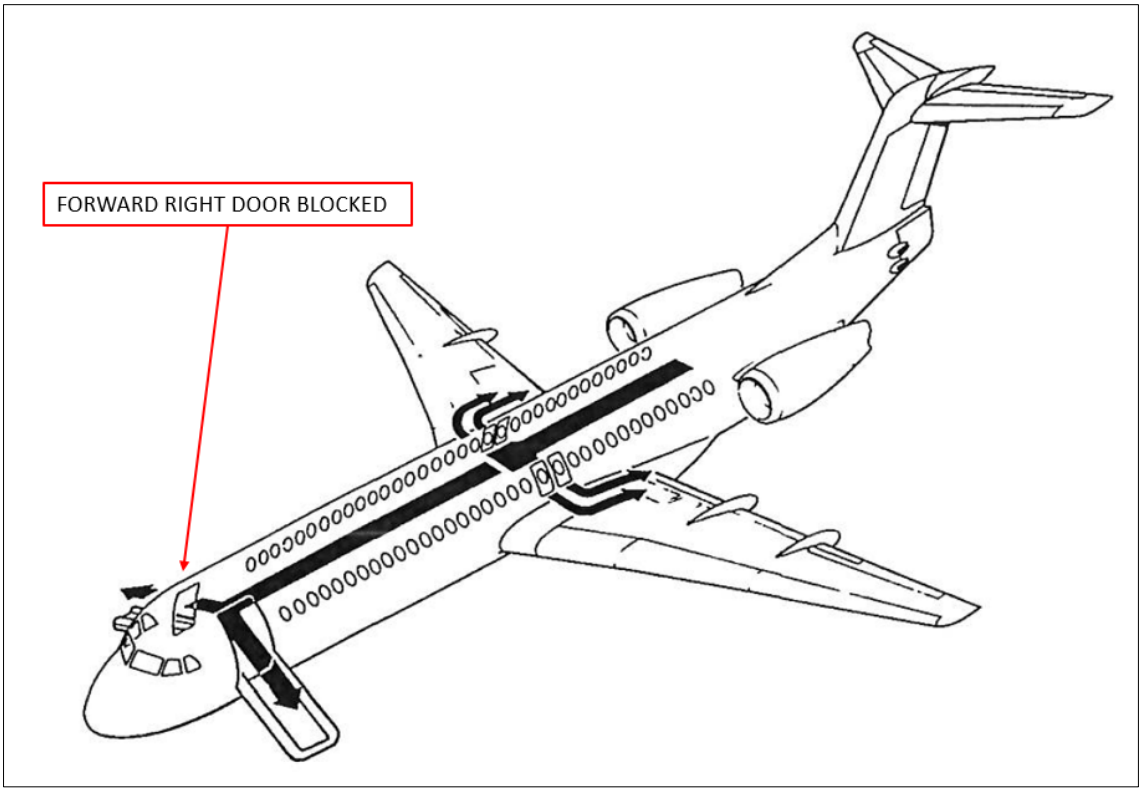
[1] PAN PAN: an internationally recognised radio call announcing an urgency condition which concerns the safety of an aircraft or its occupants but where the flight crew does not require immediate assistance.

situation and discuss the public address requirements. While on the interphone to the captain, the CCM reported that there were fumes present in the cabin. The captain turned the APU bleed off, to prevent the APU supplying air to the cabin. However, the CCM then reported that the fumes in the cabin were getting worse. Consequently, the captain suspected the fumes could be from the engines and in consultation with the CCM they elected to conduct an emergency evacuation (Figure 1).

The flight crew started the emergency evacuation checklist and the captain called for the evacuation over the public address system. The cabin crew opened the two front doors and the four over-wing emergency exits were removed by the passengers (Figure 2). The forward left door (L1) slide did not automatically inflate when the slide deployed, so the CCM manually inflated the slide. When the CCM checked on the forward right door (R1) slide they observed that it was not deployed and the cabin crewmember was blocking the exit. The passengers evacuated through the forward left door and the over-wing exits.

The flight crew completed the emergency evacuation checklist and the captain directed the first officer to take the fire extinguisher from the flight deck and join the passengers. The captain then left the flight deck about one minute after the evacuation started with the passenger manifest. They noted there were only a couple of passengers left in the cabin, and the CCM was directing one of them to leave their baggage behind and evacuate. The captain waited for all personnel to leave the aircraft, completed an inspection of the cabin and then exited the aircraft to join the passengers, provide them with support and liaise with the authorities. During the emergency evacuation, three passengers received minor injuries.

Figure 2: Aircraft emergency evacuation routes



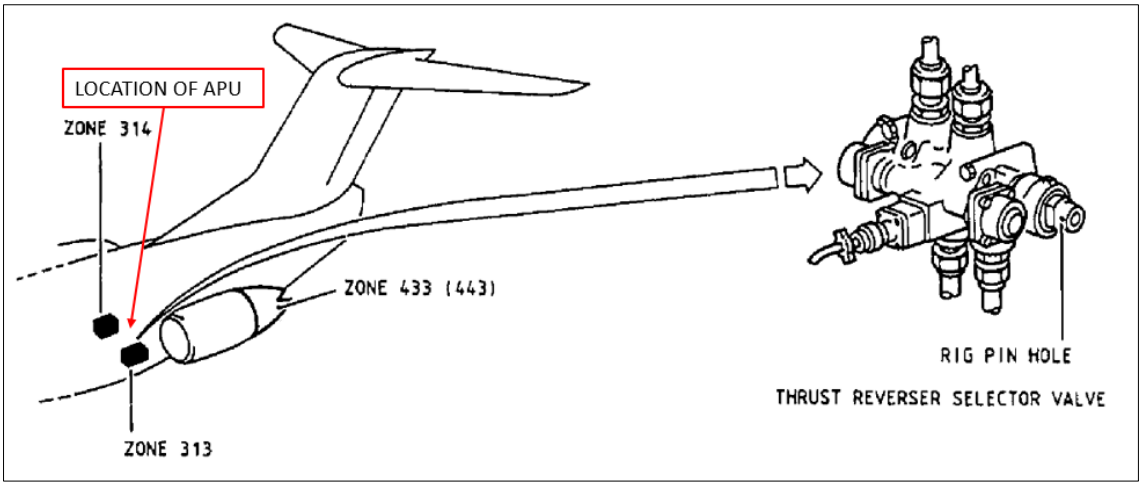
Source: Operator, annotated by ATSB

Maintenance findings

The maintenance organisation found the number 1 engine thrust reverser selector valve (see *Thrust reverser selector valves*), located in the left outboard APU (see *Auxiliary power unit*) compartment (zone 313), leaked hydraulic fluid from a damaged O-ring (Figure 3). Further inspection found the APU and air-conditioning system were contaminated with hydraulic fluid.

A gap between the APU intake door actuator rod cut-outs was identified as the path for contaminated air to enter the APU inlet. When the APU inlet door is open inflight, air is scooped into the inlet creating an area of high pressure. However, when the aircraft is on the ground with the APU running, the APU inlet becomes an area of lower pressure as the APU is now 'sucking' air into the inlet.

Figure 3: Location of APU and thrust reverser selector valves



Source: Operator, annotated by ATSB

The R1 door was found by the maintenance organisation to be in the 'DISARM' position ('MANUAL' mode; see *Cabin emergency exits*) and an inspection was conducted on the slide and associated mechanism. No defects were found. Inspections of the L1 door slide could not identify a reason for this slide to not inflate automatically.

Auxiliary power unit

The APU is located in the aft fuselage, behind the rear pressure bulkhead. It supplies pneumatic power for starting of the main engines and air-conditioning on the ground, and electrical power if the number 1 and 2 engine driven generators are not supplying power. If the APU is started while airborne, it will not supply air to the air-conditioning system until the ground-flight logic switch detects the aircraft is on the ground.

Thrust reverser selector valves

The thrust reverser selector valves supply hydraulic fluid under pressure to the thrust reverser actuators. Hydraulic fluid for the thrust reverser selector valves is supplied by hydraulic system 1. The number 1 selector valve (left side) is installed in the rear aircraft fuselage behind the pressure bulkhead in zone 313 adjacent to the APU compartment.

Cabin emergency exits

The aircraft is fitted with one forward left side passenger door with an inflatable slide, one forward right side door with an inflatable slide, and four over-wing escape hatches. The inflatable slides will deploy automatically when the door is opened from the inside with the door selector set to 'AUTOMATIC'. If the slides do not inflate in the automatic mode, then the red inflation handle on the right side of the slide pack must be pulled for inflation. When disarmed ('MANUAL' mode), the slide is not attached to the aircraft doorway and remains inside the door assembly when the door is opened. Once the door is opened in the MANUAL mode, there is no way to deploy the slide.

Previous incidents

A search of the ATSB database revealed two previous incidents of fumes entering the cabin on Fokker F28 aircraft from the same operator following a hydraulic leak when the APU was supplying air to the air-conditioning system:

- 21 November 2014: VH-NHM cabin fumes present on pre-departure. Source of hydraulic leak found to be from the horizontal stabiliser actuator.
- 21 January 2016: VH-NHP hydraulic system 1 low quantity inflight followed by cabin fumes during aircraft tow to the gate. Tail section was found wet internally with hydraulic fluid. Speed brake actuator found with damaged O-ring, which was identified as the source of the leak.

In response to the incident in 2014, the operator contacted the aircraft manufacturer to propose the design of a seal located at the entry point of the APU air intake. This would mitigate the potential for contamination of the air-conditioning system following a hydraulic leak. The manufacturer considered the proposal plausible and reasonable, but elected not to initiate action as this was their first reported occurrence.

Following the latest incident, and in light of the two previous incidents, the aircraft manufacturer considered if an amendment to emergency procedures was required to warn flight crew of the potential risk of a fumes incident from operation of the APU following a hydraulic leak. The manufacturer decided this was not supported based upon the following service experience:

> The majority of the reported hydraulic leaks are not located in the tail section. Hydraulic fumes entered the cabin or flight deck in less than 1% of the non-tail origin events. The APU was not implicated in the non-tail origin events.
>
> A change to the hydraulic quantity low emergency procedure was considered, but their review indicated that only a small percentage of tail origin hydraulic leak events that could potentially lead to fumes were associated with a hydraulic quantity alert.

Safety analysis

The hydraulic leak was the result of a failure of an O-ring in the number 1 thrust reverser selector valve. The checklist actions resulted in switching off the pumps supplying the number 1 hydraulic system with the loss of the associated systems, which included the nose wheel steering. The loss of nose wheel steering necessitated a tow to the gate by a tug after landing. The captain elected to start the APU inflight so that it would be available to supply air for the air-conditioning system after landing and electrical power after the engines were shutdown. However, unknown to the flight crew, the location of the hydraulic leak relative to the APU air intake, and a gap between the APU intake door actuator rod cut-outs, resulted in the contamination of the air-conditioning system. This occurred when the ground-flight logic switch detected the aircraft was on the ground and the APU started to act as a source of air supply for the air-conditioning system.

After the fumes were detected in the cabin, the first action by the captain was to switch off the air supply from the APU. Following this action, the air for the air-conditioning system was supplied by the engines. However, by this stage various parts of the air-conditioning system were contaminated with hydraulic fluid. Therefore, fumes continued to enter the cabin through the air-conditioning system.

During the emergency evacuation, the R1 door slide did not deploy. The maintenance inspection found the R1 door was disarmed and no fault was found with the door operating mechanism. Therefore, it is likely that during the emergency evacuation procedure the cabin crewmember at the R1 door reverted to previous experience and disarmed the door prior to opening it, which prevented the slide from automatically deploying.

Findings

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

- A damaged O-ring in the left engine thrust reverser selector valve resulted in a hydraulic leak.
- Hydraulic fluid, or vapour, entered the APU air intake through a gap between the APU intake door actuator rod cut-outs.

- The cabin fumes were the result of the APU supplying air contaminated with hydraulic fluid to the air-conditioning system after the ground-flight logic switch detected the aircraft on the ground, which resulted in the contamination of the air-conditioning system.
- The R1 door slide did not deploy automatically because the door was disarmed when it was opened.

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:

Air quality checks

Following the replacement of parts contaminated with hydraulic fluid and cleaning of the APU area and air-conditioning system, the operator and their maintenance organisation conducted air quality checks on the aircraft before return to service.

Flying operations advisory bulletin

The operator's flight operations department issued flying operations advisory bulletin (FOAB) 031/16: *Fumes ingestion by the APU*. The bulletin advises flight crew of the potential for ingesting fumes through the APU intake in the event that the APU is operating with a hydraulic leak in the tail section of the aircraft.

Human factors review

The human factors review of the incident was conducted for learning points and future training considerations.

Maintenance program

Changes to the aircraft maintenance program have been introduced to proactively identify potential issues, such as detailed visual inspections within areas which may lead to potential air quality issues.

Safety message

This incident highlights the importance of training and procedures, and the need for organisations to educate their workforce about safety incidents. The flight crew on board NHY were confronted with two consecutive emergencies. They responded to each situation in accordance with their training and procedures, which resulted in everyone safely evacuating the aircraft with only minor injuries reported.

Further information about the risk of fumes can be found in ATSB research report AR-2013-213: *an analysis of fumes and smoke events in Australian aviation*.

General details

Occurrence details

Date and time:	23 September 2016 – 1048 WST	
Occurrence category:	Incident	
Primary occurrence type:	Systems - hydraulic	
Location:	550 km north Perth Aerodrome, Western Australia	
	Latitude: 27° 13.20' S	Longitude: 117° 43.05' E

Aircraft details

Manufacturer and model:	Fokker Aircraft B.V. F28	
Registration:	VH-NHY	
Operator:	Network Aviation	
Serial number:	11467	
Type of operation:	Air transport high capacity - Passenger	
Persons on board:	Crew – 5	Passengers – 97
Injuries:	Crew – 0	Passengers – 3 (minor)
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.