Australian Government
Australian Transport Safety Bureau

Engine in-flight shutdown involving Saab 340, VH-ZRJ

19 km N of Ballina/Byron Gateway Airport, New South Wales, 23 August 2016

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Addendum

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In-flight engine shutdown involving Saab 340, VH-ZRJ

What happened

On 23 August 2016, at about 0634 Eastern Standard Time (EST), a Regional Express Saab 340B aircraft, registered VH-ZRJ, taxied at Ballina/Byron Gateway Airport, for a scheduled passenger flight to Sydney, New South Wales. On board were two flight crewmembers, one cabin crewmember and 22 passengers (Figure 1).

Figure 1: VH-ZRJ

Source: Victor Pody

All engine indications had been normal throughout the start and after-start procedures. The crew elected to use runway 06 for take-off. The runway was wet so the flight crew selected the environmental control system (ECS) off for take-off in accordance with the operator's standard operating procedures.

Shortly after take-off, the captain called 'positive rate gear up' and the first officer selected the landing gear up. While the gear was retracting, the crew heard loud bangs and the left engine performance degraded noticeably, reducing the climb performance. The crew also noticed that the left engine instruments were fluctuating rapidly and indicating a high inter-turbine temperature. At that time, the cabin crewmember advised the flight crew that passengers could see flames coming from the left engine.

The flight crew kept the aircraft tracking straight ahead over water and climbing. Based on the noises and engine instrument indications, the crew identified the issue as a compressor stall and carried out the failure management procedure. This included reducing the power on the left engine and setting maximum continuous thrust on the right. Reducing the power also reduced the banging noises to popping noises.

At about 0639, the first officer contacted air traffic control (ATC) and declared a PAN.[1] The crew then commenced the checklist procedures for a compressor stall from the operator's quick reference handbook. The checklist procedure involves trying to increase the rearward flow of air through the compressor via the low and high pressure bleed valves and the engine anti-ice bleed valves. Although reducing the fuel flow to the left engine reduced the popping noises, the compressor stall continued. The crew therefore commenced the appropriate failure management procedure to shut down the left engine and feather the left propeller.

At about 0650, the crew shut down the left engine and the first officer advised ATC that they had one engine inoperative. The crew also advised ATC that once they had completed their checks, they would return to Ballina via an area navigation (RNAV) approach.

After levelling out at 5,000 ft, the captain completed two to three holding patterns while the crew completed all relevant checklists. They then made an RNAV approach to runway 24. The captain reported that the approach and landing went smoothly and the aircraft landed at about 0720.

During the landing roll, as the captain moved the thrust lever on the right engine from flight idle to ground idle, the aircraft deviated to the right of the runway centreline. The captain later commented that this was probably associated with asymmetric propeller drag (the left propeller was feathered and the right propeller generated more drag as the right thrust lever was moved into ground idle). The captain moved the right engine thrust lever forward, out of ground idle, and the aircraft straightened up. The taxi to the bay was uneventful. There were no injuries to crew or passengers and no damage to the aircraft.

Pilot comments

The captain commented that ECS is usually selected ON for take-off on the first flight of the day (see *Similar incidents*). However, as the runway was wet, the crew selected ECS to OFF for this take-off, which was the standard procedure because of the performance considerations associated with a wet runway. In this incident, it is unlikely that the ECS selection contributed to the compressor stall, as the stall did not clear despite reducing the fuel flow and managing the bleed air in the failure management checks.

Both members of the flight crew commented that their simulator training, dealing with compressor stalls and one-engine inoperative scenarios, had been invaluable in contributing to their effective management of the situation. A compressor stall scenario that the captain had recently practised in the simulator was very similar to the incident, except that during the actual incident, the noises were louder and the instrument fluctuations more varied.

The captain also commented that the aircraft was easier to handle than the simulator during the compressor stall/one engine-inoperative situation, except during the landing roll where the simulator did not mirror the yawing tendency when ground idle is selected.

Engineering report

Engineers reviewed the flight data from the incident flight, which confirmed a compressor stall had occurred. No exceedances of torque, inter-turbine temperature, or turbine speed (rpm) limits (Ng and Np) were recorded. Borescope inspections of the engine did not detect any compressor damage. After finding no fault that may have caused the compressor stall, engineers replaced the hydromechanical unit (HMU) in accordance with the manufacturer's fault isolation procedure.

The SAAB 340B *Aircraft operations manual* includes the following in the description of the HMU:

> The HMU provides high pressure metered fuel for combustion. It contains a high pressure vane pump and a pressure regulator and metering valve that schedules fuel to meet the various engine operating conditions and demands. The HMU also controls the variable geometry system (inlet guide vanes and stage 1 and 2 stator vanes) and the start and anti-

[1] 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.

ice bleed valve to provide for efficient and smooth engine operation throughout the entire speed range.

Significantly, the variable geometry system is instrumental in minimising the risk of compressor stall.

After replacing the HMU, engineers conducted ground runs of the engine with no defects found and the aircraft was returned to service.

Compressor stall

A turbine compressor stall occurs when there is a breakdown in airflow through the compressor. This can lead to a flow reversal, banging sounds and flame expulsion. The normal (rearward) air flow can usually be restored by reducing the engine power or thrust setting. Despite the noise, flames and associated heat, a compressor stall often results in no damage to the engine.

Similar occurrences

ATSB investigation 200300040 reported two incidents involving compressor stalls shortly after take-off in different Saab 340B aircraft. Both of those incidents also occurred on the first flight of the day. In response, the engine manufacturer made some recommendations to the operator of those aircraft, including that the operator consider amending procedures to include the selection of ECS ON for the first flight of the day. Use of the ECS opens the bleed air valves and reduces the likelihood of compressor stalls. The report stated that use of ECS on the first flight of the day would counteract the conditions of temperature inversions that were usually more pronounced in the early morning.

Safety message

This incident highlights the importance of well-designed simulator training and robust failure management procedures. Faced with an abnormal scenario, from their training and robust procedures, the crew was able to manage the situation efficiently and safely.

General details

Occurrence details

Date and time:	23 August 2016 – 0640 EST	
Occurrence category:	Incident	
Primary occurrence type:	Technical – Powerplant/propulsion – Engine failure or malfunction	
Location:	19 km N of Ballina/Byron Gateway Airport, New South Wales	
	Latitude: 28° 40.00' S	Longitude: 153° 33.75' E

Aircraft details

Manufacturer and model:	SAAB Aircraft Company 340	
Registration:	VH-ZRJ	
Operator:	Regional Express	
Serial number:	340B-396	
Type of operation:	Air transport low capacity – Passenger	
Persons on board:	Crew – 3	Passengers – 22
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

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.