

25th August, 1999

The Secretary,
Senate Rural and Regional Affairs and Transport References Committee,
SG. 62
Parliament House,
CANBERRA ACT 2600.

Dear Sir,

1. Re: Proposal to replace Pressure Altitude and Mean Tracheal Partial Pressure of Oxygen as the criteria for flight crew capacity to act at altitude, with Blood Oxygen Saturation Level.

Surveys of accident investigation records attribute about 70% of aircraft accidents and incidents to human error. Of these, the greatest number occur in the later phases of flight, during the descent, approach, and landing. This is, recent research suggests, when the crew are most likely, even when complying with current regulations, to be subject to a degree of incapacitation due to hypobaric hypoxaemia, or lack of sufficient oxygen.

The degree of incapacitation is determined by the deficit in the amount of oxygen transferred from the alveoli (air sacs) in the lung to the pulmonary capillaries, which in turn reduces the amount available for uptake by the tissues. Whilst this may present no difficulty if it occurs over one or two minutes, it will result in impairment of higher cerebral function if it continues over more prolonged periods.

The amount of oxygen in arterial blood can now be easily measured with a pulse oximeter. This instrument can provide a reliable measure of blood oxygen levels spectrophotometrically. This is performed by placing a small probe onto a finger and transmitting light through the finger. A sensor in the probe then measures the wavelength of the transmitted light and compares it to known values of blood oxygen levels. It indicates the result as a percentage of the value that would be recorded if the blood oxygen levels were at a maximum. This value, known as the saturation level, is then displayed on the oximeter screen. Pulse oximeters are small, reliable, consistent, cheap and can be used with accuracy after only a few minutes training. Flight crew can monitor their own levels in flight, and take corrective action to maintain these above the required minimum.

Under the present rules (CAO 20.4) all flight crew can operate in a cabin pressure up to 10,000' without supplemental oxygen for up to 8 hours, day or night.

The July, 1998 issue of the CASA Publication, Flight Safety Australia, carried an article, which stated that hypoxia could affect flight crew's night vision, at altitudes as low as 4000', and concentration and judgement were likely to be affected on long flights, well below 10,000'. It further suggests that the accompanying sense of well being ensures that pilots without training and experience will not recognise their intoxication.

Other published work tends to confirm the belief of many pilots, that crew capacity is impaired in subtle ways well below 10,000'. Above this level, the effects are obvious to an observer, and if you are exposed long enough, you lose consciousness. At lower altitudes, you don't pass out, but fatigue accumulates quickly. Studies indicate that cognitive, decision making and calculating abilities and short term memory all begin to deteriorate from 5000' to 8000', though well learned skills remain. Work in 1997 at the FAA's Civil Aeromedical Institute, found pilots continuing to make more procedural errors on descent from altitude and approach, indicating that impairment does persist for some time after returning to a lower level.

This presents less of a problem to a pilot carrying out a well rehearsed approach when he is presented with new information, or a new or different situation requiring the application of cognitive skills. Then there is a greater risk of an error or delay in judgement and or decision making. Usually the new situation arises towards the end of a flight. The still partially hypoxic crew have to plan and execute an Approach and landing, often with significant differences to what they may have been expecting.

The physiological response to altitude of fit young men has been found to vary widely, both between individuals, and in the same individual, depending on his physical condition and level of arousal. The pilot population, particularly in General Aviation, is not composed of fit young men. After 50 the arterial plasma oxygen tension, which alone governs oxygen transfer to the tissues, normally drops. As with the rest of the population, some pilots are smokers, which limits their lung performance. Length of exposure at altitude also plays a significant part. Lactic acid accumulates in hypoxic tissues, which shows up as fatigue, which further magnifies the effects of the hypoxia.

Current ideas on safety emphasise the chain of multiple causes, which together end up in an accident. At the wrong time, perceptual error, or a delay in responding, may make the difference between a non-event and an accident. Most pilots are unaware of the effect of low levels of hypoxia on their performance and fatigue. There is no requirement for them to be told, and the nature of the effect makes it unlikely that they will work it out for themselves. It usually takes some experience, both without and with Supplemental Oxygen, to demonstrate the difference. This proposal is to require flight crew to monitor their Blood Oxygen Saturation level with pulse oximeters, or use estimates from records established for each crew member under similar conditions, and maintain a minimum level, by use of additional supplementary oxygen, or lower cabin altitude. There should in particular be a minimum Saturation level maintained during descent and instrument approach.

2. Re: Low level Hypoxia and Oil Mist.

The oil mist problem probably presents a hazard that is a bit subtle, and there should be some advice given to pilots on the dangers and appropriate procedures in the event that they encounter it.

A fine oil mist entering the cockpit or cabin of a pressurised or unpressurized aircraft has the potential to incapacitate the crew and passengers, probably without their realising it is happening.

Oil and lungs don't get on well together. The wall of the alveoli, or air sacs, is coated with a surfactant film. It has a low surface tension which is required to maintain the open geometry of the air sacs. Any small quantity of oil (or lipids) alters the surface tension. That can cause distortion or partial collapse, and affect ventilation and blood flow matching. It may even upset the sac's ability to remain open, and will provoke a reaction that fills the sacs with fluids and makes the damage more permanent. The references provide examples of this. The net result is that the lung's capacity to transfer oxygen from the air breathed in, is reduced, and probably fairly quickly.

In an aircraft cockpit or cabin, the crew will already be partially hypoxic, because the cabin pressure is well below that of sea level. A pressurized cabin is normally maintained at a pressure equivalent to 6000' to 8000'. A loss of some lung capacity will drop their blood oxygen saturation levels further, so they will probably experience hypoxia equivalent to a much higher cabin altitude. If the loss is severe enough they may become incapacitated, without realising what is happening.

If a person breathes smoke, the large particles are intercepted in the nose and airways, where their deposition causes chemical or mechanical irritation, manifested usually by cough, chest tightness and sometimes breathlessness, so he knows that he is in trouble. Particles, including fluid droplets below 5 micron in diameter, will largely pass through the mechanical defenses on the lung and reach the alveoli without there being much of a physical cue. There are no nerves in the lung itself.



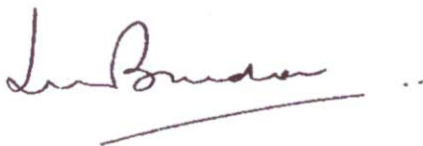
There appear to be no training or emergency procedures appropriate to handling the entry of oil mist into an aircraft cockpit or cabin. It is probably not a common occurrence, but there are stories of an oil mist entering in several aircraft types. It deserves some consideration..

We recommend that advisory material be provided to flight crew on the hazard presented by oil mist entry to the cockpit or cabin. This should at least cover identification and emergency procedures.

Yours sincerely,

A handwritten signature in cursive script that reads "Andrew Thom". The signature is fluid and includes a long, sweeping underline that extends to the right.

Andrew Thom

A handwritten signature in cursive script that reads "Jonathon Burdon". The signature is fluid and includes a long, sweeping underline that extends to the right.

Jonathon Burdon.

Annex 1. List of references.

Annex 2. Authors' background.