Australian Government
Australian Transport Safety Bureau

Flight crew incapacitation involving a Reims Aviation F406, VH-EYQ

near Emerald, Queensland, 1 August 2014

ATSB Transport Safety Report
Aviation Occurrence Investigation
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Addendum

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Flight crew incapacitation involving a Reims Aviation F406, VH-EYQ

What happened

On 1 August 2014, at about 0935 EST, the crew of Reims Aviation F406 aircraft, registered VH-EYQ, departed Emerald, Queensland, on an aerial survey task. The crew consisted of a pilot and a navigator. The navigator was positioned in the cabin of the aircraft to operate survey equipment and direct the pilot according to survey requirements. The aircraft was unpressurised, but fitted with an oxygen system to allow the crew to operate at altitudes above 10,000 ft. The crew planned to climb to flight level (FL)[1] 240 for the survey task about to be undertaken. Prior to the flight, the pilot checked that there was adequate oxygen in the storage cylinder located in the nose area of the aircraft, and tested the oxygen system for normal operation.

The departure proceeded normally and, as the aircraft climbed through about 8,000 ft, the pilot turned on the aircraft oxygen supply and connected and donned his oxygen mask. This task involved connecting his oxygen system controller (which leads to the oxygen mask) to a port located beneath the pilot's armrest. The task also required the pilot to remove his headset, transfer the microphone function from the headset to his oxygen mask, and place the headset back on (to allow continued receipt of communications through the headset ear cups). The pilot completed transition checks prior to passing 10,000 ft, which included confirmation that his oxygen system was in use and operating normally. The navigator also connected and donned his oxygen mask in the cabin of the aircraft during the climb.[2]

The pilot also placed an oxygen pulse meter (supplied by the operator) on one of his fingers.[3] As the aircraft continued to climb, the pilot monitored his blood oxygen saturation level readings on the oxygen pulse meter, and monitored his flow of oxygen by reference to a flow indication in the supply tube. The pilot recalled that everything appeared normal as the climb continued, but passing about FL 180, he noticed that his blood oxygen saturation level had fallen significantly. The pilot recalled that although flow indications appeared to remain satisfactory, his blood oxygen saturation level had fallen to about 77% - substantially less than what the pilot indicated he would normally expect (in excess of 90%).[4]

As the climb continued, the pilot expressed concern to the navigator about his abnormally low blood oxygen saturation level. Based upon his knowledge from hypoxia awareness training, the navigator was aware that such an abnormally low blood oxygen saturation level meant that the pilot was probably experiencing the effects of hypoxia. Accordingly, the navigator encouraged the pilot to address the problem and increase his blood oxygen saturation level, and began to monitor the pilot's condition.

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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 240 equates to 24,000 ft.

2 The navigator also connected to the aircraft oxygen supply, but using a separate oxygen system controller to that used by the pilot.

3 An oxygen pulse meter allows the wearer to monitor his or her pulse and blood oxygen saturation level (a measure of the concentration of oxygen in the blood). An oxygen pulse meter therefore provides a direct indication of the extent to which a wearer is likely to be suffering the effects of hypoxia.

4 The navigator recalled the pilot mentioning blood oxygen saturation levels as low as about 70% during the incident. The navigator was also wearing an oxygen pulse meter – his oxygen saturation level remained normal throughout the flight.

Although the sequence of events is unclear, a number of things happened over the course of the following several minutes which are broadly summarised as follows:

- The pilot initially attempted to increase the amount of oxygen he was receiving by making an adjustment to his oxygen system controller.[5] He later identified a problem with his oxygen system connection, and spent some time handling the supply tubing and connections in an attempt to resolve the problem. Aware that the pilot was experiencing some difficulties with his oxygen supply, the navigator moved forward in the cabin to render assistance and to more closely monitor the actions of the pilot.
- Without an effective supply of oxygen, the accuracy with which the pilot was controlling the aircraft deteriorated.[6] The navigator recalled encouraging the pilot to maintain control and to descend, a number of times. The pilot recalled losing situational awareness, and prompts from the navigator drawing his attention to the attitude of the aircraft.
- The navigator commented that the pilot failed to respond to some air traffic control (ATC) transmissions, and when he did respond, the responses were non-standard and his speech was slurred. ATC also noticed that the pilot was not responding normally, also noting that his radio transmissions were slurred. ATC encouraged the pilot to ensure that he was receiving a supply of oxygen by transmitting 'oxygen oxygen oxygen' and clearing the pilot to descend. Concerned about the safety of the aircraft, ATC also declared an ALERFA.[7]
- Despite his apparently hypoxic condition, the pilot was ultimately able to identify that an oxygen supply system fitting had become disconnected. The fitting was located beneath the pilot's armrest, and was the same fitting that the pilot had earlier connected during the climb (Figure 1). When he reconnected the fitting, he took a number of deep breaths and sensed almost immediate relief.
- At about the time the pilot appeared to be recovering from his hypoxic condition, the navigator recalled handing his oxygen pulse meter to the pilot, after the pilot indicated that his was not working correctly.
- The pilot commented that his confused state cleared quickly when the flow of oxygen was re-established. He noticed at that point that the engines were still set to climb power. He reduced power and commenced a controlled descent. The navigator noted that the pilot's speech became more coherent and standard radio phraseology returned soon after commencement of the controlled descent.

Following the incident, the crew elected to return to Emerald. The pilot remained on oxygen throughout the remainder of the flight, including the arrival and landing at Emerald, which was uneventful. After landing, the pilot noted that his blood oxygen saturation level had increased back to a normal level (around 97%).

The entire flight lasted about 35 minutes. Available evidence suggests that the length of time from the first indication of a low blood oxygen saturation level to the point at which the pilot's oxygen supply was re-established and a controlled descent commenced, was of the order of 10 minutes. During most of this time, the aircraft was probably manoeuvring between about FL 200 and FL 240. The maximum altitude reached was about FL 245.

5 On-demand oxygen delivery system controllers provide a measured amount of oxygen as the user inhales. The controller in this case included provisions for the operator to make selections (on the body of the controller itself) that supplement and enrich the standard oxygen flow.

6 The aircraft was fitted with an autopilot which the pilot recalled having engaged in lateral heading mode, but no vertical mode was engaged. The pilot was uncertain, but believed that the autopilot was inadvertently disconnected as he attempted to re-establish his oxygen supply.

7 ALERFA (Alert Phase) is an emergency phase declared by ATC when, for example, apprehension exists as to the safety of an aircraft and its occupants, or there is a reason to believe that the safe conduct of a flight is in jeopardy.

Figure 1: Oxygen port beneath pilot's armrest and associated oxygen fitting

Source: Aircraft operator, modified by the ATSB

Oxygen system controller. The pilot's oxygen system controller included oxygen delivery indications in the form of flashing LEDs (light emitting diodes). Among these indications were a green LED that flashed with each pulse of oxygen (associated with a valid inhalation event), and an amber LED and audible beeps intended to alert the user to the absence of a valid inhalation event after a set period of time. The controller also included a red LED and chime to alert the user to a fault in the flow of oxygen to the controller. The controller visual indications and audible alerts did not effectively capture the attention of either crew on this occasion.

Pilot comments

The pilot commented favourably on the role played by ATC in the event, particularly the way in which ATC reacted to their concerns about the condition of the pilot with very deliberate recommendations and clearances. The extent to which ATC contributed to a safe outcome is unclear, but encouragement to the pilot to check his oxygen supply may have been vital. The pilot also commented that his hypoxia awareness training (mandated by the operator for unpressurised survey operations) helped the pilot appreciate the effects of hypoxia and his symptoms.

Operator's report

Consistent with the pilot's recollection of the event, the operator's investigation dealing with the incident found that the pilot's oxygen supply was interrupted when the fitting in the supply system beneath the pilot's armrest became disconnected. The investigation found that the bayonet fitting may not have been fully locked when connected by the pilot, noting that the connection could be in place but not necessarily properly locked. The investigation report added that the position of the port is such that some concentration and manipulation is required to ensure that the connection is seated correctly. The investigation also found that the supply tube may not have been correctly routed through an armrest cut-out, and that movement of the armrest may have dislodged the improperly secured bayonet fitting.

The operator's report also found that the pilot's oxygen controller was not visible to the pilot or navigator. As such, the crew were unable to see indications on the controller that could have alerted them to an oxygen supply problem.

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 actions are being considered in response to this occurrence.

Aircraft operator

As a result of this occurrence, the aircraft operator has taken steps in relation to pre-flight oxygen system checks, and crew cross-checks on the performance of each other's oxygen system during flight above 10,000 ft.

Safety message

This incident highlights the importance of careful attention to aircraft oxygen systems, particularly with respect to connecting and monitoring oxygen system performance. An interruption in the supply of oxygen can quickly lead to hypoxia and crew incapacitation, particularly at higher altitudes. While the pilot was able to re-establish the flow of oxygen on this occasion and recover from his hypoxic condition, pilots are reminded that hypoxia is an insidious condition and the time of useful consciousness is often very limited. A prompt and decisive response to the first indication of an oxygen supply problem is imperative.

The signs and symptoms of hypoxia vary from individual to individual, and may be affected by environmental factors such as temperature and physical activity. The SKYbrary website Hypoxia Briefing Note[8] available at www.skybrary.aero/index.php/Hypoxia_(OGHFA_BN), addresses the stages of hypoxia, along with common signs and symptoms, and discusses the concept of time of useful consciousness. The Briefing Note includes a summary of key points regarding hypoxia, including:

> Hypoxia is dangerous because it impairs cognitive and physical performance, sometimes without the flight crew realising that anything is wrong.

The SKYbrary website includes an additional descriptive article outlining the nature of hypoxia, including signs and symptoms, and discusses sudden and gradual onset defences. The article, available at www.skybrary.aero/index.php/Hypoxia, includes the comment:

> Sudden onset may require a rapid and instinctive response by aircrew whereas gradual onset is a matter of awareness so that an appropriate response can be made before incapacitation occurs.

An article in the CASA *Flight Safety Australia* magazine July-August 2005 edition titled *Blackout* provides additional information about the nature of hypoxia and the time of useful consciousness. That article is available online at www.casa.gov.au/wcmswr/_assets/main/fsa/2005/aug/21-23.pdf. The article includes a table dealing with the time of useful consciousness and some effects of oxygen loss on the brain (Figure 2). The September-October 2013 edition of the CASA *Flight Safety Australia* magazine also includes an article on hypoxia, titled *Do not go gentle: the harsh facts of hypoxia*. That article and a hypoxia training video are available on the CASA website via the following link: www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_101633

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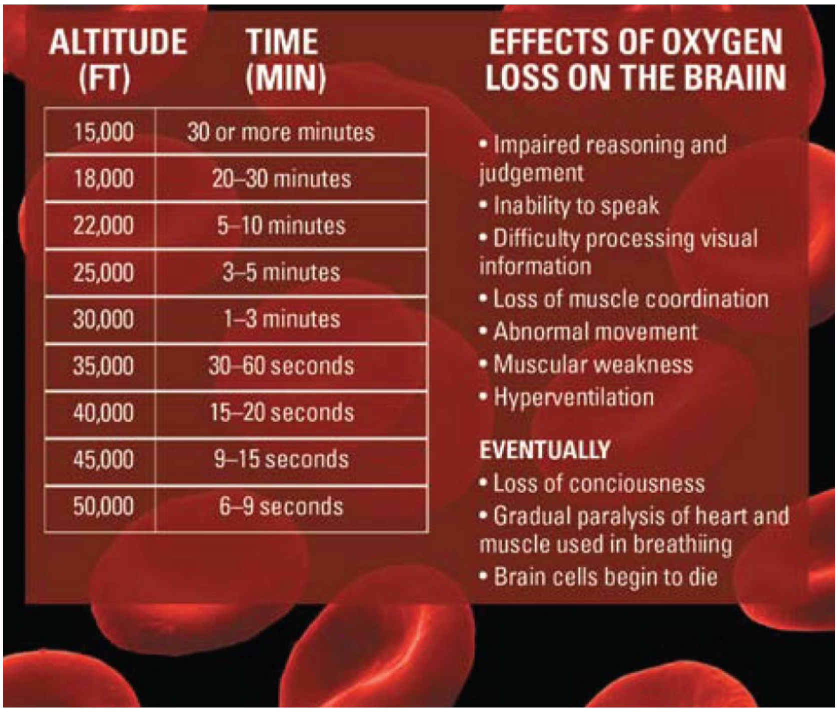
[8] Full title is Operator's Guide to Human Factors in Aviation – Human Performance and Limitations – Hypoxia Briefing Note. Content source identified as the Flight Safety Foundation.

Figure 2: Time of useful consciousness and some effects of oxygen loss on the brain



Source: CASA Flight Safety Australia magazine July-August 2005

General details

Occurrence details

Date and time:	01 August 2014 – 1000 EST	
Occurrence category:	Serious incident	
Primary occurrence type:	Crew incapacitation	
Location:	Near Emerald Aerodrome, Queensland.	
	Latitude: 23° 34.05' S	Longitude: 148° 10.75' E

Aircraft details

Manufacturer and model:	Reims Aviation S.A. F406	
Registration:	VH-EYQ	
Serial number:	F406-0047	
Type of operation:	Aerial work	
Persons on board:	Crew – 2	Passengers – Nil
Injuries:	Crew – Nil	Passengers – Nil
Damage:	None	

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.