Australian Government
Australian Transport Safety Bureau

Smoke event involving a Cirrus SR22T, VH-EPG

44 km W of Bendigo Airport, Victoria, on 19 May 2015

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Aviation Occurrence Investigation
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Addendum

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Smoke event involving a Cirrus SR22T, VH-EPG

What happened

VH-EPG

Source: Fly Cirrus

On 19 May 2015, the pilot of a Cirrus SR22T aircraft, registered VH-EPG (EPG), planned to conduct a flight from Moorabbin to Mildura, Victoria, under the instrument flight rules (IFR) with one passenger. At about 0812 Eastern Standard Time (EST), the aircraft departed Moorabbin Airport, and the pilot conducted a climb to flight level (FL) 180.[1] During the climb, the pilot selected the de-ice system on, which then remained on for about 20 minutes. After levelling off at FL180, the pilot switched off the de-ice system.

About 5 minutes later, the pilot received an 'ALT AIR OPEN' alert on the primary flight display (PFD). The alternate air caution indicated a blockage, probably due to ice, of the induction air intake to the engine. The alternate air then routed unfiltered air to the engine. Soon after the alert illuminated, light brown smoke entered the cabin through the cabin air vents. The pilot attempted to determine the source of the smoke. All engine parameters, exhaust gas, turbo and engine temperatures were normal, the electrical system was functioning normally and no circuit breakers had popped. The source of the smoke appeared to be forward of the engine panel, with no flames or external smoke visible.

The pilot assessed the probable cause of the smoke to be a turbocharger issue and elected to conduct a descent. The pilot also commenced preparations for a possible diversion to the nearest airport. At about 0848, the pilot requested a descent to FL140 and air traffic control (ATC) cleared the aircraft to descend to FL150, due to traffic. When the pilot reduced power for the descent, the smoke cleared. However, after reaching FL150, the pilot resumed cruise power and the smoke reappeared. This added to the pilot's assessment that there was a turbocharger leak. The Cirrus recommendation for a suspected turbocharger leak was to descend and land as soon as possible, which the pilot followed.

At about 0852, the pilot declared a PAN[2] and requested further descent and a diversion to Bendigo, Victoria. Passing FL140 on descent, the separation between EPG and a SAAB 340 aircraft was 4.2 NM. That distance was less than the required separation standard for that airspace, of 5 NM. The controller issued a turn to the SAAB to re-establish the required separation. The pilots of both aircraft were aware of each other.

During the descent, the smoke evaporated, but a moist brown residue was depositing on the windscreen reducing the visibility. To try to clear the windscreen, the pilot turned on the cabin heated air, and fan up to full ('3'). Turning on the cabin air had the effect of drawing in more contaminant, which was condensing and increasing the deposit on the windscreen.

The pilot selected the radio navigation (RNAV) global navigation satellite system (GNSS) approach to runway 17 at Bendigo Airport (Figure 1). They then conducted the descent and approach using the autopilot and the flight director. At about 0904, the aircraft turned left to track towards the initial approach fix for the RNAV approach procedure (Figure 2). The aerodrome

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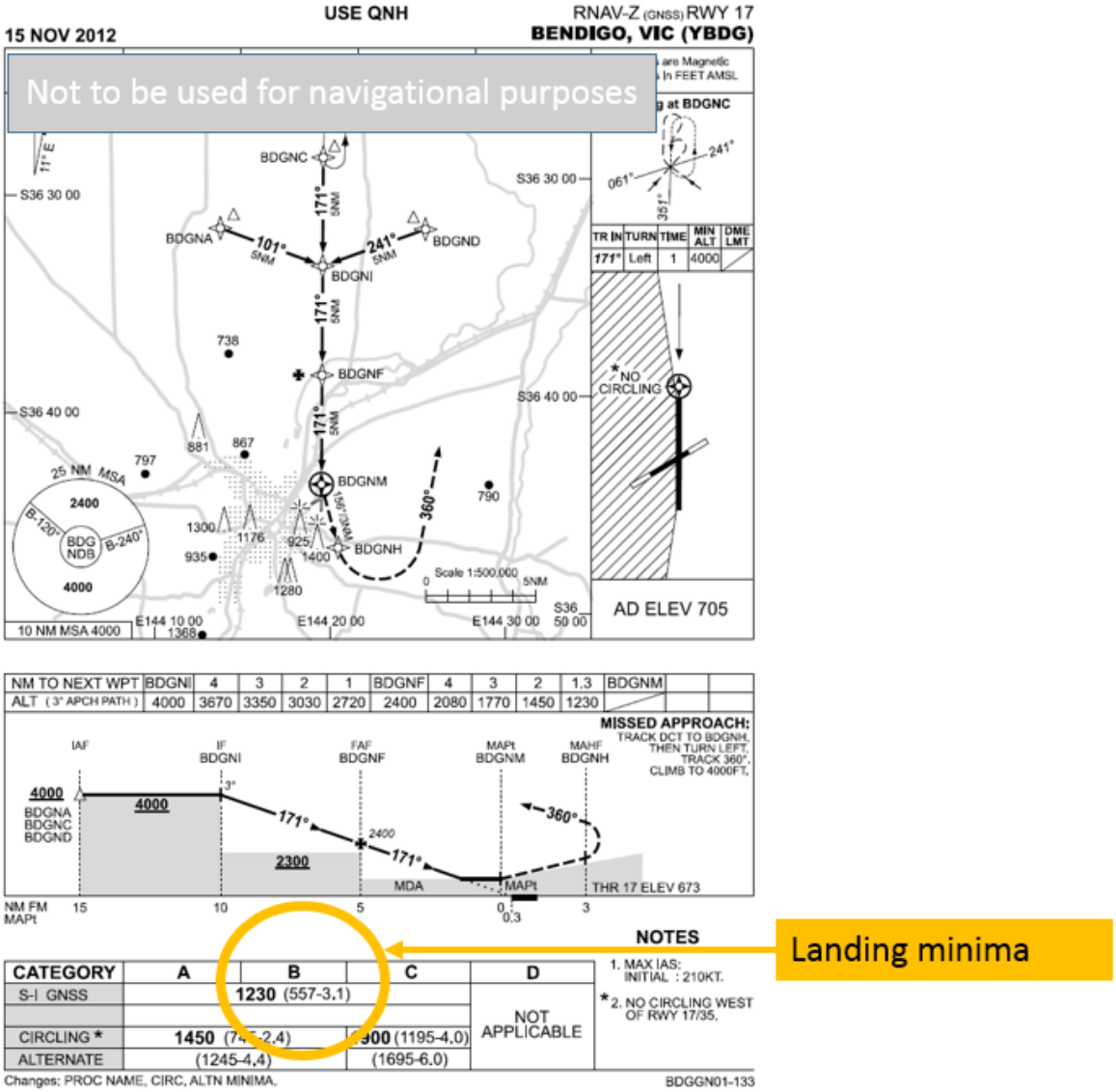
1 At altitudes above 10,000 ft in Australia, an aircraft's height above mean sea level is referred to as a flight level (FL). FL 180 equates to 18,000 ft.

2 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.

weather information service (AWIS) at Bendigo was reporting cloud below the minima.[3] Despite the weather conditions, the pilot elected to continue the approach. The pilot based the decision to continue on their assessment of a turbocharger leak. The pilot also considered the smoke that increased with power increase and the potential for catastrophic engine failure or fire.

The pilot switched on the runway lights. Bendigo Airport did not have approach lighting available.

Figure 1: RNAV-Z (GNSS) approach for runway 17 Bendigo



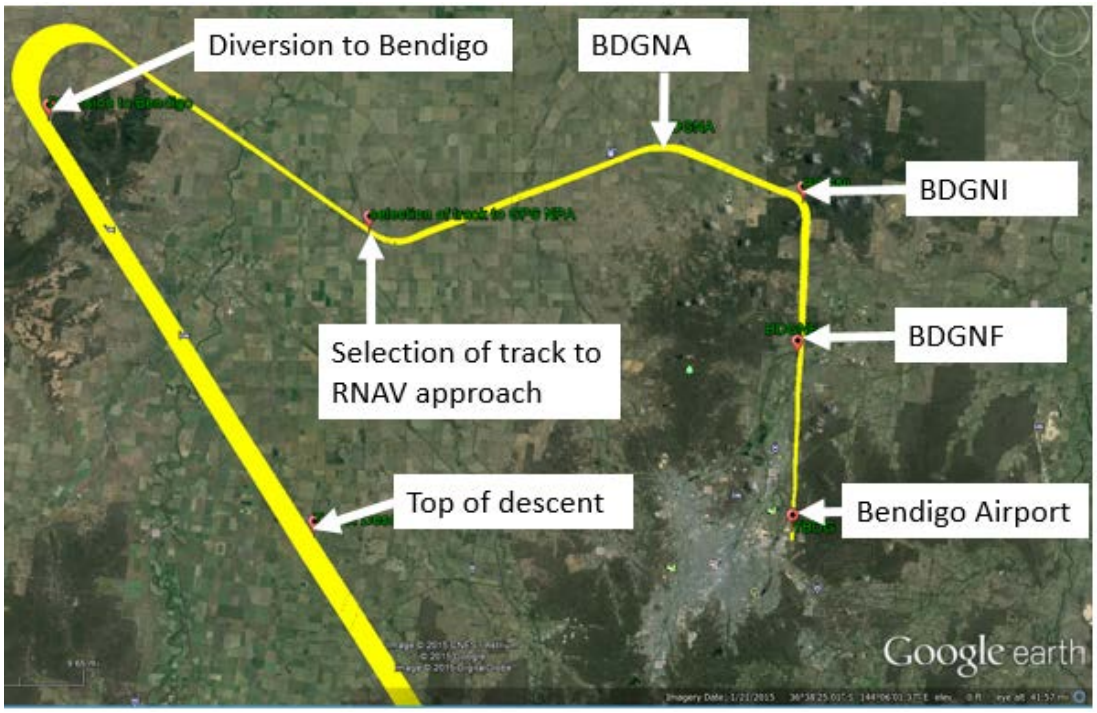
Source: Airservices Australia

After arriving at the final approach fix 'BDGNF', the autopilot disengaged and the pilot took over manual control of the aircraft. No vertical profile guidance was available to the pilot from the navigation system. They reported being in heavy rain, and that visibility through the windscreen was obscured by the contamination. The pilot could see the runway lights through the contaminated windscreen and rain, but reported difficulty in identifying the exact location of the ground. The aircraft was clear of cloud, but in rain, and the pilot estimated the visibility to be about 2 km. The flight data indicated that the aircraft's rate of descent in this section of the approach reached about 1,200 ft per minute.

[3] Specified meteorological conditions of cloud ceiling and visibility. In order for an aircraft to land at an aerodrome, the actual weather conditions need to be at or above the landing minima.

When on final approach to runway 17, about 0.6 NM from the runway threshold, the pilot suddenly sighted a row of trees. The pilot immediately conducted a climb to avoid them, and estimated that the aircraft cleared the trees by a few feet. The pilot then landed the aircraft on the runway threshold. The pilot and passenger were uninjured and the aircraft was not damaged.

Figure 2: Aircraft track showing diversion to Bendigo and RNAV approach



Source: Google earth and flight data, annotated by the ATSB

Pilot comments

The pilot stated that the emergency and abnormal checklists were electronic and built into the aircraft system. If engine compartment fire is suspected, the actions are to set throttles to idle, select mixture to cut-off, and select the fuel to off. The recommendation is then to conduct an emergency descent and land immediately, and to not deploy the aircraft parachute (Cirrus airframe parachute system – CAPS). However, if there is no power available and the aircraft is in instrument meteorological conditions (IMC), the recommended action is to deploy the CAPS. The pilot stated that the ambiguity on whether or not to deploy the CAPS when you have a suspected engine compartment fire in IMC may need to be addressed.

In addition, the pilot commented that:

- Because they had the windscreen heat on in the freezing conditions, the residue condensed and deposited on the windscreen.
- Their workload was not too high because of familiarity with the aircraft (over 1,200 hours on type) and the avionics available.
- They did not have vertical profile information after the final approach fix (FAF) but have subsequently upgraded the *Integrated Modular Avionics – Perspective* software. This version of the software now provides a Baro-VNAV approach. That mode option provides vertical navigation guidance.
- The pilot considered the option to continue to Mildura, where the weather was better, but that would have required another 1.5 hours of flying. With the smoke increasing as they increased power, the pilot elect to divert to Bendigo.
- They were using oxygen due to the requirements of operating at flight levels. The aircraft was fitted with a carbon monoxide warning which did not activate.

- The aircraft was fitted with an infra-red camera to aid visibility outside the aircraft in poor weather conditions. The pilot had not switched the camera on during the incident flight, but subsequently used the camera in reduced visibility conditions. The pilot believed that the improved vision provided by the camera would have assisted from the final approach fix to the landing at Bendigo.

Weather

The weather at Bendigo at the time included heavy rain, visibility less than 2 km, cumulus cloud with base about 500 ft above ground level, and temperature 14 °C.

Engineering report

After the incident, an engineering inspection found the following sequence had occurred to create smoke in the cockpit and residue on the windscreen:

1. De-icing fluid from the Anti-Ice System had pooled in the aircraft cowling. For propeller de-icing, the fluid is distributed from a slinger ring mounted to the spinner backing plate, to rubber boots at the root end of the propeller blades. The engineer found a partial blockage of the slinger ring nozzle, which disrupted the flow spray pattern. This had caused one of the propeller deice fluid lines to spray fluid into the cowling and engine compartment, and reduced flow to the propeller.
2. When the alternate air source opened, the engine intake allowed the air/de-ice fluid vapour mixture through the induction system to the turbo/intercooler system. The engine compartment air had therefore drawn in the de-ice fluid and compressed it in the intercooler.
3. The heated cabin air was drawn from fresh air on the right cowl, and heated air from the intercoolers. The cabin air drew in the de-ice fluid and was distributed into the cabin. Due to the cold outside air temperature and the selection of warm air onto the windscreen, the moisture condensed onto the windscreen. Contamination on the inside of the window was found to be moisture contamination with deice fluid residue.

The engineer was unable to capture the foreign material that had blocked the slinger ring nozzle, but after the line was blown clear and the system flushed, operation was returned to normal. The system has a strainer and filters which have a two-year life and without trapping the blockage material they were unable to report whether the item was internal or external of the nozzle as it dislodged easily from the discharge nozzle.

There were no faults found with the turbocharger – no leaks, no cracks, and no obvious concern of fire risk.

Cirrus Aircraft in the United States advised that they were not aware of any previous examples of de-icing fluid entering the cabin via the alternate air box. The engineer and pilot queried whether there was a risk of spontaneous combustion, as the de-ice fluid was flammable, compressed in the engine and then vaporised. Cirrus Aircraft responded that the fluid could not spontaneously combust as:

- the auto-ignition temperature (ignition by heat) of the de-ice fluid is 770 degrees Fahrenheit (410 ^{o}C)
- the flash point (ignition by spark or flame) for the de-ice fluid is 220 degrees Fahrenheit (104 ^{o}C)
- the air temperature entering the intercooler is around 550 degrees Fahrenheit (288 ^{o}C)
- the de-ice fluid in the warm air entering the intercooler is well below the auto-ignition temperature of the de-ice fluid and no spark or flame is found in the induction system.

Cirrus instructor comment

A certified Cirrus instructor advised the ATSB that the Bendigo RNAV could be flown in VS mode using the appropriate power settings without pilot intervention. This should be done rather than manually overriding the vertical speed mode to reduce pilot workload and maintain the optimal vertical profile.

Flight data analysis

The ATSB analysed the aircraft flight data and noted the following.

The aircraft was fitted with a Garmin GFC-700 autopilot system. The recorded data indicated the aircraft was flown with the autopilot engaged and controlling both pitch and roll modes until the aircraft descended to about 1,100 ft barometric altitude and was about 1.1 NM from touchdown.

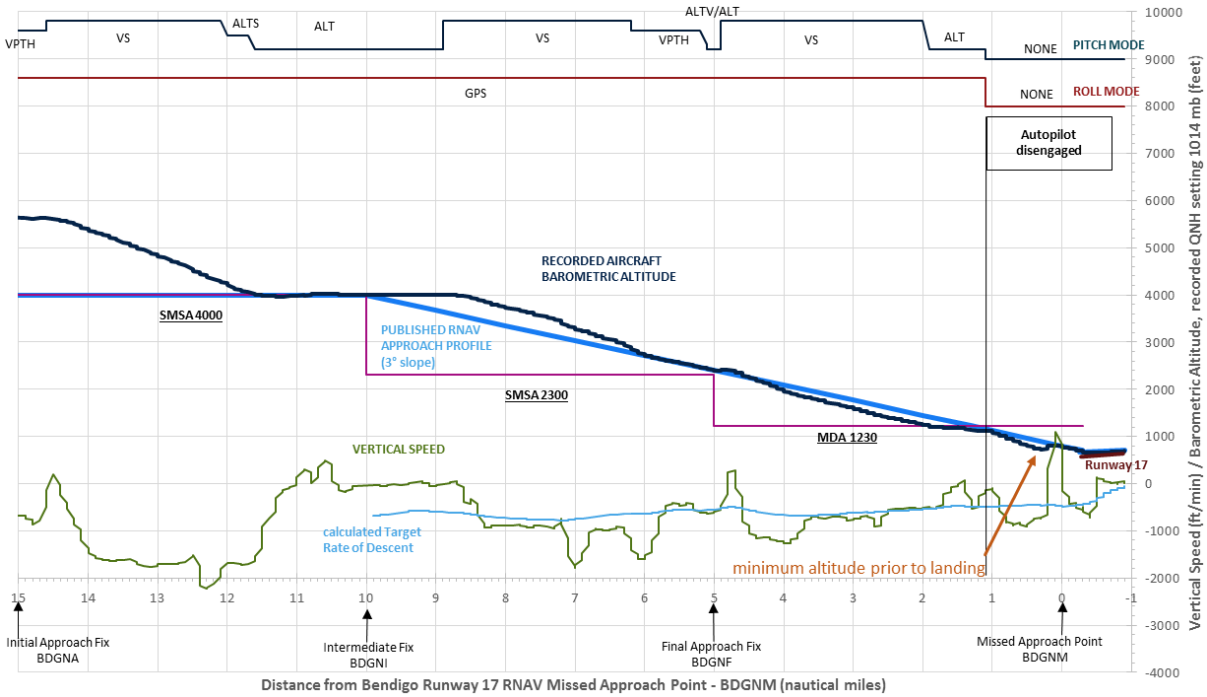
The aircraft followed the published RNAV approach lateral path, passing over the published waypoints. The recorded data showed that the roll control mode was made by using GPS information, which resulted in very precise lateral tracking.

The vertical profile recorded by the aircraft systems showed significant variation both above (about 350 ft high) and below (about 120 ft low) the 3° approach path angle shown in the published RNAV procedure (black line in Figure 3). The aircraft pitch modes during the approach were predominantly vertical speed with altitude capture hold and vertical path also becoming active. The aircraft recorded vertical speed was plotted in comparison with a target rate of descent calculated using the recorded groundspeed (light blue line in Figure 3).

Descent from sector minimum safe altitude of 4,000 ft was initiated using vertical speed as the pitch mode. The aircraft was above the published approach profile when the descent began (black line in Figure 3). The aircraft recorded a vertical speed of about 900 ft per minute. At about 6.2 NM from the missed approach point, as the aircraft was descending through 2,900 ft, the pitch mode changed to vertical path. The rate of descent reduced and the aircraft followed the published descent profile to about 5.1 NM, where the pitch mode changed to VNAV target altitude capture and then altitude hold (recorded barometric altitude of 2,393 ft, FAF published altitude 2,400 ft) modes at the final approach fix. About 8 seconds after altitude hold mode became active the pitch mode changed to vertical speed. The rate of descent increased to about 1,200 ft per minute and the aircraft descended below the published approach profile. The rate of descent reduced to a value similar to the calculated target rate of descent at 9:13:28, as the aircraft was passing through about 2,000 ft. This rate of descent was maintained until 9:14:26 when the pitch mode changed to altitude hold (recorded barometric altitude 1,235 ft, MDA 1,230 ft) at about 1.9 NM from the missed approach point.

The autopilot was disengaged at 9:14:59, about 1.1 NM from the missed approach waypoint, ‘BDGNM’. Following the autopilot disengaging, the rate of descent increased and the aircraft reached a barometric altitude of about 715 ft at 9:15:33, about 0.3 NM from ‘BDGNM’. The aircraft then proceeded to pitch up, to about 15°, and climbed to about 810 ft. The aircraft regained the published approach path angle and continued the approach to land at Bendigo Airport. The estimated touchdown was about 9:15:57, on the runway threshold – about 0.3 NM beyond the missed approach point), and the barometric altitude recorded was about 670 ft.

Figure 3: Comparison of recorded aircraft altitude and published approach procedure vertical profile



Source: Aircraft flight data analysed by the ATSB

ATSB Comment

The checklist in the aircraft's pilot operating handbook for Smoke and Fume Elimination included selecting Air Conditioner to OFF and if the source of smoke and fumes was forward of the firewall forward selecting Airflow to OFF. Following these selections may have prevented the contaminant condensing on the windscreen during the approach.

Safety message

The ATSB SafetyWatch highlights the broad safety concerns that come out of our investigation findings and from the occurrence data reported to us by industry. One of the safety concerns is *safety around flying with reduced visual cues*. This incident provides a timely reminder to flight crews of the importance of monitoring the flight instruments when encountering areas of reduced visual cues.

This incident provides an excellent example of challenges that may be involved in pilot decision making processes. The pilot was faced with an emergency situation and poor weather conditions. The decision to continue an approach in marginal conditions led to very quick action needed to avoid trees on the final approach. Pilots are encouraged to think through such scenarios in advance, which may assist with their decision making if confronted with similarly challenging circumstances. Following published checklists, particularly in emergency situations is important to enable pilots to identify the issue and to resolve it.

The Federal Aviation Authority handbook includes a chapter on Aeronautical Decision-Making. The American AOPA Air Safety Foundation Safety Advisor, *Decision making for pilots*, stated that effective decision making begins with anticipation – thinking about what could go wrong before it actually does.

General details

Occurrence details

Date and time:	19 May 2015 – 0856 EST	
Occurrence category:	Incident	
Primary occurrence type:	Smoke event	
Location:	44 km W of Bendigo Aerodrome, Victoria	
	Latitude: 36° 37.75' S	Longitude: 143° 51.42' E

Aircraft details

Manufacturer and model:	Cirrus Design Corporation SR22T	
Registration:	VH-EPG	
Serial number:	0269	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – Nil	Passengers – Nil
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 fare-paying passenger operations.

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.