CABIN CREW: WHAT TO DO IF YOU SUSPECT A PASSENGER IS INTOXICATED

LOCKHART RIVER ACCIDENT
ATSB releases a 3rd factual report

CORROSION CRISIS LOOMS
Hidden menace for ageing GA aircraft

THAT SINKING FEELING
Angle of bank and stall speed

RED ALERT
The 25-year fight against human error
Icing conditions

The What Went Wrong article, “Thin ice”, in the July-August issue of Flight Safety Australia described an incident in which a Cessna 310R flew into icing conditions.

While it is unclear from the author’s story if weather conditions at the time were conducive to icing, readers should be aware that for many light aircraft types, flight into forecast or known icing conditions is prohibited.

This is the case for the Cessna 310R which was the aircraft involved in this incident. All pilots of light aircraft should be familiar with the operating limitations set out in the pilot operating handbook or aircraft flight manual of the aircraft they are flying.

— Graham Sparrow, Sydney, NSW

The right extinguisher

An article in the May-June issue of Flight Safety Australia, “Whiteout”, reported an incident in which a dry chemical fire extinguisher was inadvertently activated in a Cessna 182. These extinguishers contain mono-ammonium phosphate which is extremely corrosive, especially to aluminium. Once activated within the aircraft all electrical components exposed to the chemical would require overhaul and the airframe would need to be taken apart in order to clean it properly. Without complete clean up, the airframe will corrode over time.

— Werner Lushington, Brisbane, Queensland

In our analysis we noted that dry powder fire extinguishers (for example, ABC powder) are the wrong type to be installed in a cockpit. A manufacturer’s technical paper on this subject makes clear why. The paper says, "Any chemical powder can produce some degree of corrosion or other damage, but mono-ammonium phosphate is acidic and corrodes more readily than other dry chemicals, which are neutral or mildly alkaline. Furthermore, corrosion by other dry chemicals is stopped by moderately dry atmosphere, while phosphoric acid has such a strong affinity for water that an exceedingly dry atmosphere would be needed to stop corrosion. "Mono-ammonium phosphate is highly corrosive to [aluminium], and once it contacts hot [aluminium] and flows down into the structural cracks and crevices it cannot be washed out as the BC dry chemical agents can. "Once an ABC extinguisher is used on an [aircraft], it is necessary to disassemble the aircraft piece by piece, and rivet by rivet to accomplish cleanup. Failure to do so will result in destruction of the aircraft by corrosion. To sum up: ABC extinguishers (hand portable and wheeled) are not proper aircraft … fire protection, onboard, on ramps or in hangers."

Halon extinguishers (BCF and BTM) are widely considered the best general purpose extinguishers for use in aircraft. You should not use dry powder extinguishers.

AD/general/65 says, “[For] all aircraft except private and aerial work aeroplanes with maximum take-off weight (MTOW) not exceeding 5,700kg, rotorcraft with MTOW not exceeding 2,750kg and gliders, powered sailplanes and power-assisted sailplanes … dry powder or water based extinguishers are not to be located in the pilot compartment or any compartment common to the pilot compartment.”

For those aircraft for which this AD does not apply, CASA recommends against use of dry powder and water-based extinguishers.

Note that using an extinguisher in a confined space can result in breathing difficulties; of course, putting out an in-flight fire – by any means – is your first priority.
Emergency procedures in AFMs

A recent straw poll taken by a company of its flight crew as to the mandatory or otherwise nature of the term “recommended” in the listed emergency procedures within aircraft flight manuals (AFMs) indicated that about 50 per cent of the crew thought the term “recommended” was discretionary.

What is CASA’s interpretation of the effect of recommended emergency procedures in aircraft flight manuals?

– Name withheld

CASA considers that the emergency procedures specified in an aircraft manufacturer’s flight manual/pilot operating handbook are an instruction, procedure or limitation concerning the operation of the aircraft. While a manual may characterise such procedures as recommended or not mandatory, CASA considers the effect of regulation 138 of the civil aviation regulations 1988 is to require compliance with these procedures. For aircraft operated in commercial operations, an operator’s operations manual may also mandate compliance or describe emergency procedures that operating crew are to comply with (regulation 215(2)).

Position, position, position

The July-August issue of Flight Safety Australia printed a response to a letter that questioned the link between following published procedures and global navigation satellite system (GNSS) accuracy. The response described GNSS integrity, and outlined how receiver autonomous integrity monitoring (RAIM), which alerts pilots to a loss of satellite integrity, has limits for enroute, terminal and approach modes.

While the description of RAIM was technically correct, I am concerned about the link that might be implied between departing from published procedures and loss of RAIM. This could lead some less technically minded pilots to falsely assume that adherence to published procedures will guarantee that they have satellite integrity, which could lead to a hazardous ignoring of RAIM warnings.

— Peter Lapthorne, Melbourne

There are two key operational points: first, a RAIM warning means that you cannot be confident that there are sufficient satellites in view to safely conduct an approach, and you must follow the published procedure for a missed approach; second, you must follow published procedures for a legal RNAV (GNSS) non-precision approach because if you do not pass within certain tolerances of the approach fixes, your receiver will fail to give you the finer level of positional tolerance that the design safety of the approach requires.

ERRATA

Our answer to question 7 of the VFR operations quiz in the July-August issue was out of date. We said that you cannot carry passengers on a day VFR flight if you have not completed 3 landings to a full stop in the last 90 days. In fact, changes to the rules have removed the full stop requirement, so that touch-and-go landings will suffice (CAR 1988 5.82).

In the story marking the 75th anniversary of the loss of the Southern Cloud, we stated that the chart the crew used was published on Saturday and used for their Sydney-Melbourne flight the following Monday morning. This should have read, “The synoptic chart the Southern Cloud crew used for their fateful Saturday flight was based on data the bureau received the previous morning.”
## MAJOR INTERNATIONAL ACCIDENTS/INCIDENTS JULY–AUGUST

<table>
<thead>
<tr>
<th>DATE</th>
<th>AIRCRAFT</th>
<th>LOCATION</th>
<th>FATALITIES</th>
<th>DAMAGE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/07</td>
<td>Canadair CL-215</td>
<td>Off Patroklos Island, Greece</td>
<td>Nil</td>
<td>Destroyed</td>
<td>While scooping up sea water, the aircraft crashed into a wave and sunk. Both pilots escaped and were rescued.</td>
</tr>
<tr>
<td>07/07</td>
<td>Antonov 12B</td>
<td>10km NW of Sake, Congo Democratic Republic</td>
<td>6</td>
<td>Destroyed</td>
<td>The aircraft suffered problems with one engine and crashed into a hill, broke up and caught fire.</td>
</tr>
<tr>
<td>09/07</td>
<td>Airbus A.310-324</td>
<td>Irkutsk Airport, Russia</td>
<td>124</td>
<td>Destroyed</td>
<td>The aircraft landed but failed to decelerate, overran the runway at high speed, collided with a concrete barrier and burst into flames.</td>
</tr>
<tr>
<td>10/07</td>
<td>Fokker F-27</td>
<td>Near Multan Airport, Pakistan</td>
<td>45</td>
<td>Destroyed</td>
<td>The aircraft suffered engine problems and struck a powerline before crashing in a field.</td>
</tr>
<tr>
<td>10/07</td>
<td>Tupolev 134</td>
<td>Gvardeyskoye Air Base, Ukraine</td>
<td>Nil</td>
<td>Destroyed</td>
<td>On takeoff the engine failed and caught fire, possibly as a result of bird strike. Takeoff was aborted and aircraft overrun runway.</td>
</tr>
<tr>
<td>10/07</td>
<td>Cessna 560 Citation V</td>
<td>Hamilton-Ravalli County Airport, USA</td>
<td>Nil</td>
<td>Substantial</td>
<td>The aircraft overran runway, the nose gear collapsed and the aircraft came to rest in a marsh.</td>
</tr>
<tr>
<td>12/07</td>
<td>Lockheed L-100-30 Hercules</td>
<td>Manono Airport, Congo Democratic Republic</td>
<td>Nil</td>
<td>Destroyed</td>
<td>While attempting to land, a go around was made. On the second landing attempt the aircraft descended at a high speed and crashed.</td>
</tr>
<tr>
<td>15/07</td>
<td>Embraer RJ135ER</td>
<td>Madrid-Barajas Airport, Spain</td>
<td>Nil</td>
<td>Substantial</td>
<td>While taxiing a Boeing 747 struck an Embraer with its right-hand wing tip. The wing cut through the tail of the Embraer, ripping off the entire tail section.</td>
</tr>
<tr>
<td>19/07</td>
<td>Douglas DC-3C</td>
<td>1.5km off Saint Thomas-Cyril E King Airport, Virgin Islands</td>
<td>Nil</td>
<td>Substantial</td>
<td>The aircraft could not maintain altitude and airspeed and was ditched in the ocean. All occupants exited the aircraft into a life raft.</td>
</tr>
<tr>
<td>19/07</td>
<td>Antonov 2</td>
<td>Limanskoye, Ukraine</td>
<td>Nil</td>
<td>Destroyed</td>
<td>The aircraft nosed over following harsh braking.</td>
</tr>
<tr>
<td>25/07</td>
<td>Spectrum Aeronautical 33</td>
<td>Spanish Fork-Springville Airport, USA</td>
<td>2</td>
<td>Destroyed</td>
<td>The aircraft entered a right roll after takeoff. The right wingtip hit the ground.</td>
</tr>
<tr>
<td>29/07</td>
<td>De Havilland Canada DHC-8 Twin Otter 100</td>
<td>Sullivan Regional Airport, USA</td>
<td>6</td>
<td>Destroyed</td>
<td>After takeoff the aircraft lost height, contacted a utility pole and tree during landing.</td>
</tr>
<tr>
<td>03/08</td>
<td>Antonov 28</td>
<td>15km from Bukavu, CDR</td>
<td>17</td>
<td>Destroyed</td>
<td>The aircraft struck a mountainside, crashed in a forest and caught fire.</td>
</tr>
<tr>
<td>04/08</td>
<td>Embraer 110P1 Bandeirante</td>
<td>Near Pownal, USA</td>
<td>1</td>
<td>Destroyed</td>
<td>The aircraft circled for a second approach and crashed on a mountainside.</td>
</tr>
<tr>
<td>07/08</td>
<td>Antonov 24</td>
<td>El Fasher Airport, Sudan</td>
<td>Nil</td>
<td>Substantial</td>
<td>The aircraft crash-landed, coming to rest near the runway threshold.</td>
</tr>
<tr>
<td>12/08</td>
<td>Antonov 2</td>
<td>Kazakhstan</td>
<td>1</td>
<td>Destroyed</td>
<td>The aircraft crashed after completing a crop spraying mission.</td>
</tr>
<tr>
<td>13/08</td>
<td>Lockheed L-100-30 Hercules</td>
<td>Near Piacenza, Italy</td>
<td>3</td>
<td>Destroyed</td>
<td>The aircraft was at 24,000ft when it entered a high speed descent until it hit the ground and collided with terrain.</td>
</tr>
<tr>
<td>22/08</td>
<td>Tupolev 154M</td>
<td>45km N of Donetsk, Ukraine</td>
<td>170</td>
<td>Destroyed</td>
<td>At 39,500ft the aircraft stalled then entered a spin until it collided with terrain. The crew could not recover and the plane entered a spin. The aircraft crashed and burned in a field.</td>
</tr>
<tr>
<td>27/08</td>
<td>Canadair CL-600-219 Regional Jet</td>
<td>Lexington-Blue Grass Airport, USA</td>
<td>49</td>
<td>Destroyed</td>
<td>The aircraft took off from the shorter runway, but was unable to rotate within the distance available. The aircraft overran the runway, knocked down a fence before striking several trees and bursting into flames.</td>
</tr>
</tbody>
</table>

**Notes:** Compiled from information supplied by the Aviation Safety Network (see aviation-safety.net) and reproduced with permission. While every effort is made to ensure accuracy, neither the Aviation Safety Network nor Flight Safety Australia make any representations about its accuracy, as information is based on preliminary reports only. For factual information refer to final reports of the relevant official aircraft accident investigation organisation. Information on injuries unavailable.
**AUSTRALIAN ACCIDENTS/INCIDENTS JULY–AUGUST**

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</tr>
</thead>
<tbody>
<tr>
<td>1/07</td>
<td>Fairchild Industries SA227-AC Metroliner</td>
<td>Canberra, ACT</td>
<td>Nil</td>
<td>Substantial</td>
<td>During the landing in darkness, the aircraft was flared higher than normal, which resulted in a firm landing.</td>
</tr>
<tr>
<td>11/07</td>
<td>Piper PA-31-350 Chieftain</td>
<td>Bathurst Island, NT</td>
<td>Nil</td>
<td>Substantial</td>
<td>During the take-off run the pilot reported that the aircraft did not respond to control back pressure and failed to rotate.</td>
</tr>
<tr>
<td>12/07</td>
<td>Britten Norman BN-2A-21 Islander</td>
<td>Horn Island, Qld</td>
<td>Nil</td>
<td>Substantial</td>
<td>During the night takeoff, the right engine power fluctuated and the pilot rejected the takeoff.</td>
</tr>
<tr>
<td>13/07</td>
<td>Cessna U206G</td>
<td>Yalakun Station, NT</td>
<td>Nil</td>
<td>Substantial</td>
<td>The aircraft became airborne in ground effect but was unable to achieve sufficient airspeed to continue.</td>
</tr>
<tr>
<td>17/07</td>
<td>Schweizer 269C</td>
<td>19km NW Tipperary, NT</td>
<td>Nil</td>
<td>Destroyed</td>
<td>The helicopter landed in long grass which then caught fire.</td>
</tr>
<tr>
<td>20/07</td>
<td>Piper PA-20</td>
<td>Latrobe Valley, Vic</td>
<td>Nil</td>
<td>Substantial</td>
<td>During the landing roll, the pilot applied rudder and brake to counter the aircraft’s nose swinging to the left. The aircraft nosed over and came to rest inverted.</td>
</tr>
<tr>
<td>24/07</td>
<td>Vans RV-6</td>
<td>Yarrawonga, Vic</td>
<td>Nil</td>
<td>Substantial</td>
<td>During the landing, the aircraft veered to the left of the runway and collided with a fence.</td>
</tr>
<tr>
<td>24/07</td>
<td>Robinson R22 BETA</td>
<td>93km WNW Charters Towers, Qld</td>
<td>Nil</td>
<td>Substantial</td>
<td>A drive belt failed and the clutch light illuminated. The pilot turned the helicopter towards more favourable terrain for landing then the second drive belt failed. The engine oversped, the helicopter yawed left and impacted the ground.</td>
</tr>
<tr>
<td>1/08</td>
<td>Robinson R22 BETA</td>
<td>Devoncourt, Qld</td>
<td>Nil</td>
<td>Substantial</td>
<td>As the helicopter became airborne, the pilot’s swag jammed the cyclic. The helicopter then impacted the ground.</td>
</tr>
<tr>
<td>2/08</td>
<td>Robinson R22 BETA</td>
<td>80km S Rolleston, Qld</td>
<td>Nil</td>
<td>Substantial</td>
<td>During mustering operations, the helicopter’s tail rotor struck a dead tree.</td>
</tr>
<tr>
<td>2/08</td>
<td>Amateur Built CH801</td>
<td>Williambury Station, WA</td>
<td>Nil</td>
<td>Substantial</td>
<td>During the landing roll, the pilot applied rudder and brake to counter the aircraft’s nose swinging to the left. The aircraft nosed over and came to rest inverted.</td>
</tr>
<tr>
<td>1/08</td>
<td>Cessna 182P Skylane</td>
<td>5km W Archerfield, Qld</td>
<td>Serious</td>
<td>Destroyed</td>
<td>The pilot declared a Mayday advising that the aircraft was experiencing engine problems. The aircraft collided with a house.</td>
</tr>
<tr>
<td>9/08</td>
<td>Cessna 172N Skyhawk</td>
<td>37km NW Latrobe Valley, Vic</td>
<td>Minor</td>
<td>Destroyed</td>
<td>Due to icing conditions, the pilot declared an emergency and made a forced landing in lightly timbered country.</td>
</tr>
<tr>
<td>15/08</td>
<td>Kavanagh Balloons B-400</td>
<td>3km N Mareeba Township, Qld</td>
<td>Serious</td>
<td>Nil</td>
<td>The passenger caught his foot on the top edge of the basket and fell awkwardly on his left leg.</td>
</tr>
<tr>
<td>16/08</td>
<td>Hughes 269A</td>
<td>Maroochydore/Sunshine Coast, Qld</td>
<td>Nil</td>
<td>Substantial</td>
<td>While practicing autorotations, the skid became stuck in soft ground. The helicopter rocked forward and the main rotor struck the tail boom.</td>
</tr>
<tr>
<td>24/08</td>
<td>Beech 58 Baron</td>
<td>Cunderdin, WA</td>
<td>Nil</td>
<td>Substantial</td>
<td>The pilot inadvertently retracted the landing gear instead of the flap.</td>
</tr>
<tr>
<td>26/08</td>
<td>Cessna 152</td>
<td>Bankstown, NSW</td>
<td>Nil</td>
<td>Substantial</td>
<td>During early solo circuit training, the aircraft veered off the side of the runway and collided with a fence.</td>
</tr>
<tr>
<td>27/08</td>
<td>Stemme S 10 VT Motor gider</td>
<td>10km E Camden, NSW</td>
<td>Fatal</td>
<td>Destroyed</td>
<td>The aircraft collided with the ground.</td>
</tr>
</tbody>
</table>

**Disclaimer:** Information on accidents is the result of a cooperative effort between the Australian Transport Safety Bureau (ATSB) and the Australian aviation industry. Data quality and consistency depend on the efforts of industry where no follow-up action is undertaken by the ATSB. The ATSB accepts no liability for any loss or damage suffered by any person or corporation resulting from the use of this data. Note that descriptions are based on preliminary reports and should not be interpreted as findings by the ATSB. The data do not include sports aviation accidents.

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**SEPTMBER–OCTOBER 2006 FLIGHT SAFETY AUSTRALIA 11**
Crack inspections required for Beechcraft 1900s

Six Australian Beechcraft 1900 aircraft were grounded in September for urgent inspections for wing spar cracks. Four of the six aircraft, which can carry two crew and 19 passengers, are operated by regional airlines in NSW and the Northern Territory.

The action follows the release of an airworthiness directive (AD) by the US Federal Aviation Administration (FAA) after it received reports of cracks in the rear wing spars of two Raytheon Beechcraft 1900D regional turboprops.

The Australian AD (AD/BEECH 1900/48), issued on September 1, calls for a one-time visual inspection of the left- and right-wing rear spar lower caps for cracking and other damage, such as loose or missing fasteners. Repair of cracks or other damage is required before further flight. The action followed discovery in the US of significant cracks in the wing rear spar lower caps and rear spar webs of two 1900D airliners.

The Raytheon Aircraft Company structural inspection manual requires a thorough inspection of the wing rear spar at 17,500 hours time-in-service (TIS) with repetitive inspections at intervals of 3,000 hours TIS. One aeroplane had 19,126 hours TIS when cracks were found.

The cracks were in the lower aft spar cap flange, and extended upward into the web and terminated at the lightening hole in the spar web. Fasteners were missing in the spar cap and splice plate. There were no discrepancies recorded from the initial inspection at 17,500 hours TIS on this aeroplane.

Analysis has shown that similar cracks could also develop in the wings of the models 1900 and 1900C aeroplanes.

Laptop battery alert

The Civil Aviation Safety Authority (CASA) is contacting leading international aviation authorities to work out safety procedures for using laptop computers on aeroplanes.

The move has been prompted by the recall by manufacturers Apple and Dell of millions of laptop computers in order to replace faulty overheating batteries.

The problem is that if the battery is in the computer, and the computer is plugged into the aircraft’s power system, there is risk that the battery will catch fire. Airlines are asking passengers to remove batteries of Apple or Dell laptops before they are used on board.

Chance to comment on CASA charges

Time is running out to make comments on proposed changes to charges for CASA regulatory services, with the October 31 deadline fast approaching as Flight Safety Australia goes to print.

CASA is seeking feedback on the service charge proposals with a new charging regime due to be introduced from July 1, 2007, in line with the Australian government’s cost recovery policy.

In response to calls for a more accurate user-pays system, CASA has reviewed existing charges and is proposing to move from the current two hourly rates to four. The proposed hourly rates are $100, $130, $150 and $180, with fixed fees still applying to some services where appropriate.

Other proposed changes include a reduction in fees for the processing of medical certificates. CASA proposes to reduce this fee to $75, however this could change depending on industry feedback.

CASA is reviewing charges associated with travel for the provision of regulatory services.

Email your comments to: costrecovery@casa.gov.au or post to: Civil Aviation Safety Authority, Cost recovery feedback, GPO Box 2005, Canberra ACT 2601. Further information, including a full list of the proposed fees, is available on the CASA website (casa.gov.au/corporate/fees/index.htm).
WEBWATCH

Stressed out? Although small amounts of stress can increase alertness and an improved ability to concentrate, an accumulation of stress has been associated with numerous health problems. Check out a detailed discussion of the effects of stress on flight crew members (www.flight-safety.org/hfam_home.html).

System safety: The seventh International Symposium of the Australian Aviation Psychology Association will focus on “Evolving System Safety”. To be held from November 9-12 at Manly Pacific Hotel in Sydney, the symposium will feature Bob Helmreich, whose article marking the 25th anniversary of the introduction of CRM is our cover story this issue. Details of the conference are on the web (http://www.ess2006.com).

Weather on the web: An international effort to provide up-to-date aviation weather hazard educational material on the web has resulted in the creation of a new site by the World Meteorological Organization (http://www.caem.wmo.int/).

Further action on Lycoming crankshafts

Could it be the last episode of regulatory actions on Lycoming crankshafts? We don’t know for sure but the US Federal Aviation Administration (FAA) has recently issued airworthiness directive (AD) 2006-20-09 seeking retirement of more than 5,000 suspect crankshafts globally from active service.

There have been more than 23 reported failures of Lycoming crankshafts which may be attributable to a loss of strength due to a crankshaft internal material defect.

CASA has been following developments closely and has issued AD/Lyc/107, AD/Lyc/112 and AD/Lyc/115 along the way, and is issuing an Australian AD to back up the latest FAA action.

Meanwhile Lycoming has announced that the engines affected by SB569/SB569A, which are overhauled at the Lycoming factory at any time within 12-year limit, will receive a replacement crankshaft at no additional charge. Operators and owners opting to have their crankshaft replaced at facilities other than Lycoming will receive a crankshaft replacement kit specially priced at $2,000, a discounted price that is available for the three years following issue of Lycoming service bulletin SB 569A.

If you are already compliant with the requirements of earlier CASA ADs, and you are not affected by Lycoming MSB 569A, then no further action is required. If your crankshaft is listed in MSB 569A, then no further action is required. If your crankshaft is not affected by Lycoming MSB 569A, then no further action is required.

CASA conducted a viability study based on the facilities in Barcelona and came to the conclusion the race could be safely run in Australia.

Red Bull race cleared to go

The Red Bull air race 2006 world series final, to be flown in Perth in November, has been given formal approval by CASA to go ahead.

The Red Bull Air Race is an international competition held in nine locations around the world including Barcelona, Berlin, Istanbul, Budapest and San Francisco.

The competition is more a time trial than a race, testing pilot precision, skill and speed in a controlled situation. It is conducted at low level over water on a slalom style course.

Pilots perform at speeds over 400km/hr while negotiating 19m-high obstacles.

Twelve pilots of various nationalities will compete. Over a hundred and fifty people are involved on the ground with a further 500,000 spectators expected at the event. The location over the Swan River where the race is being held is usually restricted for aviation activities.

CASA conducted a viability study based on the facilities in Barcelona and came to the conclusion the race could be safely run in Australia.

160 hp Lycoming. Garmin Com/GPS and TXP. Intercom.

New 2006 Citabria Adventure. Aluminium spar wing. 1000 lbs. 115Kts cruise @33lph. 560lbs load. Low operating costs.}

FLIGHT SAFETY AUSTRALIA SEPTEMBER–OCTOBER 2006
Right runway advice

The US Federal Aviation Administration (FAA) has issued a safety alert for operators following the crash of a Bombardier CRJ-100 aircraft in Kentucky in August (pictured right) which killed 47 passengers and two crew members.

The aircraft had attempted takeoff from the wrong runway at Blue Grass Airport in Lexington. The CRJ flight crew used runway 26, a 3,500ft strip used by GA aircraft, instead of the runway they were cleared to takeoff from which is over 7,000ft long.

The safety alert includes recommendations that are relevant for Australian operators.

The advice for taxi preparation includes:
• Review notices to airmen (NOTAMs) for information on runway/taxiway closures and construction areas.
• During taxi operations have a current airport diagram readily available for reference and check the assigned taxi route against the diagram, paying special attention to any unique or complex intersections.
• If the flight has more than one crew member, both should fully understand clearances and runway assignments.
• During taxi operations the pilots’ maximum attention should be on maintaining situation awareness.
• The pilot taxiing should have his or her attention focused outside the aircraft at all times while the other pilot should monitor the taxi progress using the airport diagram and give guidance to the taxiing pilot.
• Confirm, using the challenge and response technique, that the aircraft is actually positioned on the assigned runway by reference to the heading indicator.

LEGAL BRIEF

IMPLICATIONS OF TRANS-TASMAN RECOGNITION

In February 2000, CASA issued a commercial pilot (helicopter) licence to a pilot who, in January 2002, applied to the Civil Aviation Authority of New Zealand for registration as a helicopter pilot. On March 11, 2002, the NZ CAA issued the applicant with a commercial pilot (helicopter) licence.

With effect from 12 August 2005, the pilot’s New Zealand commercial pilot (helicopter) licence and his instructor rating were revoked by the NZ CAA.

Section 32 of the Trans-Tasman Mutual Recognition Act 1997 provides that if a person’s registration in an occupation in New Zealand is cancelled or suspended, or is subject to a condition on disciplinary grounds, or as a result of or in anticipation of criminal, civil or disciplinary proceedings, then the person’s registration in the equivalent occupation in an Australian jurisdiction is affected in the same way. However, the local registration authority of the Australian jurisdiction (CASA) may reinstate any cancelled or suspended registration or waive any such condition if it thinks it appropriate in the circumstances.

CASA wrote to the pilot advising him that his CASA-issued licence was affected in the same way as his New Zealand licence. The pilot then made an application to the Federal Court of Australia seeking review under the Administrative Decisions (Judicial Review) Act 1997 of an administrative decision said to have been made by CASA to cancel his CASA issued licence. CASA submitted to the Court it had not cancelled the licence, but that the licence was cancelled by operation of section 32.

On May 25, 2006, the Federal Court refused to order an injunction against CASA. Justice Ryan said: “Section 32 contemplates that any Australian registration may be affected by cancellation, suspension or imposition of conditions by a New Zealand registration authority if that action is taken in respect of the same person’s registration in an equivalent occupation in New Zealand.” For these reasons, there was not a decision of CASA which was reviewable under the Administrative Decisions (Judicial Review) Act.

Pilots and engineers therefore need to be aware that if they obtain a licence in New Zealand on the basis of a mutual recognition of an Australian issued licence, if New Zealand cancels the New Zealand issued licence, the Australian issued licence will be affected in the same way.
A private pilot learns the value of correct procedures and the worthlessness of runway behind you.

Our local airfield has a wide, smooth runway that is not far short of 1,000m. We joke that the council engineer was briefed that it had to be long, flat and straight but nobody told him it would be better if it did not have a mountain at one end.

The runway runs east-west with a 150ft-high ridge a relatively short distance from the eastern end of the strip. As you could imagine, landing to the west requires an unusually steep approach, while taking off to the east requires a short-field takeoff.

Our local flying school has two Cessna 152s available for hire. Although they are almost identical to look at, one of them is quick to accelerate but rather slow in cruise, while the other is slow to get going but some 10kt faster overall. Presumably one propeller is finer than the other.

On the day in question, the only aircraft available was the one that was slower to accelerate. I pre-flighted, started the engine and began a slow taxi to the runway. The only taxiway at our airfield joins the runway at the far eastern end; so departures to the east require a full-length backtrack. A light easterly was blowing so I was in for a long taxi to reach the takeoff point.

To avoid a long interval between the engine checks and the takeoff run – and because there was nobody else in the circuit – I decided to defer the run-up checks until I’d lined up for takeoff. I soon reached the end of the runway, turned the aircraft around to line up and started the engine checks. I was part way through the checks when I noticed a large flock of seagulls settling just a few metres down the runway in front of the aircraft.

Conscious of the damage that could be caused by a birdstrike, I opened the window and did my best impersonation of a seagull alarm call. The gulls were unfazed. I tried slapping the side of the fuselage with my palm to scare them off. Still no luck. I ran the engine up to full static RPM and still they didn’t budge. Finally I rolled the aircraft forward a few metres. This worked, but they only moved a few metres further along the runway and settled back down again. I am not sure how many times I rolled towards them but they eventually got the message and took their corroboree elsewhere.

I was ready to depart. I had taken off over the same ridge hundreds of times and I knew there was sufficient margin, even with a few metres of runway behind me. Full power, brakes off. Oil temperature and pressure were in the green. The RPM was lower than normal but the speed was creeping up. So too was the ridge at the end of the runway. By the time we were airborne, it was much more...
conspicuous in my field of view than usual. **Too low:** I quickly trimmed for best angle-of-climb speed but the damage was already done. We were too low and it looked as if we were on a collision course with a house on top of the ridge. It’s remarkable how difficult it is in such a situation to resist the temptation to increase angle of attack – even though you know it will decrease, rather than increase the aircraft’s rate of climb.

Our ground clearance was slowly increasing but it was clear our little bird had lost the will to fly. I made plans to get back on the ground and while holding the best-angle-of-climb speed, gingerly began a turn to make a very compact downwind leg to land again. Established on a low-level downwind leg it was time to investigate the problem. Carburator heat was cold, mixture set to rich and the throttle fully open. What about the mags? I reached down to the key and immediately realised it was on “Left”. I quickly switched it to “Both” and the engine gained another 150rpm. Concepts like “accelerate” and “climb” became realities again. I cancelled the early landing and completed the flight without incident.

With hindsight, it’s easy to see there were things I could have done better. At the time, my one airmanship-like thought was to get rid of the gulls before takeoff. My experience of easterly take-offs indicated that there was still plenty of room to clear the ridge from the point where we eventually started. Of course, I had not counted on taking off on just one magneto.

My dislike for taking off to the east now borders on paranoia. If the wind is light enough from the east, I take off to the west with a small downwind component. If it is blowing a gale from the east so that the takeoff profile matches that of a Harrier, I will happily take off to the east. Otherwise, especially if it is hot, I will wait for a westerly that almost always comes in with the sea breeze later in the day. I also learned that the adage about “runway behind you” is not to be taken lightly. If I ever have to use the aircraft as a mobile bird scarer again, you can be sure that I will backtrack afterwards to use the full runway length.

Most importantly, I learned that memorised checklists must be completed without interruption. Nowadays, if there is ever an interruption from an ATC call, a question from a passenger, or something distracting out the window, I always go back to the top and start again.

And now, when I get to the point just before I push the throttle forward to start the takeoff roll, my wife always murmurs “Mags on both?”

**$1,000 Best entry**
WHAT WENT WRONG

LONG FLOAT TO LAND
A Boeing 737 copilot recalls a difficult approach to a rain-soaked Sydney airport.

We had been in the air for 6 hours and, all going well, would soon be on the ground at Sydney Airport. The trip from our home airport had been uneventful, though thunderstorms and heavy rain promised to make the approach interesting.

I was first officer on the B737, and pilot flying on this sector. The captain was an experienced pilot with 15 years on the B737. Before this trip, I had flown a small half-hour sector domestically, so my total duty time would be around 12 hours by the time I signed off for the day.

The Sydney approach controller put us at number three behind a B767 and an A320. We listened on the radio as one-by-one both aircraft executed missed approaches due to the heavy rain and very poor visibility.

Then it was our turn. Like the aircraft before us, we could not get visual, even though the approach lights were at maximum intensity. I carried out the missed approach and we were given radar vectors to position for a second approach. Unfortunately, that ended in another missed approach.

We still had plenty of fuel to divert to Brisbane, our alternate, and we considered our options while stacked in the holding pattern with several other aircraft. Finally, we heard a couple of aircraft get visual and land.

At this point, the captain took over as pilot flying. I had flown two take-offs and landings, two missed approaches and a 15-minute holding pattern, and I was relieved that the pressure of flying was no longer on my shoulders, especially in such bad weather.

I should have been more assertive and done more to alert the captain to my concerns.

We were once again set up in the approach and as I was the pilot-not-flying, my eyes were on the lookout for the approach lights outside. The rain was still very heavy and the windscreen wipers were on maximum. Finally, I saw the lights and called “visual” which the captain confirmed.

Float: The radio altimeter callout came next: “100ft” then “50ft”. But the descent stopped there. The captain was holding the aircraft between 40 and 50ft and not letting it descend any further. The runway was rushing past and I was concerned that we weren’t landing.

On the other hand, I was also aware that with 30 years in aviation the captain might have known something that I didn’t. Anyway, this was a long runway and we were okay for the time being.

The “float” continued, and I now had to do something to alert the captain that things were getting dangerous (in a nice way). I started calling out the radio altimeter heights, “40ft, 50ft, 40ft”. It broke his trance and he finally made a firm touchdown.

The rain was so heavy as we taxied towards the international terminal that we had trouble making out the buildings. We did not talk about the incident until we reached the hotel room. In retrospect, I should have been more assertive and done more to alert the captain to my concerns. It wasn’t enough to simply call out the radio altimeter heights.

$500 Highly commended
This reluctance to question authority can be fatal if the authority figure is in error. That’s one of the reasons that airlines around the world have introduced crew resource management training (CRM). Among other things, CRM teaches crew how to improve communication, including how to overcome barriers to assertiveness.

In Australia proposed new safety regulations (part 121) are likely to require CRM training for passenger carrying operations and cargo aircraft above 5,700kg MTOW.

Assertiveness can be defined as the willingness or readiness to actively participate, state and maintain a position until you are convinced by the facts that other options are better. If you are uncomfortable with the safety of the operation then you need to speak up.

If you question authority it is important to avoid being either too passive or too aggressive.

Flight crew training should ensure CRM instruction emphasises not only the importance of speaking up, but that any decision to take control from the captain for a perceived dangerous situation is an action of last resort and a matter of personal judgment that had better be right first time.

If you question authority it is important to avoid being either too passive or too aggressive (see table). It is more difficult for members of a team to question the person in charge, if the so-called “authority gradient”, or command hierarchy, is steep. Members of a crew with a domineering, overbearing, or dictatorial team leader experience a steep authority gradient. Expressing concerns, questioning, or even simply clarifying instructions can require considerable determination on the part of team members who perceive their input as devalued or unwelcome.

Most teams require some level of authority gradient; otherwise roles are blurred and decisions can’t be taken in a timely manner. However, effective team leaders encourage team members to speak up when they see an error or a situation that needs attention in order to avert a threat to safety.

Tail strike risk: This story indicates the captain held off high and floated. Heavy rain and refraction on the wind-screen would have made it hard for the captain to accurately judge flare height.

If the thrust levers are not fully closed, the chances of a prolonged float are increased, along with the probability of a tail strike in long body aircraft such as the Boeing 737-800. The captain would have known this but may have accepted the risk rather than conduct a late go around to join the queue for another approach.

The first officer, perhaps with the advantage of youthful eyesight, was faced with the unenviable position of seeing the captain apparently mesmerised and digging a hole for himself.

Failure to recognise a deteriorating situation is a known factor in numerous overrun accidents. On the other hand, the prospect of taking over control from the captain and either attempting to force the aircraft onto the runway or conducting a late go-around, would have weighed heavily on the mind of the first officer – and rightly so. Regardless of the outcome, he would have had some explaining to do – with a real risk to his future career.

Under the circumstances described, the actions of the first officer were sound.

Note that although every pilot tries to achieve a smooth touchdown, a positive touchdown is preferred on a wet runway in order to reduce the risk of aquaplaning. Although a positive touchdown may not have been the plan in this case, it was certainly the result.

<table>
<thead>
<tr>
<th>Passive</th>
<th>Assertive</th>
<th>Over-aggressive</th>
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<tbody>
<tr>
<td>Overly courteous</td>
<td>Actively involved</td>
<td>Dominating</td>
</tr>
<tr>
<td>“Beats around the bush”</td>
<td>Ready to take action</td>
<td>Intimidating</td>
</tr>
<tr>
<td>Avoids conflicts</td>
<td>Provides useful information</td>
<td>Abusive</td>
</tr>
<tr>
<td>“Just along for the ride”</td>
<td>Makes suggestions</td>
<td>Hostile</td>
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Source: Qantas aviation schools command
An encounter with low-level windshear leaves a young commercial pilot struggling to stay airborne. Name withheld by request.

I was just three weeks into my first full-time flying job when a bad landing nearly forced me into early retirement. I was employed on general charter duties flying a Piper Commanche 250. My passengers included cattle and sheep buyers, vets, telco techs, bookies, tourists, farm machinery mechanics and injured stockmen – among others.

I had about 800hrs in my logbook, quite a bit of that in a 180hp Piper Comanche. The 250hp model handled almost identically, though to a relative beginner, it felt a little heavier and less forgiving in the landing configuration. But I believed Comanches didn’t hold any surprises for me. I was wrong.

The job on this day was to fly two sheep dealers and a stock agent to a strip on a very remote property near the NSW/Queensland border, then to another about 300nm further northeast, and finally to return them all to our base in Western NSW, via a fuel stop.

The company’s airstrip register showed no problems with the first strip, which comprised about 3km of unobstructed claypan. The second strip was a little trickier, and while it was theoretically long enough, there wouldn’t be much runway left over. The strip’s usual takeoff and landing direction was into the west because of the prevailing northwest and southwest winds. The notes also told me that longer grass at the western end sometimes concealed wild pigs and other animals.

To top it off, the strip was described as “surrounded by fairly tall trees”. Clearly I would have to use all my short-field landing skills.

Good price: At this point, it’s necessary to provide some background about the purpose of the flight. The old “bush telegraph”, meant the business of my passengers was likely to become well known within minutes of a deal being made, and our customers definitely didn’t want their business publicised. Therefore I’d been briefed that after we departed each of the two strips, I was to pass an innocent-sounding message to the company on HF radio, which when decoded, would in fact detail how many sheep (if any) my passengers had bought, their general condition on a scale of one to five, and the agreed price.

This information would be passed on to the stock agent’s company back at our base, and would influence a decision on whether to confirm or waive another large purchase, on which an option was held. They needed the second message to reach them before 3pm. If they didn’t receive the message by then, they would assume no purchase had been made, and buy the other sheep that were on option. This turned out to be a bad idea.

The first inspection went well, and the buyers signed up for an astronomical number of drought-affected sheep at a favourable price. The passengers stood around chatting with the grazier and his agent until I reminded them that we were a little behind schedule for the second inspection.

Almost two hours later we were in the circuit for the second strip, which was easy to find despite some dust haze because it formed a long rectangular gash through fairly dense trees. On an overfly the surface looked OK, but the bare patch faded into what appeared to be rather long grass half way down the 1,000m strip. I resolved to put down as soon after the threshold as possible and try to stop before we got to the longer grass. The remains of a tattered windsock drooped with no apparent movement.

The PA-24’s stated stall speed range was 55-63kt depending on configuration and weight, and company policy was to adopt a minimum of 1.2Vs as the approach reference speed.

We’d been flying for almost four hours, the passengers weren’t heavy and had no baggage, and the calculated approach speed for the weight and configuration was 69kt. Lined up on final in apparently
In the aircraft, somebody suggested that as the time was 2.45pm, we should try to get off the ground as decisively as we had sunk to earth. But when we got airborne, the HF radio was silent – even the customary static was gone. I later found out that landing had jarred the set’s antenna lead right off the back of the set.

Up to that point the passengers had remained reasonably good-humoured, possibly not realising how close they had been to crashing amongst fallen trees. But when the vital message couldn’t be transmitted, they were accusingly silent. When we landed there was a dash for the phone at the terminal, and a brief phone conversation before one of the buyers walked across to the aircraft.

“We now own 18,000 more skinny sheep than we need, no trucks to pick them up, and no feed for them. Would you like to buy them in situ?”

Since that event, many years ago, I’ve witnessed quite a number of equally botched landings on bush airfields surrounded by trees, and I’ve observed that the backgrounds of the pilots involved had probably not helped them understand the cause, the effect, or how to avoid such an outcome.

The event caused me to develop my own methods of anticipating the problem, including noting forecast low-level winds, and assessing wind by the movement of dust, treetops and windmills against windsocks and the surfaces of dams.

$500 Highly commended

**What Went Wrong**

**Analysis: Dealing With Downdraughts**

This pilot is right in saying that there are a number of runways where buildings or nearby hills create their own “wake turbulence” when a crosswind is blowing. The condition is known to have been a contributing factor in several notable accidents, even at licensed aerodromes.

In this incident, the only obvious clue this pilot had was the anomaly of noticeable drift on the final approach, suggesting low-level wind, despite apparently calm air at ground level.

In these conditions, windshear is created by the trees and terrain interlocking with the lower level of a moving air mass and stopping its low level movement. This provides observably calm air at surface level, a moving (but possibly not turbulent) air mass above, and a layer of disturbed air (as observed by the pilot) at the level where the two air masses interact. For that reason, sudden turbulence at or near where the interaction would be occurring is often a clear warning of a possible problem.

In this incident, the only obvious clue this pilot had was the anomaly of noticeable drift on the final approach, suggesting low-level wind, despite apparently calm air at ground level.

The same situation can also create actual downdraughts, in the same way that lee wave turbulence is generated by wind passing over a ridge. This was quite possibly part of the problem this pilot experienced.

Chief flying instructors and chief pilots are urged to point out the potential for problems at every opportunity.

Any pilot unaccustomed to narrow airstrips surrounded by trees, who may fly into a similar situation, should consider the lessons learnt by a fellow pilot who survived to relate the experience.
A record breaking single-engine flight around the world.

Polly Vacher, mother of three, first learnt to fly at the age of fifty. She then flew twice around the world. On her second around-the-world flight, at the age of 60, she became the first pilot to complete a solo flight around the world via both poles in a single-engine aircraft.

Her “voyage to the ice” in her Piper Dakota was a 60,000nm journey that took her to 34 countries on all seven continents. Vacher’s 156-page book recounting her flight has just been released by Grub Street publishing.

The trip was done in a spirit of adventure with the aim of raising funds to support the charity, Flying for the Disabled, which helps disabled people rebuild their lives through the physical and mental challenge of learning to fly.

Flying for the Disabled was first established in memory of one of Britain’s most famous World War 11 pilots, Sir Douglas Bader. Bader became a World War 11 flying ace after having both legs amputated as a result of a low-level acrobatic accident in a Bulldog before the war.

“OK, I’ve lost my legs,” he said, “but I can still pilot an aircraft”.

With two tin prosthetics, Bader eventually flew a Hawker Hurricane, and ended up shooting down 22 enemy aircraft. Following the Battle of Britain he was chosen to lead the three hundred aircraft victory flypast over London. Each year 10 flying scholarships are given to people with disabilities in honour of Bader’s courage. It is a story that inspired Polly to her own achievement.

North then south: The reader follows Polly Vacher’s meticulous preparations, which included training to survive a forced landing anywhere – including ditching mid-ocean and the possibility of facing polar bears if forced to ditch in the Arctic.

The whole flight took a year, with a total of 550 flying hours and 106 stops. She had one oil leak, one brake failure and a cracked window. Although she carried 60 spare parts, only the spare oil filters were needed.

Chugging southwards over a vast expanse of sea ice, everything suddenly turned silent. It was the most terrifying moment of the trip – an engine failure.

She set off from Birmingham International Airport with a Hurricane and Spitfire escort provided by the Battle of Britain Memorial Flight. Flying north to Scotland, Vacher went on to the North Sea and then Norway, before waiting for clear weather for the trip over the Arctic.

Escorted by two Norwegian F16s she flew her Dakota to Longyearbyen, a Norwegian Island close to the Arctic Circle, and then over the North Pole to Canada. The flight from Longyearben to Resolute Bay took 14 hours.

Chugging southwards over a vast expanse of sea ice, everything suddenly turned silent. It was the most terrifying moment of the trip – an engine failure. Initial panic, and then into automatic mode, “Carby heat on, fuel pump on, change tanks”. The engine sprang back to life. Later maintenance checks in Alaska found nothing amiss.

Down through Canada, the US and South America, the challenge was to become the first woman to fly solo in Antarctica. She describes the trip from the southern most point of Chile to the Antarctic Peninsula as an experience of “sheer elation”. Landing on a gravel strip which runs out to sea on Adelaide Island, Vacher’s final approach was surrounded by huge icebergs – a precarious landing in a spectacular environment.

Vacher recounts sights that few will ever see – the vast ice stream of the Hampton Glacier, tops of mountains protruding from the ice, known as nunataks, the huge ice plateau of Ellsworth Land, Vinson Massif, the tallest mountain in Antarctica.

But strong headwinds consumed too much fuel, and Vacher was forced to turn back to the British Antarctic base, Rothera. Fuel supplies became a problem and she had to abandon plans to fly to the South Pole. Crossing the Antarctic Peninsula to land at the Argentine base of Marambio, Vacher had at least crossed Antarctica close to the magnetic South Pole.

After a long detour to New Zealand via California and the Pacific Ocean, Vacher headed across Australia, Indonesia, southeast Asia, India, the Middle East and Europe before arriving back at Birmingham International Airport exactly 352 days after she left.

Three records were established: Polly Vacher became the first woman to fly solo across the North Pole in a single-engine aircraft, the first woman to fly solo in Antarctica, and the first person to fly solo around the world landing on all seven continents. As a result of her efforts, she raised over $1m for Flying for the Disabled.

Wings around the world, by Polly Vacher, is published by Grub Street Press. The Australian version of Flying for the Disabled is an affiliated organisation called Wheelies with Wings, which has been running now for five years (see www.wheelieswithwings.com.au).
Human error has been a concern since the dawn of aviation, and various forms of training to reduce its impact have long been a focus in military aviation. But it was not until the early 1980s that research on the causes of aviation accidents led to the introduction of structured crew resource management training in the civil aviation sector.

The “red alert” on human error in civil operations was first sounded in 1979 when NASA convened a conference, “Resource management on the flight deck”, to discuss work at NASA Ames Research Centre on commercial airline crashes. This research found that more than 60 US jet transport accidents between 1968 and 1976 involved failures in decision making, leadership, pilot judgment, communication and crew coordination.

Among those accidents singled out at the 1979 safety summit was the 1972 crash of a Lockheed L-1011 in the Everglades, which occurred after the crew became so preoccupied with changing a burned-out nose landing gear indicator lamp that they failed to notice that the altitude hold function of the autopilot had disengaged, causing the aircraft to gradually descend and crash.

In the same year a Boeing 737 crashed at Chicago Midway Airport while attempting a go-around from a non-precision approach. The crew had focused on a light indicating “flight data recorder inoperative” and lost situation awareness. After crossing the final approach fix high, fast and not configured for landing, the crew attempted to land using speed brakes. When they realised they could not make the landing, they tried to go around with the speed brakes fully deployed and crashed off the end of the runway.

The focus on human error was given added impetus by the results of a classic study conducted under NASA sponsorship by Patrick Ruffell Smith and reported at the 1979 conference. In this simulator study, experienced B-747 crews flew a demanding full flight from takeoff to landing. Those who made effective use of all resources performed well while those with poor communications and coordination skills made a large number of errors, including a 100,000 pound error in calculating gross weight for landing.

KLM in Europe, United Airlines in North America and Ansett in Australia were early adopters of the first generation of CRM, known then as cockpit resource manage-

World-renowned expert on human factors, Bob Helmreich, reviews the development of CRM since it was first introduced 25 years ago.
ment. The impetus for KLM was the loss of one of the company’s aircraft in a runway incursion accident at Los Rodeos airport at Teneriffe in the Canary Islands in 1977.

A KLM 747 taking off in fog slammed into a Pan Am 747 taxiing on the same runway. A total of 583 people died, and the accident remains the deadliest in aviation history.

Among the chain of events that led to the disaster was a series of communication problems, including confusion about whether a takeoff clearance had been issued by ATC to the KLM crew. It is likely that the captain mistook a clearance to fly a certain route after takeoff for an actual takeoff clearance.

The KLM flight engineer expressed concern that the Pan Am 747 was not yet clear of the runway just as the captain of the KLM flight began the takeoff run, but he was overruled.

The cockpit voice recorder captured what happened.

**Teneriffe tower:** Stand by for takeoff, I will call you.

**Pan Am captain:** And we’re still taxiing down the runway, the clipper one seven.

**Teneriffe communications caused a shrill noise in KLM cockpit – messages not heard by KLM crew.**

**Tower:** Roger alpha one seven three six.

**Pan Am captain:** OK, we’ll report when we’re clear.

**Tower:** Thank you.

**KLM Flight engineer:** Is hij er niet af dan? (Is he not clear then?)

**KLM captain:** Wat zeg je? (What do you say?)

**KLM flight engineer:** Is hij er niet af, die Pan American? (Is he not clear that Pan American?)

**KLM captain:** Jawel. (Oh yes [emphatic].)

The accident sparked changes to communication protocols and a new focus on group decision making that down played the cockpit hierarchy.

In the United States, structured cockpit/crew resource management training was first instituted by United Airlines following an accident at Portland, Oregon when a United Airlines Douglas DC-8 ran out of fuel and crashed short of the runway in December of 1978. The crew in this accident was preoccupied with a landing gear warning and continued to circle, despite warnings by the flight engineer that the fuel state was becoming critical.

United Airlines called in consultants who had conducted training in managerial effectiveness for corporations to help the company address human error. In 1981 the airline rolled out one of the world’s first comprehensive CRM programs (which they called CLR or command-leadership-resource management). CRM training for crew has since been introduced and developed by aviation organisations worldwide.

[In Australia, Ansett Airlines was among the first to pioneer the “new technology” of CRM training. After surveying the available resources, KLM materials were chosen in 1982. The package consisted of a slide-tape program, covering all aspects of flight crew behaviour, including performance weaknesses and illusions.]

... more than 60 US jet transport accidents between 1968 and 1976 involved failures in decision making, leadership, pilot judgment, communication and crew coordination.

[In early 1985, the two creators of the KLM program, Captain Frank Hawkins and Professor Elwyn Edwards, of Aston University, UK, delivered a two-week course for senior Ansett managers, “Human factors for transport aircraft operation”. This course attracted representatives from Qantas, TAA, the RAAF, Air New Zealand, the then Bureau of Air Safety Investigation, the Department of Aviation (now CASA) and many others.]

The United Airlines program was conducted in an intensive seminar setting and included getting participants to analyse their own interpersonal styles (based on a questionnaire). The focus of the training was correcting behavioural deficits such as a lack of assertiveness by juniors and authoritarian behaviour by captains. Other airlines developed similar programs.

Reactions to the first generation of CRM were generally positive – with some reservations. Some referred to the program as “charm school” and the content as “psycho-babble”.

By the early 1990s, attitudes to CRM training had shifted. At the University of Texas, our research group surveyed crews in 1991 to find out how they assessed the usefulness of the training. We collected data from more than 15,000 crew members from 12 airlines and military organisations in the US. The majority rated the training as very or extremely useful. Additionally, the great majority agreed that CRM training had the potential to increase safety.

We also measured changes in attitudes to concepts such as communications and coordination and the effects of stressors on human performance. On each of the scales reflecting these concepts highly significant improvements in attitudes following CRM training were noted (these data were reported by Helmreich & Wilhelm in the *International Journal of Aviation Psychology* in 1991 and are not limited to first generation CRM courses).

No more dramatic endorsement of the effectiveness of CRM can be given than the judgement of Al Haynes, the pilot of a United Airlines DC-10 that managed a successful crash landing at Sioux City, Iowa, in 1989 after an uncontrolled engine failure severed hydraulic lines, resulting in the loss of flight controls.

The crew, using all their available resources, controlled the aeroplane using differential thrust on the two remaining engines. Captain Al Haynes gave credit for the outcome to CRM training the crew had received.

At a 1991 presentation on the flight at NASA’s Dryden Flight Research Facility in California he said, “As for the crew, there was no training procedure for hydraulic failure. We’ve all been through one failure or double failures, but never a complete hydraulic failure. But the preparation that paid off for the crew was something that United … called cockpit resource management, or command-leadership resource training.

“Up until [then] we kind of worked on the concept that the captain was THE authority on the aircraft. What he [says], goes. We had 103 years of flying experience there in the cockpit, trying to get that [aeroplane] on the ground, not one minute of which we had actually practised, any one of us. If I hadn’t used CLR, if we had not let everybody put their input in, it’s a cinch we wouldn’t have made it.”
From cockpit to crew: Research and experience during the 1980s led to a key shift in CRM from a focus on cockpit resource management to one on crew resource management. This change was highlighted at a second NASA workshop, held in 1986, that recognised that CRM needed to involve all crew members as well as other resources existing in the aviation system (maintenance, air traffic control, and so on). While many of the early CRM courses that were derived from general management development programs focussed on the immediate operational environment, experts saw a need to refine the CRM concept to take account of the broader complexity of aircraft operations.

Our research at the University of Texas has followed the evolution of CRM training that has occurred over the past 25 years. We have identified six “generations” of CRM, as a way of trying to make sense of the changes we have observed.

These descriptive labels try to capture significant changes in the nature of the training – although I suspect one could find early generation training programs still being delivered by some companies.

The first generation of CRM, as implemented by pioneering organisations in the US, Europe and Australia, focused mainly on resources in the cockpit, teamwork, leadership and effective communication.

Second generation CRM was typified by a name change from cockpit to crew resource management, reflecting growing awareness of the involvement of more than the cockpit crew in safe flight. Second generation courses dealt with more specific aviation concepts and became more modular as well as more team oriented. Concepts included team building, briefings, situation awareness and (in some cases) stress management. Criticisms regarding too much pop psychology still continued – for example, the concept of synergy was often derided as silly jargon.

Third generation CRM courses emerged in the early 1990s and addressed a broader segment of the aviation environment including flight attendants, dispatchers and maintenance personnel. Some organisations began to conduct joint cockpit/cabin CRM training. Attention was given to factors such as how organisational culture can influence safety. Efforts were made to present specific skills and behaviours that pilots can use to work more effectively. Some carriers also developed specialised CRM training for new captains to address leadership issues related to command. While these courses were very useful in extending the concept of crew to those outside the cockpit, they may also have inadvertently diluted the initial focus on error reduction.

Fourth generation CRM training reflected the introduction of the US Federal Aviation Administration’s advanced qualification program (AQP). The AQP program gave airlines the ability to develop innovative training reflecting the needs and cultures of their organisations. Two of the requirements of AQP have been the integration of CRM into technical training and the provision of full mission, non-journey simulation (line oriented flight training, or LOFT). As part of this integration of CRM with technical training some airlines began to “proceduralise” CRM by adding specific behaviours to their checklists and to require formal evaluation of crews in full mission simulation (line operational evaluation or LOE).

One of the most positive developments I have observed among airlines has been the willingness of organisations that are fierce competitors in the marketplace to share information.

Fifth generation CRM represents a return to the original of CRM as an error reduction and management strategy. Underlying fifth generation CRM is awareness that error is ubiquitous and inevitable. Behaviours that are taught and reinforced can be understood as countermeasures against error and strategies to mitigate the consequences of error. The success of this generation of CRM is contingent on organisational recognition that errors happen and that a non-punitive attitude towards error is needed (except, of course, for intentional violations of procedures or rules).

Sixth generation CRM is a logical extension of the fifth generation. It reflects the fact that flight crews must not only cope with human error within the cockpit but also with threats to safety that come from the operating environment. In this framework an ATC error (for example an erroneous communication that could cause a mid-air) is a threat that must be managed. The difference between fifth and sixth generation training is significant in the fact that it reveals a much greater awareness of the contextual risks that must be handled.

Pilots exposed to the sixth generation of CRM training have been enthusiastic about...
the addition of threat recognition and management. While error management is a reality, in some ways the focus on pilot error has been somewhat limited by being seen to concentrate on those at the "sharp end".

One of the most positive developments I have observed among airlines has been the willingness of organisations that are fierce competitors in the marketplace to share information. For many years those involved in CRM have met regularly to share approaches to training and, in many cases, resource material, and to exchange experiences in the delivery of CRM training. As a result, I think it most appropriate to say the evolution of CRM that we have seen has reflected industry’s shared successes and failures in training.

At a global level, initial attempts to export CRM to other cultures (or indeed to other organisations within the same culture) have sometimes met with resistance. Within a culture, crews might apply the NIH (not invented here) response to denigrate programs acquired from another carrier. There are, of course, some organisations that have delivered effective CRM training to pilots in a variety of cultures by being sensitive to local issues and by using local subject matter experts to validate the approach and material employed. “Local solutions for local issues” appears to be the most effective approach.

Airlines that have developed their programs locally or showed sensitivity to cultural issues (such as deference to hierarchy) seem to have been quite successful in implementing CRM. These companies have stressed the responsibility crews have to the health of their organisation.

There is, of course, a lot of variability in the quality of courses, the amount of time devoted to the training, and the degree of support demonstrated by senior management to CRM.

**Systematic observation:** Contemporary CRM involves looking at how crews utilise all available resources to manage threat and error. But to understand how crews manage threat and error you need to know what is actually happening during normal flight.

One way of doing this is to use systematic observation methods that have been well validated through research in social psychology. At the University of Texas we have employed systematic observation in a variety of settings, including people living in undersea habitats during projects SEALAB and TEKTITE and in operating theatres during surgery.

In aviation, this systematic observation technique is known as a line operations safety audit (LOSA). LOSA is a formal process that requires expert and highly trained observers to ride the jumpseat during regularly scheduled flights in order to collect safety-related data on environmental conditions, operational complexity and flight crew performance. Confidential data collection and non-jeopardy assurance for pilots are fundamental to the process.

As my colleague and LOSA expert, James Klinecet, says, you could say that a LOSA is similar to a patient’s annual physical examination. People have comprehensive check-ups in the hope of detecting serious health issues before they become consequential. A set of diagnostic measures – such as blood pressure, cholesterol and liver function – flag potential health concerns, which in turn suggest changes that might be needed to the patient’s lifestyle. A LOSA is built upon the same notion. It provides a diagnostic snapshot of strengths and weaknesses that an airline can use to bolster the “health” of its safety margins and prevent their degradation.

LOSA is distinct from but complementary to other safety programs such as electronic data acquisition systems (for example flight operational quality assurance, or FOQA), and voluntary reporting systems (such as the US aviation safety reporting system, or ASRS). There are two major conceptual differences. First, FOQA and ASRS rely on outcomes to generate data. For FOQA, it is flight parameter exceedances, and for ASRS, it is adverse events that crews report. By contrast, LOSA samples all activities in normal operations. There may be some reportable events, but there will also be some near-events, and importantly, a majority of well-managed, successful flights.

The second major difference is the perspective taken by each program. With its focus on electronic data acquisition downloaded directly from the aircraft, FOQA can be said to have the “aeroplane perspective”. ASRSs provide the “pilot perspective” by utilising pilots’ voluntary disclosure and self-reporting of events. ASRS reports provide the “pilot perspective” by utilising pilots’ voluntary disclosure and self-reporting of events. ASRS reports
THREE KEY DISASTERS THAT TRIGGERED AN INCREASED FOCUS ON HUMAN ERROR

Everglades: Among the accidents singled out at a 1979 NASA safety summit was the 1972 crash of a Lockheed L-1011 in the Everglades, which occurred after the crew became so preoccupied with changing a burned out nose landing gear indicator lamp that they failed to notice that the altitude hold function of the autopilot had disengaged, causing the aircraft to gradually descend and crash. Ninety-nine of the 176 on board perished.

Chicago: One of the initiating factors in the crash of a Boeing 737 at Chicago Midway Airport in 1972 was crew pre-occupation with a light indicating “flight data recorder inoperative”. Crossing the final approach fix high, fast and not configured for landing, the flight crew tried to land using speed brakes, but couldn’t make it. On go-around with the speed brakes fully deployed, the aircraft crashed off the end of the runway. Forty-three of the 61 aboard died.

Tenerife: A total of 583 people died in a 1977 runway incursion accident in which a Pan Am B-747 and a KLM B-747 collided at Los Rodeos Airport at Tenerife in the Canary Islands. The accident remains the deadliest in aviation history. Among the chain of events that led to the disaster was a series of communication problems, including confusion about whether a takeoff clearance had been issued by ATC to the KLM crew. It is likely that the captain mistook a clearance to fly a certain route after takeoff for an actual takeoff clearance.

provide insight into why events occur, as seen from the crew’s perspective. LOSA provides an observer’s perspective of how threats and errors are handled on every phase of flight, regardless of the outcome. Most LOSA observers are pilots from the airline, with some 20 per cent of observations conducted by observers outside of the airline. All three perspectives provide useful data to an airline’s safety management system.

The foundation of LOSA grew out of the need to find out how threats and errors are managed and how well CRM training translated into line operations.

In the US LOSA was introduced after Delta Airlines put in place a very intensive CRM program in the early 1990s. Delta management was eager to discover whether the training was working, and approached our research group to find out. We were asked to observe crews to obtain these data, with guarantees of confidentiality of individual information. Later, in 1996 Continental Airlines and The University of Texas refined the concept and observations were conducted that included recording threats and errors as well as ratings of CRM practices.

To date some 5,500 LOSA observations have been completed with around 30 airlines in the US and elsewhere. The results show that there is an average of four threats per flight – most problematic are challenging ATC clearances and late changes. There is also an average of 3 errors per flight (20 per cent are error free). The most frequent errors are procedural.

The LOSA concept is now being applied within airlines to areas outside the cockpit where important safety issues exist. For example, the methodology has been extended to ramp operations, as well as to air traffic control. Airservices Australia is the first in the world to test LOSA methodology in ATC.

Our LOSA observations have revealed the critical role of threat and error management in normal flight operations. Indeed, the concept of threat and error management seems to provide a common framework for integrating safety data from a variety of sources – from incident reporting (ASRS) to systematic observations (LOSA) to accident investigations and data recorders (FOQA). The ability to examine these components in
a consistent manner should foster the development of safety cultures and allow the exchange of data across domains.

**Threat and error defined:** A threat can be defined as an event or error that is not caused by the crew, and increases operational complexity of a flight, requiring crew attention and management if safety margins are to be preserved.

Some threats come from the environment – adverse weather, airport conditions, terrain, traffic and ATC. Other threats arise from within the airline, such as aircraft malfunctions and minimum equipment list (MEL) items, problems, interruptions, or errors from dispatch, cabin, ground, maintenance and the ramp. Threats may be anticipated by the crew, for example, by briefing a thunderstorm in advance, or they may be unexpected, occurring suddenly and without warning, such as in-flight aircraft malfunctions. A mismanaged threat is defined as a threat that is linked to or induces flight crew error.

Results from our "10-airline" archive show the most prevalent threats by type were:
- Adverse weather (61 per cent of flights).
- ATC (56 per cent).
- Environmental operational pressures (36 per cent).
- Aircraft malfunctions (33 per cent).
- Airline operational pressures (18 per cent).

The threats that were most often mismanaged, by type, were:
- ATC (12 per cent of threats mismanaged).
- Aircraft malfunctions (12 per cent).
- Adverse weather (9 per cent).
- Dispatch/paperwork (9 per cent).
- Airline operational pressure (7 per cent).

There was little variability in threat mismanagement, shown by the small range (6-12 per cent). These results show that flight crews are good threat managers, in an environment full of threats – with over 81 per cent of flights observed encountering at least one threat.

Crew error is defined as action or inaction that leads to a deviation from crew or organisational intentions or expectations. Errors in the operational context tend to reduce the margin of safety and increase the probability of adverse events.

Broadly speaking, there are handling errors (flight controls, automation), procedural errors (checklists, briefings, callouts) and communication errors (with ATC, ground, or pilot-to-pilot).

Understanding how errors are managed is as important, if not more important, than understanding the prevalence of different types of error. It is of interest then if and when the error was detected and by whom, as well as the response(s) upon detecting the error, and the outcome of the error. As with threats, some errors are quickly detected and resolved, leading to an inconsequential outcome, while others go undetected or are mismanaged. A mismanaged error is defined as an error that is linked to or induces additional error or an undesired aircraft state.

Our error archive provides some interesting insights into flight crew errors and their management. The most common errors were:
- Automation (25 per cent of flights).
- Systems/instruments/radio (24 per cent).
- Checklists (23 per cent).
- Manual handling (22 per cent).
- Crew to external communication (22 per cent).

The most often mismanaged errors were:
- Manual handling (79 per cent mismanaged).
- Ground navigation (61 per cent).
- Automation (37 per cent).
- Checklists (15 per cent).

After 10 years of examining how flight crews manage error it is clear that there is one thing that all successful crews do. They all co-operate to rigorously monitor and cross-check to make sure they pick up threats and errors early. These crews are actively engaged in checking and verifying every setting and action that can affect safety.

This requires excellent co-ordination and a good cross flow of communication. Rather than any particular personality trait, the key marker for a good pilot is a sense of professionalism, and an appreciation of backup.

Good leadership is essential, in which a tone of professionalism sets the standard. Leadership must be decisive, yet allow for input.

CRM performance is not the magic bullet, but one of many things flight crew have to do to manage threats and errors. In the future we will see sixth generation CRM more fully integrated into training, and an increased emphasis on understanding and reacting to how all elements of the aviation system respond to threat and error.

Additional material from James Klinect, researcher at the University of Texas Human Factors Research Program, and head of the LOSA Collaborative, which offers LOSA implementation services to airlines world-wide.

Assistance is acknowledged from University of Texas human factors researchers, Ashleigh Merritt, project data specialist, and Chris Henry, principal investigator, University of Texas normal operations safety survey (NOSS).
## CRM SINGLE-PILOT OPERATIONS

### MAINTAINS EFFECTIVE LOOKOUT

1. Maintains lookout and traffic separation using a systematic scan technique at a rate determined by traffic density, visibility and terrain.
2. Maintains radio listening watch and interprets transmissions to determine traffic location and intentions of traffic.
3. Performs airspace cleared procedure before commencing any manoeuvres.

### MAINTAINS SITUATION AWARENESS

1. Monitors all aircraft systems using a systematic scan technique.
2. Collects information to facilitate ongoing system management.
3. Monitors flight environment for deviations from planned operations.
4. Collects flight environment information to update planned operations.
5. Analyses aircraft systems and flight environment information to identify actual and potential threats or errors.

### ASSESSES SITUATIONS AND MAKES DECISIONS

1. Identifies and reviews problem causal factors.
2. Systematically and logically breaks down problems or processes into component parts.
3. Applies analytical techniques to identify solutions and considers the value and implications of each.
4. Generates, in the time available, as many solutions as possible.
5. Assesses solutions and risks.

6. Decides on a course of action.
7. Communicates plans of action and directs crewmembers to clearly specified tasks.
8. Takes actions to achieve optimum outcomes for the operation.
9. Monitors progress against agreed plan.
10. Re-evaluates plan in line with changing circumstances and is improvement focused to achieve optimum outcomes.

### RECOGNISES AND MANAGES UNDESIRED AIRCRAFT STATES

1. Recognises undesired aircraft state.
2. Manipulates aircraft controls or systems, or modifies actions or procedures to maintain control of the aircraft or situation, in the time available.

### SETS PRIORITIES AND MANAGES TASKS

1. Organises flight, navigation, communication and passenger management tasks and sets priorities to ensure that the workload at any phase of flight allows, in the time available, the pilot to safely manage the flight.
2. Prioritises and organises workload to ensure completion of all tasks relevant to the safety of the flight in the time available.
3. Puts the safe and effective completion of every task or operation of an aircraft ahead of competing priorities and demands.
4. Plans events and tasks to occur sequentially.
5. Critical events and tasks are anticipated and completed in the time available.
6. Uses technology to reduce workload and improve cognitive and manipulative activities.
7. Avoids fixation on single actions or functions.

### MAINTAINS EFFECTIVE COMMUNICATIONS

1. Establish and maintain effective communications and interpersonal relationships with all stakeholders to ensure the safe outcome of a flight.
2. Applies standard phraseology to radio communication.
3. Communicates with stakeholders in an effective and efficient manner to achieve all requirements for safe flight.
4. Defines and explains objectives to applicable/involved stakeholder.
5. Demonstrates a level of assertiveness that ensures the safe completion of a flight.
6. Encourages passengers to participate in and contribute to the safe outcome of a flight.
CRM MULTl-CREW OPERATIONS

MULTI-CREW OPERATIONS

OPERATES AS A CREW MEMBER (CO-OPERATION)

1. Establishes an atmosphere to encourage open communications.
2. Listens critically and provides feedback to clarify information.
3. Applies assertive strategies when working with others.
4. Presents ideas in a way that shows respect for others.
5. Conveys information that is appropriate to the receiver.
6. Considers the condition (capability) of other crewmembers to perform crew duties.
7. Monitors and appraises crew members performance.
8. Interacts with crew members in a supportive and constructive way.
9. Assists other crew members in demanding situations.
10. Motivates and encourages other crew members.
11. Identifies the signs, stages and possible causes of conflict.
12. Implements strategies to deal with conflict.
13. Establishes communications that encourage constructive responses to conflict.

LEADERSHIP AND MANAGEMENT

1. Manages cockpit gradient relative to task.
2. Ensures that all crew members have a clear picture of the objective.
3. Manages changing priorities and if necessary, re focus crew members to accommodate the changed priorities.
4. Maintains crew member commitment to task.
5. Monitors the crew to ensure that they achieve specified standards of performance.
6. Corrects individual or crew members deviations from standards.
7. Insists on clarification of roles and functions.
8. Establishes and maintains clear, orderly systems.
10. Monitors outcomes, evaluates and measures performance.
11. Collects information and identifies key issues and relationships relative to achieving determined roles.
12. Monitor aircraft systems, flight environment and crew members, collects and analyses information to identify potential or actual errors.
13. Implements strategies and procedures to prevent errors or takes action in the time available to correct errors before the aircraft enters an undesired aircraft state.
14. Applies checklists and standard operating procedures to prevent aircraft handling, procedural or communication errors; and identifies committed errors before safety is affected or aircraft enters an undesired aircraft state.
15. Recognises undesired aircraft state.
16. Manipulates aircraft controls or systems, or procedures to correct undesired aircraft state in the time available.
17. Breaks down goals and establishes courses of action to accomplish specified goals.
18. Ensures that all crew members have role clarity and relevant information to achieve goals.
19. Allocates sufficient resources and time to complete workload.
20. Maintains patience and focus when processing large amounts of data or multiple tasks.
21. Manages time and resources to ensure that work is completed safely and effectively.

MAINTAINS SITUATION AWARENESS DURING MULTI-CREW OPERATIONS

1. Monitors all aircraft systems using a systematic scan technique.
2. Collects information to facilitate ongoing system management.
3. Monitors flight environment for deviations from planned operations.
4. Collects flight environment information to update planned operations.
5. Identifies environmental or operational threats that could affect the safety of flight. Analyses threats and develops options to mitigate or control threats.
6. Analyses threats and develops options to mitigate or control threats.
7. Reports aircraft systems and flight environment information for analysis.
8. Analyses aircraft systems and flight environment information to identify actual and potential threats or errors.

MAKES DECISIONS

1. Identifies problems causal factors and reviews these with crew members.
2. Breaks down systematically and logically problems or processes into component parts.
3. Employs analytical techniques to identify solutions and considers the value and implications of each.
4. Generates, in the time available, as many solutions as possible amongst crewmembers.
5. Implements an option (action) that mitigates or controls threats.
6. Assesses solutions and risks with other crew members.
7. Decides on a course of action.
8. Communicates plans of action and directs crew members to clearly specified tasks.
9. Takes actions to achieve optimum outcomes for the operation.
10. Monitors progress against agreed plan.
11. Monitors and assesses flight progress to ensure a safe outcome; or modifies actions when a safe outcome is not assured.
12. Re-evaluates plan in line with changing circumstances and is improvement focused to achieve optimum outcomes.

Note: CRM competencies should be customised to reflect the specific operating environment, culture and standard operating procedures of individual operators.
Imagine this – you are flying VFR and are down to nearly 800ft AGL with your fin in the cloud. As you enter a light shower of rain, the visibility reduces significantly. The pressure is on. You reduce speed, and mentally curse yourself for not turning back earlier. You notice the highway ahead, and with some relief you decide to follow it to the nearest town where, thankfully, there is a regional airport you know reasonably well.

But your relief is short lived. While making your inbound radio broadcast a pop-up alert on the GNSS navigator flashes “TERRAIN AHEAD”. The reason for the alert quickly comes back to you – there is a 1,000ft ridgeline to the right of the highway. You immediately track to the left. Thirty seconds later the cloud topped ridge slides past the right wingtip, slightly above you. You realise just how lucky you have been!

“What was that?” asks your front-seat passenger, clearly alarmed at the flashing warning sign. “Just a standard warning”, you say feebly, knowing that you owe your lives to this gadget.

“Terrain and obstacle database: A word of caution – at the time of publishing obstacle databases available overseas, which offer protection from man-made obstacles such as radio masts, buildings, TV towers etc, are not yet available in Australia.

In any case, obstacles up to 360ft in height do not have to be reported here, so many obstacles up to this height may not be included in any Australian obstacle database when it eventually becomes available.

Like any database, “terrain” is only as good as its last update and the manufacturer’s website is the best place to obtain advice on database currency. It is vital to have the latest navigation database installed because the premature descent alerting function (see below) is predicated on accurate navigational data (mandatory for IFR operations).

Terrain awareness: This refers to the graphical display of terrain in red, yellow, or black— depending on the terrain location relative to the aircraft altitude. Normally, red means terrain within 100ft (or above the aircraft altitude), and yellow within 1,000ft. On some systems these and other

Terrain and obstacle database: A word of caution – at the time of publishing obstacle databases available overseas, which offer protection from man-made obstacles such as radio masts, buildings, TV towers etc, are not yet available in Australia.
parameters can be selected to user requirements. On other systems you can display a cross-sectional view of the terrain in relation to your intended flight path.

**Terrain alerting:** This is a visual alert – with or without an aural alert. Normally, there is a pop-up alert that overwrites the current navigation page, or in some cases a pop-up “thumbnail” depicting the upcoming terrain. Potential impact points are marked with an “X” when the terrain page is selected. When purchasing a terrain system, or upgrading existing equipment, consider a system with the terrain alerting function, preferably with both visual and aural alerts.

**GPS altitude:** GPS altitude is compared directly with the terrain database, as well as with the published minimum initial and segment approach altitudes of an “active” instrument approach. GPS altitude is independent of baro-corrected altitude as indicated on the aircraft altimeter with the subscale set to local or area QNH.

**Premature descent alerting (PDA):** This monitors the normal descent profile in relation to aircraft height above ground level along the estimated path to the airport (assuming the airport meets “nearest airport” criteria). This monitoring occurs whether an approach is activated or not. If the aircraft descends below the calculated descent path the PDA alert annunciates: “TOO LOW – TERRAIN”.

To provide a greater margin of safety the PDA function can monitor the flight path in relation to any selectable instrument approach. The PDA function will then provide timely alerts if certain parameters are exceeded, for example if the aircraft descends 200ft or more below the prescribed altitude, or in the case of an ILS, 0.7 degrees below the ILS glide slope. Whether you are flying an ILS, or conducting a VOR or NDB approach, to get PDA protection you must load and activate the approach – even though primary navigation is not being provided by the GNSS navigator.

On an RNAV (GNSS) approach the premature descent alert function will assist in trapping errors of altitude versus distance for each approach waypoint. The PDA can also provide an alert if a grossly inaccurate QNH has inadvertently been set on the altimeter.

As well as monitoring the aircraft in relation to terrain, this “silent partner” can also provide pop-up alerts of navigational errors during an instrument approach.

In normal operations you should almost never see a terrain alert, unless you are going into an aerodrome that is either not listed in the navigation database, or has been excluded by the nearest airport criteria (pilot selectable). In this case the GNSS navigator will remain in enroute mode and some unnecessary terrain alerts will be evident as you approach your destination. These alerts can be cleared as they occur, assuming you have visual reference. This is a safer method than selecting “inhibit terrain” mode and possibly forgetting to reselect “terrain” later on.

Whichever terrain system you buy, you will need to invest time in reading the manual carefully – preferably before purchasing. Most manuals are now readily downloadable from the website of the manufacturer. The manual will enable you to understand how the system behaves in all circumstances and will give you information on functions, alerts and events you may otherwise find confusing or disconcerting when flying.

The terrain alerting function of a GNSS navigator must always be regarded as the last line of defence, and must not be used for navigation, descent below the minimum safe altitude, or manoeuvring to avoid terrain or obstacles. The terrain display does not provide either the fidelity or accuracy on which to plan decisions in relation to terrain.

It may seem to be stating the obvious, but for the system to be effective it is critical that you react immediately and without question if you receive an alert. Only after you have climbed back to the minimum safe altitude is there time to figure out what went wrong. Too many lives have been lost by pilots assuming a ground proximity alert was a false alarm and have delayed taking action.

The safety culture of aviation is based on the premise that human error will occur, and systems need to be in place to trap errors before they create dangerous situations. Terrain alerting provides such a system.

Remember that being legal does not necessarily mean being safe. Legal, by definition, defines the minimum acceptable standard. Just because terrain alerting is not mandated for your aircraft does not mean you cannot take your operation to the next level of safety by upgrading equipment.

Whether you operate under the VFR, night VFR, or IFR, the safety benefits of terrain alerting are significant. The latest systems are affordable and represent a significant breakthrough in aviation safety.


Charles Gunther is chief pilot of a general aviation company.
The term “stall” usually suggests a steeply climbing aeroplane or the cessation of motion, but you should remember from your initial ground school that an aerofoil can be stalled at any attitude and any airspeed. Even so, when you think about stalling in most flight operations, you often think about airspeed.

When you induce a stall deliberately, it usually involves a nose-high attitude. The reason for these rehearsals is usually not to practise loss of control, but to learn how to recognise its onset, and how to maintain control and recover with a minimum loss of altitude.

The last time you practised stalls, you were most likely with a flying instructor. You performed clearing turns, enriched the mixture and then – if you were planning to do “approach and landing” stalls – perhaps you reduced power along the way and added carburettor heat if needed, slowed to VFE, extended flaps if you had them, and then increased pitch attitude and simultaneously decreased power while maintaining a constant altitude.

Soon, things got mushy, and then … you get that sinking feeling. If you were practising takeoff and departure stalls, after the clearing turns and going to full rich on the mixture, you probably reduced power and slowed to a nominal climb speed, then added full power and pulled back on the yoke until you

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**NOT THE ONLY WAY TO STALL**

In case you think stall-spins happen only to novice pilots flying solo and getting in over their heads, well over half of all stall-spin accidents in the US actually happen during dual instruction.

Student pilots are among the least likely – only about 4 per cent – to succumb to a stall-spin accident. The next least likely are airline transport pilots, at around 10 per cent of incidents. Most victims are what most pilots are: private (46 per cent) and commercial (40 per cent)*.

I was lucky. In those few eternal moments of dumb-struck terror and inaction, the aeroplane came out of the spin on its own, and I learnt an indelible lesson.

These days, there’s a danger that the typical high nose attitude, power-on stall demonstration leaves fresh students with the impression that stalls only happen when the nose is high. As many pilots have learnt the hard way, that’s not the only way to increase a wing’s angle of attack.

* All US figures.
were in a steep climb attitude. You tried to keep the wings level, until things got mushy again.

**Practice makes perfect:** Why bring up this routine stuff? To be blunt, I am doing it to incite rebellion! That’s because I believe that performance manoeuvre-related hoops such as these don’t provide the best path towards becoming a better pilot. In fact, in the case of stall manoeuvres, this particular approach could conceivably increase your chances of having an accident.

> When a stall catches you by surprise, it is often because you flew the aeroplane too slowly to compensate for increased weight or there was an effective weight increase induced by load factor, for example, when you are in a turn.

But why do I say that stall practice might make an accident more likely? That’s because the one thing that most methods of teaching stalls have in common involves putting the aeroplane into that emblematic nose-high attitude. Doing so gives fledgling pilots the impression – subconsciously as well as overtly – that an aeroplane will stall only if you try to stand it on its tail. As most of us should know by now, this is wrong.

In the classroom you learned that stall speed increases in a turn, during pull-ups and in turbulence.

When a stall catches you by surprise, it is often because you flew the aeroplane too slowly to compensate for increased weight or there was an effective weight increase induced by load factor, for example, when you are in a turn. Other contributing factors can include increased density altitude, simply not enough wing area or camber (for example flaps), perhaps a wing surface roughened by ice, or any combination of these.

The operations most often involved are the so-called departure stalls during takeoff and during cross-controlled turns when you have overshoot the turn from base to final approach. Other instances can include go-around manoeuvres when power is added at a low speed before the aeroplane has been properly re-trimmed (or if the flaps have been retracted prematurely), a lack of attention to airspeed during approaches to landing, an overly abrupt recovery from a sudden high sink rate on short final or, with accelerated stalls, during overly tight turns.

In the base-to-final scenario, a spin often results. There are also equally

**WHAT IS A STALL?**

A stall involves either a loss of lift or not enough. During straight and level flight, if nothing else is changed, and as you fly more and more slowly, you must increase the angle of attack to generate the same amount of lift. Less air also flows over (and is deflected by) control surfaces. As a result control responses become increasingly sluggish and, due usually to the increase in turbulent air acting on the tail, buffeting is felt as the stall is reached. By this time, the stall warning is usually blaring.

The coefficient of lift increases as the angle between the wing chord and the relative wind is increased for a given airfoil. Remember that the critical angle of attack is specific to each airfoil.

The critical angle of attack is reached when an increasingly unfavourable pressure gradient (from higher pressure at the trailing edge to the lowest pressure at the centre of lift above the wing) collides with the relative wind from the front of the wing and has nowhere to go but away from the airfoil, which it does in churning torrents.

There’s also the visualisation involving air’s limited “elasticity” and its inability to fill the void behind a steeply pitched wing, as depicted in the accompanying diagrams showing a theoretical airfoil.

Whichever description you favour, once the airfoil exceeds its critical angle of attack, what happens next does not vary: lift drops precipitously and the resulting large change in pitching moment can often result in a wing drop. Recovery usually involves reducing the angle of attack and increasing the airspeed for good measure until the air once again is flowing smoothly over the wings.
BANKING AND LOAD FACTORS

In a constant altitude, coordinated turn in any aeroplane, the load factor is the result of two forces: centrifugal force and gravity. This relationship is charted in the diagram, “Load factor chart”. For any given bank angle, the rate of turn varies with the airspeed; the higher the speed, the slower the rate of turn. This compensates for added centrifugal force, allowing the load factor to remain the same.

Note how rapidly the line denoting load factor rises as it approaches the 90-degree bank line, reaching this theoretically at infinity. The 90-degree banked, constant altitude turn is not mathematically possible. True, an aeroplane may be banked to 90 degrees, but not in a co-ordinated turn. At slightly more than 80 degrees, the load factor exceeds 8g, the limit load factor of an aerobatic aeroplane.

The graph reveals an important fact about turns – the load factor increases at a terrific rate after a bank has reached 45 or 50 degrees. The load factor for any aeroplane in a 60-degree bank is 2g. The load factor for any aeroplane in an 80-degree bank is 5.76g.

In any event, the wing must produce lift equal to these load factors if altitude is to be maintained.

Then there is what happens when an aeroplane is in a very rapid descent, and you suddenly pull back mightily when you see the ground rushing up towards you. This is a textbook accelerated stall: high airspeed, nose-low attitude, followed by a loud noise and then silence. Dead silence.

Banked relationships: When an aircraft rolls into a bank it is the horizontal component of the lift vector that provides the centripetal turning force, while the vertical component of lift opposing gravity decreases according to the cosine of the bank angle. The cosine, by the way, is just the trigonometric ratio between the side of a triangle that is adjacent to a particular angle and the longest side of that triangle.

For small angles, the two sides are nearly the same and so the cosine is almost one; for large angles like 89 degrees, it’s quite a small number. The load factor (which is just the ratio of the lift the aircraft is producing at that bank angle to its normal weight) increases with (and equals) the reciprocal of that cosine, and we must apply more back pressure to increase the angle of attack to generate the greater lift required.

The speed the aerofoil stalls at, however, actually goes up with the square root of the load factor. Note that those white and green arcs on your airspeed are only good at one unit of gravity.

Typically in a stalled condition the influence of the ailerons on controlling roll is drastically reduced, while at the same time adverse yaw effects increase.
In general, mostly adverse properties of balance and control result.

Of course, the untrained and instinctive response is to turn the ailerons away from an alarming wing drop, which makes it worse as the downward aileron on the lower wing only further intensifies its stalled state. The correct response is, of course, to use the rudder. An even better answer is for you to guard against the need for any drastic recovery measures at all by maintaining the coordinated use of ailerons and rudder.

What’s the problem? The basic problem is that at any given moment few of us have any idea what our angle of attack happens to be.

The scary part about stall practice is, of course, that stalls lead to spins. You don’t need any theatrical reminders of how dramatic things can get during a spin: suffice to say that you could be corkscrewing down at a rate of up to 8,000 fpm.

Around 80 per cent of unintentional spins happen when the aeroplane is already at or below traffic pattern altitude. Most of these incidents involve single-engine, fixed-gear aeroplanes. It usually happens either during takeoff, while turning from the base leg to final or during manoeuvring. Often there is no second chance.

I realise that you certainly cannot land an aeroplane well and within a reasonably short length of runway without knowing what a stall is, and without inducing one on a regular basis. I do not wish to toss the “spin training or no spin training” gauntlet into the ring, and I’m not stating that we shouldn’t fully explore and exploit the potential value of the rudder for maintaining control under a variety of circumstances.

What I am saying, however, is that we must continually remain aware that stalls can occur in real life under a much wider variety of circumstances than what we might encounter in training or practice flights.

Jeff Pardo is a freelance aviation writer. Reproduced with permission from the US journal, Aviation Safety, July 2006.
In the past service of alcohol was glamourised. Now cabin crew are expected to serve alcohol responsibly. Sue Rice reports.

With drug and alcohol testing expected to be introduced for safety sensitive personnel sometime in 2007, over-consumption of alcohol by passengers is likely to come under increased scrutiny.

Intoxicated passengers are more than just annoying to passengers and staff. They also pose a risk to their own safety and the safety of others because they may not be in a fit state to follow instructions in an emergency. Alcohol impairs almost all forms of mental activity, including decision making, memory, vigilance and reasoning. It also adversely affects physical coordination.

Drunken passengers are a real safety risk, especially if there is an emergency. They may be unable to adequately comprehend instructions, and their physical ability to follow emergency commands may be impaired.

Some passengers may drink too much because of their fear of flying, some because they are celebrating the start of a holiday or an important occasion, and some because in normal life they are heavy drinkers.

Apart from the safety risk in an emergency, intoxicated passengers present a problem for maintaining order on the aircraft. Alcohol consumption has been reported as a factor contributing to 45 per cent of on-board incidents according to US research. In Australia there is plenty of anecdotal evidence that drunken passengers are a problem.

Sometimes a passenger will board your aircraft looking fine, but two drinks later and they are slurring their words and carrying on. What happened? This kind of "drunk-in-an-instant" passenger has usually had a few at the departure lounge or a nearby bar, and it only takes a drink or two to tip him or her over the edge. It’s hard to detect how much alcohol someone has already had, but it soon becomes apparent when they start misbehaving.

Airline operators in Australia have provided cabin crew with training that helps them manage passengers who are behaving badly. The key is to communicate with the passenger in a way that avoids confrontation. You should be sensitive to the passenger’s background, adjusting your style to match the passenger’s sex, age, status and whether they are in a group or alone. For example, you would approach a drunken executive in first class in a more formal style, appealing to their sense of decorum. If that doesn’t work you could slow the service right down, and hope that they fall asleep.

When all else fails you have to say no (see box). You should never apologise for refusing someone a drink – you have a responsibility for safety. Follow your company procedures and refer to the laws about responsible service of alcohol. Obviously, you are not allowed to serve alcohol to anyone under age, and if you suspect someone is too young to drink, you should ask for proof of age.

**Execs & dinnerware:** The male executive was in his early 50s, very tall and heavy set. He was quiet and there were no signs of aggression. However, within the first two hours of the flight he had consumed eight miniatures of vodka, equivalent to around 16 standard drinks. He got away with it because he kept ordering from different flight attendants. In the end there was no more vodka left on the B737.

The flight attendant approached him quietly, sat in the empty seat next to him and introduced herself, saying “Mr X, we have a bit of a dilemma; it has come to my attention that you have consumed a large

**HOW TO SAY NO**

- Be polite, yet firm.
- Say that you are concerned for their safety in the flight environment.
- Ask for their help to ensure that safety and order are preserved.
- Remind them that you have an obligation under responsible service of alcohol.
- Offer a non-alcoholic drink and food as an alternative.
- If the situation is getting out of control, inform the captain and consider closing bar service.
amount of vodka. I will need your co-operation, as we must follow the responsible service of alcohol legislation”. He seemed a bit shocked, but he said he understood, and the flight attendant thanked him for his co-operation. He was quiet for the rest of the flight. That’s the ideal situation. But things can go wrong, especially in a group situation where sometimes people encourage each other to behave badly.

We’ve all heard about problems with intoxicated footballers flying home after a game, or to a holiday destination at the end of the season. On one flight to Honolulu some years ago, a team on their end-of-season “jolly” became a bit more than just rowdy: they were vomiting, urinating in the aisles, throwing food, shouting and pulling seats apart. They were already well on their way to intoxication when they boarded, and that is where they should have been stopped. But they got through.

What do you do when things go horribly wrong like this? Your first step is to inform the captain of the situation, as there may need to be law enforcement arranged upon arrival. Rowdy and offensive behaviour is against the law. Civil Aviation Regulation (CAR) 256AA, which says, “A person in an aircraft must not behave in an offensive and disorderly manner”. You may need to protect the other passengers by moving them away from the area, if possible. Try to identify who the leaders of the group are, and appeal to their leadership to help you to calm the situation down.

Men are not necessarily more aggressive than women. A few years ago, 120 Australians aged 20–29 are the most likely of all age groups to drink at high levels. Intoxication usually refers to a blood alcohol concentration above 0.05 or 0.08 percent, but this is not universally agreed.

To stay below this level, men should have no more than 2 standard drinks in the first hour and 1 per hour after that. Women should have no more than 1 standard drink per hour.

Intoxicated persons cannot function within their normal range of physical and cognitive abilities.

FACT FILE

- One in five Australians drink at high-risk levels at least once a month.
- Australians aged 20–29 are the most likely of all age groups to drink at high levels.
- Intoxication usually refers to a blood alcohol concentration above 0.05 or 0.08 percent, but this is not universally agreed.
- To stay below this level, men should have no more than 2 standard drinks in the first hour and 1 per hour after that. Women should have no more than 1 standard drink per hour.
- Intoxicated persons cannot function within their normal range of physical and cognitive abilities.

reminding them of their responsibilities to maintain good order on the flights. There were not to be any incidents of drunkenness or bad behaviour or they would be refused carriage for the return trip. It worked. There was no trouble because each club had “read the riot act” to their players and supporters before the flights.

On one airline flight to Honolulu some years ago, a team on their end-of-season “jolly” became a bit more than just rowdy: they were vomiting, urinating in the isles, throwing food, shouting and pulling seats apart.

Not on: You should try to spot trouble before it starts. Refuse entry to anyone you suspect is intoxicated before they enter the aircraft. If someone looks and smells like they are drunk, they probably are. You could invoke the law, as Civil Aviation Regulation (CAR) 256, paragraph I states, “A person shall not while in a state of intoxication enter any aircraft”. So what are the signs? They might be any or all of the following:

- Talking loudly, quickly or with slurred speech.
- Sweating.
- Sleepy.
- Red faced.
- Vomiting.
- Uncoordinated.
- Argumentative.

All operators carrying passengers should have policies and procedures in place to guide pilots, flight attendants and ground staff on the management of alcohol consumption.

If you suspect someone is intoxicated you should follow company procedures. Do not directly accuse them of being drunk. What you should say is something along the lines of, “Excuse me, would you mind just stepping aside for a moment; someone will be with you shortly”. Then you should contact ground staff who should follow company procedures to prevent an intoxicated person entering the aircraft.

If you are in doubt about any aspect of alcohol service, ask your manager.

Sue Rice is a CASA cabin safety inspector.
Dealing with corrosion damage is emerging as one of the major cost drivers for owners of aircraft over 30 years old. Sometimes the costs can be as high as 60 per cent of an aircraft’s overall maintenance budget.

Corrosion builds up over time, often unseen until the damage is done. And the damage can be substantial, causing structural problems that can render your aircraft unairworthy.

The risks are increased by designs of older aircraft that feature lamination of different alloys, steel fasteners in aluminium structures, inadequate sealing of structural joints, and unpainted internal structures.

Routine visual inspections are not always effective in detecting corrosion and more comprehensive and intrusive inspection is often needed. Sometimes, substantial disassembly and careful inspection of critical structures is the only way to assess the extent of deterioration.

While the risk of corrosion in coastal areas is high, aircraft in Australia’s arid zone are also exposed to corrosive conditions, especially at night when water can condense on the undersides of wings and tailplane skins. CSIRO’s corrosion map of Australia highlights the susceptibility to corrosion across the continent (see diagram opposite).

No aircraft is airtight, so condensation can cause water to collect in unexpected areas. Additionally, dust and grit can be very abrasive on protective coatings, and can grind away over time until corrosion is able to get a start.

Australia’s large inland salt basins are a big problem. There are around 1,000 billion tonnes of salt in the soil and ground water of the Murray-Darling basin alone. Even the dust in central Australia contains salts that can result in corrosion. Salt crystals are hygroscopic, so if there is any moisture around, the salt will absorb it. All it takes is a rain shower, over-enthusiastic aircraft washing, or a dropped drink to get the corrosion ball rolling.

Many chemicals in the environment other than salt can combine with water to form an electrolyte and corrode aircraft metals. The key is to prevent electrolytes forming on or near airframe structures. Anything that prevents moisture getting trapped in an airframe, including protective surface treatments, contributes significantly to corrosion protection.

Hidden problems: Many older light aircraft attach steel fittings to aluminium structure in high stress areas such as wing and undercarriage attachments, control surface hinges and empennage attachments. It is common to find dissimilar metal corrosion that is so advanced that primary structures are dramatically weakened, and on the verge of failure. This type of corrosion is not normally visible without extensive dismantling of these structures.

Manufacturer’s maintenance schedules may not adequately address the problem of hidden corrosion inside an aircraft’s substructures. This can place maintainers in a difficult position – they must choose between ignoring a potentially serious problem, or possibly alienating a customer by going beyond published maintenance requirements.

Recent service difficulty reports (SDRs) to the Civil Aviation Safety Authority (CASA) have highlighted the kinds of corrosion that can occur in older aircraft. Many SDRs relate to corrosion in older Cessna singles in structurally sensitive areas. Some of these are undetectable by normal inspection processes. During disassembly many wings have been found to

Dissimilar metal corrosion: A steel bracket of a PA28-181 fuselage bulkhead providing attachment for the forward fin spar was riveted to an aluminium alloy bulkhead with no barrier. The corrosion was detected only by disassembly.

Missing rivets: This rudder torque tube was removed from a PA28-235 following discovery of 3 missing rivet heads. The corrosion is caused by attachment of the steel torque tube being riveted directly to the aluminium alloy rudder structure with no barrier.

Inside damage: Severe corrosion found on the inside of a Beech Duchess horizontal stabiliser. There were no external indications of corrosion. The aircraft had a little over 8,000 hours total time in service.
be so badly corroded that failure may have been imminent.

One C150 was thoroughly inspected after the maintainer found just one rivet missing. In the end there was such a degree of hidden structural corrosion that around 90 per cent of the structure had to be dismantled to effect repairs. A C172 which also was found to have just a single rivet missing had to have two-thirds of the wing skins and 17 ribs replaced before it could fly again.

Maintainers should discuss the problem of hidden structural corrosion with their clients. Inspection should include:
- Removal of control surfaces and floor panels at least every five years, unless there is other good access.
- Removing steel fittings at 15 years and re-assembling with proper corrosion treatment.
- Removing alloy forgings on T-tail aircraft for corrosion treatment.
- Removal of Cessna 100 and 200 series leading edge skins and drilling off spar doublers for treatment.

**Reduce costs:** Chances are that corrosion in older aircraft will be present at an advanced stage. If found in time, treatment and or repair in-situ might be feasible and is likely to be cheaper than component replacement. As always, any repair must comply with approved data, either a manufacturer’s repair instruction or a CAR 35 approved repair scheme.

Owners and operators can reduce the likely costs of corrosion with an effective strategy to prevent in-service corrosion. This could include:
- Regular cleaning to remove dust and other detritus from all accessible areas of the airframe.
- Maintenance of paint and other surface protection – keep the corrosive environment away from the metal.
- Preventing and cleaning up any spillage of potentially corrosive substances.
- Keeping the aircraft dry, inside and out (preferably in a hangar) and removal of any trapped moisture. Moisture dispersing agents (aerosols) can be effective.

There are many different types of corrosion, with different symptoms and causes. Maintainers of aircraft should be familiar with the forms of corrosion and their causes, symptoms and means of prevention and restoration.

Aircraft manufacturers and airworthiness authorities issue service letters, service bulletins, airworthiness bulletins and airworthiness directives that identify and deal with aircraft corrosion problems. However, aircraft maintainers should not depend on manufacturers and regulators to identify all corrosion problems. Maintainers should always be alert to possible sources and locations of corrosion, bearing in mind that corrosion often occurs in hidden locations.

Unexpected or unusual corrosion should be reported to the manufacturer and to CASA through the SDR system (see pages 50-51). Through SDR reporting, CASA can work with the manufacturer, and with other authorities for foreign types, to determine if an aircraft corrosion problem is isolated or widespread and, if necessary, alert others operators to a possible problem.

Remember, it’s much cheaper to treat the components in the early stages of corrosion than to replace them later.

The pilot was flying a Piper Lance from Archerfield to Moorabbin with two passengers on board. During pre-departure engine run-up checks, the pilot noted rough running. Increasing the engine RPM and leaning the mixture cleared the problem. During the flight the pilot heard one slight miss in the engine but could not do much about it.

Later, on arrival at Moorabbin, the pilot noticed some oil on the outside of the engine cowl.

During taxi for departure, the pilot had to lean the mixture again to clear engine roughness. Shortly after takeoff, and after reducing the power settings to climb power, the pilot was concerned to find the vacuum gauge indicating zero and the return of rough running.

The pilot elected to return to Moorabbin.

After landing, removal of the engine cowl revealed a significant amount of oil on the engine. A licensed aircraft maintenance engineer checked out the engine and found that it was low on oil because of an oil leak from one of the top crankcase bolts. After rescaling the bolt, topping up the oil and replacing the vacuum pump, the LAME ran a further engine check which showed no evidence of rough running.

Two days later the pilot had departed Moorabbin, and as the aircraft climbed through 1,600ft, the engine cut out, sprang back to normal operation – and then, suddenly, lost all power. The pilot was forced to land the aircraft on a stretch of road, and collided with powerlines, poles, a tree and a fence before coming to rest. Fortunately the occupants were not injured.

The Australian Transport Safety Bureau (ATSB) investigation into the accident found one major contributing factor – the engine crankcase had a “dodgy repair” done on it. The repair facility had bored out the original bush in the area of crankcase idler gear shaft bore and installed a “new” bush. The new bush was fabricated from soft (pure) aluminium which has a low resistance to deformation and was unable to bear the loads it was under.

The crankcase was supplied by an approved repair facility based in US but the actual work done did not conform to the approved repair procedures.

While this is an example of a repair going wrong, the same risks exist for engine modifications. Civil Aviation Safety Authority (CASA) airworthiness bulletin (AWB) 83-001 “Lycoming engines model L-TIO540-J2BD engine crankcase and accessory gear housing reliability” warns about one such modification reported in Australia.

Repair and modification are not exactly the same things. Repair may be defined as, “The restoration of an aeronautical product to an airworthy condition to ensure that the aircraft continues to comply with the design aspects of the appropriate airworthiness requirements used for the [issue] of the type certificate for the respective aircraft type, after it has been damaged or subjected to wear” (International Civil Aviation Organization annex 8), while modification means, “…a change to the type design which is not a repair”.

A person may modify or repair an Australian aircraft only if the design of the modification or repair is specified in the aircraft’s approved maintenance data or has otherwise been approved under regu-
relations by CASA, and the modification or repair complies with the certification basis of aircraft or part. All repairs and modifications must have the right documentation in place. A modification or repair not meeting these requirements is deemed by the safety regulations to be “unapproved”.

The ATSB investigation on the crash of a Piper Cherokee Six (PA 32-300) at Hamilton Island in 2002, involving six fatalities, revealed that the aircraft was fitted with an engine different from the one noted on the aircraft type certificate data sheet (TCDS). The lack of appropriate documentation to modify the aircraft by installing a different engine meant that the aircraft was technically not airworthy.

While the unapproved modification was not the reason the aircraft crashed, poorly designed aircraft modifications and repairs or non-compliance with the design data provided in an otherwise approved modification or repair can have severe consequences. These include control surface flutter, overstress of load carrying aircraft parts or engine failure – just to name a few.

**Choices:** What choices does an aircraft operator have available for repair or modification of a certificated aeronautical product? The Australian regulations provide a number of avenues:

- **Modifications approved by the original equipment manufacturer (OEM).** OEM service documentation (service bulletins, letters and instructions etc), in most cases, are the best way to modify your aircraft, engine or propeller.
- **Modification through a supplemental type certificate (STC).** An STC approves a product modification, defines the product design change and states how the modification affects the existing type design. An STC also identifies the certification basis of the modification and explains how the design change meets regulatory requirements. This can be very helpful for assessing any other modifications you might want to make at a later stage.

Incorporation of an approved STC does not require any formal permission. If you are considering a foreign STC, CASA airworthiness bulletin (AWB) 00-16 “Acceptance of foreign STC” may help.

Compatibility of the STC modification being incorporated with previously approved modifications is the responsibility of the installer and should be carefully evaluated. If in doubt, seek the help of a CAR 35 authorised person.

Possession of the STC document does not constitute a right to the design data or the right to install the modification. The STC and its supporting data (drawings, instructions, specifications, etc.) are the property of the STC holder.

You need to get approval to use the STC on each of your aircraft from the STC holder. Registration with the STC holder will ensure prompt delivery of STC service documentation and impending airworthiness actions, if any. See CASA AWB 02-013 issue 1.

- **Modifications approved under CAR 35.** Approval of modifications by a CAR 35 authorised person is yet another option. However, be aware that the modification you are seeking may already be on offer through the original equipment manufacturer or through an existing STC.
- **Modification by installing ATSO or equivalent parts.** An Australian technical standard order (ATSO) is a minimum performance standard for specified materials, parts and appliances used on civil aircraft. ATSO authorisation is both design and production approval for modification parts but is not an approval to install and use the article in the aircraft. A separate approval from an authorised person for installation of ATSO parts on the specific make and model of an aircraft is required. Also check for instructions for continued airworthiness (ICAs) issued by the manufacturer.
- **Modification by installing APMA or equivalent parts.** Australian parts manufacturer approval (APMA) or its equivalent (such as a parts manufacturing approval from the US Federal Aviation Administration) is a combined design and production approval for modification and replacement parts for installation on type certificated products. If the APMA documentation lists your aircraft model, no further permission is required for use of APMA parts. All operators opting for APMA parts should monitor service documents from the APMA parts manufacturer (refer to CASA AWB 02-013 issue 1 for further details).
The ultimate responsibility for airworthiness of the repaired or modified aircraft rests with the registered operator. In the overall scheme of things, CASA recommends that you:

- Use approved repairs and modifications only.
- Source modifications from reliable vendors (CASA AWB 02-016 on vendor evaluation elaborates).
- Ensure you have all the service and airworthiness information related to the STCs/modifications/repairs incorporated on your aircraft and ensure that this information is assessed for applicability and further action.
- Examine documents supplied with the modification. If you suspect a repair or a modification is dodgy, liaise with the vendor and investigate. If you find it is unapproved, inform CASA through its SDR system (see page 51). For parts originating in US, lodge FAA form 8120-11 (reference FAA advisory circular 21-29B) and send a copy to the CASA SDR system.
- Replace repaired parts/modification part(s) confirmed as unapproved and restore the aircraft to its airworthiness condition. Return the unapproved parts back to the vendor.

At times, modified or repaired parts cannot be returned to the source because of the time lapse or simply because you got them “as part of the deal” as they were fitted to the aircraft you bought overseas in an “as is” condition. In such cases, if there is no substantiating data on the approval status of incorporated repairs and modifications, it is prudent to replace the unapproved part(s) and restore the aircraft to its airworthiness condition. If you are in doubt, you should consult with a CAR35 authorised person.

The implications of installing unapproved repairs and modifications are wide ranging. You could be putting people’s lives at risk. And apart from breaching safety rules, if there is an accident, you could be exposed to compensation litigation and refusal of claims from insurance company.

Obaid Soomro is a CASA airworthiness specialist.

In Russia, the problem of unapproved parts has reached a critical stage, with a statement issued in September from the prosecutor general's office announcing that parts produced by unofficial sources were used in a number of aircraft, “possibly leading to in-flight emergencies”.

The statement came as aviation police at Moscow’s Sheremetyevo international airport charged an airport engineer with fraud in relation to an alleged attempt to sell aircraft parts with expired service-life dates by writing down false information on their overhauling records.

In the US, the Federal Aviation Administration (FAA) has launched an international campaign to raise awareness of the problem. As part of that initiative the FAA joined the Civil Aviation Safety Authority (CASA) to host a training and information forum on suspected unapproved parts (SUPs) held in Sydney in August.

The conference was told that while no fatalities had yet occurred in the large airline sector, there had been fatalities due to SUPs in the commuter and private sectors.

One example in the US was of a distributor who threw a time-expired part into the rubbish. Someone picked it out of the bin, carefully restored it and sold it for US$25,000.

The operator who purchased the part realised the problem only when the component serial number was entered into the operator’s computer system. The computer advised that the part had been scrapped because it had reached the end of its fatigue life.

CASAs new focus on the extent and nature of the SUP problem in the Australian aviation industry has revealed an interesting situation.

The majority of confirmed unapproved parts (CUP) and unapproved repairs reported to CASA are those which have been made or carried out in Australia.

Consider the Perspex or plastic storm window pictured above. During a scheduled inspection, a LAME noted that the storm window in the cockpit of a pressurised aeroplane showed evidence of stress cracking near the latch and along the radius of one of the retaining flanges. On closer inspection he found that the window did not have any of the manufacturers identifying numbers engraved on it.

The defective unapproved part was removed and replaced with the correct original equipment manufacturers (OEM) item.

Sometime in the past history of the aeroplane, the defective OEM window had been removed and replaced with a locally manufactured item without CAR 35 approval. The window was an unapproved part. Because this part was installed in a pressurised aeroplane, it could have blown out and caused a catastrophic failure of the pressurisation system.

Unapproved aircraft parts pose a real danger to aviation safety because the design and production quality of the components are unknown.

Identifying unapproved parts can be difficult because they often appear the same as approved parts. Lack of proper identifying marks on a part, or the absence documentation, are warning signs that the part may be unapproved. Other triggers for action to validate a part include unusual finishes, size or colour.

Airlines, maintenance organisations, aviation manufacturers and parts distributors should build systems for the detection and reporting of unapproved parts.

You can report a suspect part by using the online facility on the CASA website or filling in the form attached to civil aviation advisory publication (CAAP) 51-2. You can download the form from CASA’s website (casa.gov.au/download/caaps/airworthiness/51_2.pdf).

Roger Alder, airworthiness specialist, CASA.
null output from the sensor stator. P/N: 2566A21

Boeing 737476 Aileron control system cable failed. Ref 50003017

Aileron cable located in RH wheel well frayed. Cable keeper worn through. P/N: BACCD2AB002009F

Boeing 737476 Drag control actuator cables broken. Ref 50003274

LH spoiler cable broken. P/N: BACCD2CD008649DF

Boeing 737476 Flight controls vibrate. Ref 50003279

High frequency vibration evident through rudder pedals. Investigation continuing. (1 similar occurrence)

Boeing 737476 Fuel shutoff valve failed. Ref 50003237

During push-back and first start, No.2 engine (after stabilization) flamed out. Start cycle was aborted and a second start was attempted, but the engine flamed out at EGT 300 deg C and N2 at 32%. Investigation found that the No.2 engine spar fuel shut-off valve had failed. P/N: 737M28500111. TSN: 43,664 hours. TSD: 21,121 hours (1 similar occurrence)

Boeing 737476 Fuselage skin cracked. Ref 50003228

RH aft fuselage skin cracked at BS330-14R. Crack length approximately 100mm (4in.). (4 similar occurrences)

Boeing 7377X8 Horizontal stabiliser skin cracked. Ref 50003187

RH horizontal stabiliser lower skin cracked in seven locations:- 1. aft spar Stn 85 2. inap Spar Stn 101, 254mm (10in), 431.8mm (17in), 608.6mm (24in) and 711.2mm (28in) from aft spar. 3. inap spar Stn 138, 431.8mm (17in) from aft spar. 5 (similar occurrences)

Boeing 7377X8 Horizontal stabiliser lightning strike. Ref 50003210

Lightning strike exit marks on LH and RH horizontal stabiliser tip trailing edge conductive strips. Aircraft was struck by lightning on the RH forward fuselage. P/N: 57181066 (4 similar occurrences)

Boeing 747338 Wing/fuselage attachment bolts loose. Ref 50003288

During routine maintenance the RH wing gear’s aft four bolts attaching bearing retainer plate to support housing were found loose. On investigation the torque loading was approximately 5 to 10 ft lbs on all four bolts. Further investigation found that the bolts shank extension was too long and may have become shank bound if correctly torqued.

Boeing 767338ER Recirculation fan failed. Ref 50003010

LH recirculation fan failed. During replacement of the LH recirculation fan assembly it was noticed that the support rods for both the LH and RH recirculation fan filter housings were damaged. Damage was attributed to load in cargo hold protruding through curtain. P/N: 60686223. TSN: 4,3619 hours. TSD: 4,3619 hours

British Aerospace BAe1251000 Flap actuator screwjaw contain-water. Ref 50003156

LH and RH flaps failed to operate. During lubrication it was found that the screw jack ball ends were contaminated with moisture. Aircraft had been parked overnight in heavy rain. P/N: 255C20181. TSN: 5,072 hours. TSD: 5,072 hours

Fokker F28MK0100 Aileron control cable low tension. Ref 50003117

LH and RH aileron control cables tension. Low cable tension was 45lbs. Fokker F28MK0100 Fuselage lightning strike. Ref 50003110

Evidence of lightning strike in the following areas of the fuselage:- 1. Between stringer 4 and stringer 5 at Stn 9805 2. Along stringer 4 just forward of Stn 9305 3. Between string 4 and stringer 5 at Stn 10253

Lear 45 Wing skin corroded. Ref 50003218

LH and RH wing lower skins corroded beyond limits. TSN: 5,445 hours/9,941 landings

AIRCRAFT BELOW 5700 KG

Beech 200 Landing gear indicating system faulty. Ref 50003241

Following a series of undercarriage faults, the following problems were found:- 1. Nose downlock out of adjustment 2. LH downlock wire chafed 3. RH unlock switch wire faulty 4. Landing gear out of adjustment. (9 similar occurrences)

Beech C90 Landing gear actuator failed. Ref 50003230

Aircraft was conducting practice ILS when the LG was retracted. During the retraction cycle an unusual noise was heard and the LG did not complete the cycle. The LG was lowered but NLG did not fully extend and did not lock down. Investigation found that the NLG actuator had failed and stripped the internal thread mechanism to extend or retract it. It is unknown if this thread stripped fully in flight or during the landing incident due to the weight of the airframe. P/N: 5082502081. TSN: 6,597 hours/288 months

Beech E95 Landing gear system relay FOD. Ref 50003180

Landing gear dynamic relay had an AN690-10L lodged in the direction change mechanism preventing contact point operation. FOD.

Britten Norman BN2A27 Rudder control system rudder bar fractured. Ref 50003249

During a tight taxi turn the pilot pushed the RH rudder firmly and it separated from the rudder bar centre post. TSN: 16,570 hours

Britten Norman BN2280 Horizontal stabiliser bracket attach rivet loose. Ref 50003217

LH tailplane/elevator inboard hinge bracket attachment rivets (20ft) loose. Found during inspection iaw AD/BN-2/070 (SB 259). TSN: 12,332 hours/4,883 cycles

Cessna 441 Electrical wires bare at fuel pump connector end. Ref 51000305

RH hydraulic pressure pipe corroded and leaking from pin hole. Pipe is located in RH wing leading edge between engine nacelle and wing root. P/N: 572700223 (3 similar occurrences)

Cessna 441 Wing rib cracked. Ref 51000306

LH and RH wing upper and lower canted ribs cracked in the following areas. Lower angles LH and RH side cracked at approximately FS177, FS186 and FS190. Upper angles LH and RH side cracked at approximately FS189. Part numbers of affected ribs were PNs 5720001-6, PNs 5720001-5, PNs 5720001-4 and PNs 5720018-16. Found during investigation with COB03 01. P/N: 57200018 (8 similar occurrences)

Cessna 182H Wing spar cap corroded. Ref 50003260

LH and RH wing lower main spar caps severely corroded. Corrosion was through the complete thickness in some areas. Suspect caused by lack of priming at manufacture and water ingress. TSN: 6,076 hours

Cessna 182V Vertical stabiliser attachment fittings incorrectly made. Ref 50003257

Vertical stabiliser attachment fittings PNs 1213056-1 (forward) and PNs 1213056-1 (aft) incorrectly drilled. Some holes were drilled too close to the edge or drilled into the radius of the fittings. Personnel/maintenance error. P/N: 12130561

Cessna 310R Wing spar fitting corroded. Ref 50003277

null output from the sensor stator. P/N: 2566A12
Selective Service Difficulty Reports July–August 2006

Piston Engines

Agusta A119 Landing gear attachments to fuselage frame cracked. Ref 510003301

Fuselage frames cracked extensively both sides where the undercarriage damper fittings (P/No: 109-0570-111-121) attached. Ref 51000343

R.22Beta Main rotor blade out of balance. Ref 510003296

Pilot reported aircraft required track and balance. This was carried out to less than 0.2ips result. Vibration returned after 12.6 hours operation and a track and balance was carried out once again, but the vibration could not be reduced to an acceptable level. Blades removed from service.

P/No: A0164. TSN: 373 hours

Sikorsky S76C Tail rotor blade delaminated. Ref 510003270

Tail rotor blade spar delaminated on trailing edge of spar commencing from mid span to pindle attachment point. Area of delamination approximately 50.8mm (2in).

P/No: 7.610105017e+012. TSN: 6,215 hours

Turbine Engines

Allison 250C20 Engine combustion drain valve cracked. Ref 510003203

Following removal of burner drain valve due to cracking (SDR10002972) it was found that two replacement drain valves were also cracked.

P/No: 6854255 (1 similar occurrence) (Suspected Unapproved Part)

Allison 250C20 Power lever cable separated. Ref 510003103

LH engine governor flexible control cable separated at a bend in the cable located approximately 250mm (9.84in) from the firewall.

P/No: 7044A3410164. TSN: 3,314 hours

Garrett TPE331H2U Turbine engine seized. Ref 510003287

Pilot was unable to rotate engine following shutdown. Initial investigation found metal in oil system - engine removed. (7 similar occurrences)

GE CFM563C Engine turbine section damaged. Ref 510003212

No2 engine low pressure turbine damaged. Found during boroscope inspection. Suspect caused by No1 LPT blade failure. Investigation continuing.

P/No: CFM563C1 (2 similar occurrences)

PWA PT6A144 Engine oil system elbow fractured. Ref 510003055

Oil pressure feed line to reduction gearbox fractured at the elbow attachment point. Loss of engine oil. During emergency landing the RH main wheel tyre suffered a blowout.

P/No: 310365501

PWA PW123D Engine fuel and control wiring short circuit. Ref 510003254

No2 engine wiring faulty. Wire 20015B22 and 20018C22 short circuited to shield at saddle sleeves in area located at 9811 P14 near the wing root.

Rolls Royce RB211254G Turbine engine vibrates. Ref 510003243


P/No: RB2112546T (6 similar occurrences)

Aircraft


P/No: AECD5385. TSN: 405 hours (5 similar occurrences)

Continental TSO520VE Engine cylinder piston ring excess gap clearance. Ref 510003306

During a maintenance check, excessive oil was found passing by a cylinder’s piston rings. Cylinder was removed and the top compression ring was found to be delaminating. The bore was worn and shiny with no signs of hone pattern left and ring gaps were outside manufacturer’s limits.

P/No: ST110. TSN: 209 hours

P/No: ST110. TSN: 209 hours

Lycoming LT105402BBD Engine crankcase incorrect repair. Ref 510003126

Engine crankcase idler shaft bosses repaired using threaded brass pins. Crankcase deck height was measured at 113.2mm (4.460in) which is below the limits set in AWS 83-1.

P/No: LW15448LW15449. TSO: 2,000 hours (9 similar occurrences)

PROPELLERS

Hamilton Standard 14RF9 Propeller blade delaminated. Ref 510003169


P/No: RFC11161AED. TSN: 2,151 hours/1,648 cycles (20 similar occurrences)

Hartzell HC8YR1 Propeller blade incorrect part. Ref 510003213

Propeller blade diameters approx 25.4mm (1in) below manufacturer’s minimum limits. Diameter is 182.8mm (7.22in). Minimum diameter should be 185.4mm (7.29in). Incorrect part. Personnel/maintenance error.

P/No: F7666A3RX2. TSN: 4,919 hours. TSO: 2,336 hours (2 similar occurrences)

Hartzell HCC2YR1 Propeller hub cracked. Ref 510003077

Propeller hub cracked and leaking grease.

P/No: HCC2YR1BF. TSN: 1,865 hours (3 similar occurrences)

Note: Occurrence figures based on data received over the past 5 years.
Part 39-105 - lighter than air
There are no amendments to Part 39-105 - Lighter than Air this issue

Part 39-105 - rotorcraft
Bell Helicopter Textron Canada (BHTC) 206 and Agusta Bell 206 Series Helicopters
AD/BELL 206/163 - Vertical Stabiliser Supports and Vertical Stabiliser
Eurocopter AS 332 (Super Puma) Series Helicopters
AD/S-PUMA/52 Amdt 1 - Hoist Hooks
Eurocopter AS 350 (Ecureuil) Series Helicopters
AD/ECUREUIL/94 Amdt 1 - Hoist Hooks
AD/ECUREUIL/95 Amdt 1 - Engine Controls - Twist Grip Solenoid
AD/ECUREUIL/107 Amdt 1 - Stabilisers - Upper and Lower Vertical Fin Spurs
AD/ECUREUIL/120 - Engine Controls - Twist Grip Assembly
Eurocopter AS 355 (Twin Ecureuil) Series Helicopters
AD/AS 355/76 Amdt 1 - Hoist Hooks
AD/AS 355/84 Amdt 1 - Stabilisers - Upper and Lower Vertical Fin Spurs
AD/AS 355/91 - Upper and Lower Fins of Stabilisers
Eurocopter SA341 and SA342 (Gazelle) Series Helicopters
AD/GAZELLE/28 Amdt 1 - Hoist Hooks
Eurocopter SA 360 and SA 365 (Dauphin) Series Helicopters
AD/DAUPHIN/89 Amdt 1 - Hoist Hooks
AD/DAUPHIN/B1 Amdt 2 - Tail Rotor Blade Sleeve

Part 39-105 - below 5,700kg
Beechcraft 90 and 65-90 (King Air) Series Aeroplanes
AD/BEECH 90/86 Amdt 2 - Rudder Trim Tab
Beechcraft 200 (Super King Air) Series Aeroplanes
AD/BEECH 200/73 - Main Landing Gear Actuator Nut
DHC-6 (Twin Otter) Series Aeroplanes
AD/DHC-6/64 - State of Design Airworthiness Directives
Short SC7 (Skyvan) Series Aeroplanes
AD/SCT/71 Amdt 5 - Fatigue Life Limitations
Twin Commander (Gulfstream/Rockwell/Aerocommander 500, 600 and 700) Series Aeroplanes
AD/AC/100 - Aileron Inboard and Centre Hinge Support Structure

Part 39-105 - above 5,700kg
Airbus Industrie A319, A320 and A321 Series Aeroplanes
AD/A320/169 Amdt 1 - Fuel Tank Electrical Bonding
Airbus Industrie A330 Series Aeroplanes
AD/A330/26 Amdt 1 - Spooler Servo-Controls Life Limitations
AD/A330/57 - Engine - Icing Conditions During Descent - Operational Procedure
AD/A330/58 - Belly Fairing Heat Shields
AD/A330/59 - Electronic Instrument System Software Upgrade
Boeing 727 Series Aeroplanes
AD/BD72/204 - Outboard Aileron Balance Tab and Rudder Tab Vibration
Boeing 737 Series Aeroplanes
AD/BD737/37 Amdt 1 - Fuselage Lap Joints BS259 to BS1016
AD/BD737/285 Amdt 1 - State of Design Airworthiness Directives
AD/BD737/291 - Auxiliary Fuel Tank Float Switch
AD/BD737/292 - Elevator Rear Spar Web at Tab Hinge Bracket
Boeing 747 Series Aeroplanes
AD/BD747/85 Amdt 3 - Corrosion Prevention and Control Program
Bombardier (Boeing Canada/De Havilland) DHC-8 Series Aeroplanes
AD/DHC-8/87 - Airworthiness Limitation Items
AD/DHC-8/128 - Wing Root Electrical Wiring Chafing
Fokker F50 (F27 Mk 50) Series Aeroplanes
AD/F50/50 - Passenger Service Units
AD/F50/96 - Bottom Skin Chine Line
Fokker F100 (F28 Mk 100) Series Aeroplanes
AD/F100/79 - Passenger Service Unit
AD/F100/80 - Anti-Collision and strobe Lights
AD/F100/81 - Autopilot Disconnect Unit
Part 39-106 - piston engines
Lycoming Piston Engines
AD/LYC/90 Amdt 1 - Fuel Injection Supply Lines
Teledyne Continental Motors Piston Engines
AD/CON/60 Amdt 1 - Fuel Injection Supply Lines
Part 39-106 - turbine engines
Allison Turbine Engines - 250 Series
AD/AL 250/89 - Gas Producer Rotor Tie Bolt
General Electric Turbine Engines - CF6 Series
AD/CF6/36 Amdt 1 - Forward Engine Mount Assembly
Rolls Royce Turbine Engines - RB211 Series
AD/RB211/36 - High Pressure Turbine Cooling Air Holes
Part 39-107 - equipment
Emergency Equipment
AD/EMY/24 - Emergency Evacuation Slide/Raft - Pressure Relief Valves

SEPTEMBER 28, 2006

Part 39-105 - lighter than air
There are no amendments to Part 39-105 - Lighter than Air this issue

Part 39-105 - rotorcraft
Agusta A108 Series Helicopters
AD/A108/54 - Tail Rotor Pitch Control Link Assembly
Agusta A119 Series Helicopters
AD/A119/8 - Tail Rotor Pitch Control Link Assembly
Bell Helicopter Textron 421 Series Helicopters
AD/BELL 421/51 - State of Design Airworthiness Directives
Bell Helicopter Textron 427 Series Helicopters
AD/BELL 427/5 - Tail Rotor Gearbox Case Oil Feed Gallery
Eurocopter AS 350 (Ecureuil) Series Helicopters
AD/ECUREUIL/71 Amdt 1 - Tail Rotor Blade Trailing Edge
Eurocopter AS 355 (Twin Ecureuil) Series Helicopters
AD/AS 355/60 Amdt 1 - Tail Rotor Blade Trailing Edge
Eurocopter SA 360 and SA 365 (Dauphin) Series Helicopters
AD/DAUPHIN/82 - Main Rotor Rotating Star - CANCELLED
AD/DAUPHIN/87 - Optional Ski Installation
Part 39-106 - below 5,700kg
Aerospatiale (Socata) TB20 (Trinidad) Series Aeroplanes
AD/TB20/45 - Wing Spar Lower Boom Aerospolae (Socata) TB700 Series Aeroplanes
AD/TBM 700/45 - Nose Landing Gear Actuator Hinge Pin
Mooney M202 Series Aeroplanes
AD/M202/36 Amdt 6 - Fuselage Tubular Structure
Piper PA-24 (Seneca) Series Aeroplanes
AD/PA-24/43 Amdt 2 - Nose Gear Upper Drag Link Bolt
Part 39-105 - above 5,700kg
Airbus Industrie A319, A320 and A321 Series Aeroplanes
AD/A320/178 Amdt 1 - Trimming Horizontal Stabilizer Actuator
AD/A320/192 Amdt 1 - Main Fuel Pump System - Airworthiness Limitations and Modifications
Airbus Industrie A330 Series Aeroplanes
AD/A330/60 - Wing Shroud Box Bottom Panel
AD/A330/61 - Laval Lower Panel at Rib 8 Level
AD/A330/82 - CFRP Rudder
AMD Falcon 10 Series Aeroplanes
AD/AMD/10/26 - Wing Anti-Ice Hoses
AMD Falcon 50 and 900 Series Aeroplanes
AD/AMD/50/37 - Landing Gear Components
Beechcraft 400 Series Aeroplanes
AD/BEECH 400/27 - Generator Control Unit
Boeing 737 Series Aeroplanes
AD/BD737/24 Amdt 1 - Forward Galley Doorway Upper Corners
AD/BD737/28 Amdt 2 - Flight Attendant Seats
AD/BD737/29 Amdt 2 - Window Belt Skin Doubler
AD/BD737/33 Amdt 1 - Forward and Aft Cargo Compartments
AD/BD737/285 Amdt 2 - State of Design Airworthiness Directives
AD/BD737/293 - Master Dim and Test System Wiring
AD/BD737/294 - Flightcrew Oxygen Masks
AD/BD737/295 - Airstrip Doorstop Intercolastal
Boeing 747 Series Aeroplanes
AD/B747/351 - Engine Pylon Internal Structure
British Aerospace BAe 146 Series Aeroplanes
AD/BAe 146/125 - Centre Fuselage Top Al Longeron at Rib 0'
Dassault Aviation Falcon 2000 Series Aeroplanes
AD/F2000/20 - Landing Gear Components
Dornier 328 Series Aeroplanes
AD/DO 328/85 - Power Plant Air Intake
AD/DO 328/86 - Hydraulic System Modifications
Part 39-106 - Piston Engines
There are no amendments to Part 39-106 - Piston Engines this issue

Part 39-106 - turbine engines
AlliedSignal (Garrett/AirResearch) Turbine Engines - TPE 331 Series
AD/TPE 331/63 - Fuel Control Unit Drive Spline
Allison Turbine Engines - 250 Series
AD/AL 250/85 Amdt 1 - Fuel Nozzle Screens
General Electric Turbine Engines - CF6 Series
AD/CF6/61 - Thrust Reverser Actuation System
Part 39-107 - equipment
Propellers - Variable Pitch - Hamilton Standard
AD/HPS/24 Amdt 1 - Propeller System Actuator Yoke Arms
Propellers - Variable Pitch - McCauley
AD/PMC/49 - Propeller Blade Cracking
Radio Communication and Navigation Equipment
AD/RAD/55 - Rockwell International, Collins Air Transport Division, TCAS II Processors - CANCELLED
AD/RAD/56 - Honeywell, Commercial Flight Systems Group, TCAS II Processors - CANCELLED
AD/RAD/57 - AlliedSignal, Air Transport Avionics TCAS II Processors - CANCELLED

AIRWORTHINESS BULLETINS

September 12, 2006
AWB 76-001 Issue 1 - Metroliners - Engine Control Cable Replacement
July 25, 2006
AWB 82-014 Issue 1 - Approval of Aircraft Tyres
July 19, 2006
AWB 79-003 Issue 1 Premature Blackening of Oil in Piston Engines
July 17, 2006
AWB 62-002 Issue 1 - Robinson R22 and R44 main rotor blade disbonds
Boeing’s plans for the new 787 use more light weight composite materials than any civil aircraft ever built. Ahead of certification, safety specialists are focusing on structural integrity. John Mulcair & David Villiers report.

Boeing’s revolutionary 787 is only a projected two years or so from entry to service, but scrutiny is intensifying of the greatest ever use of composite materials in a civil airliner.

Half of it will be made of various composites, and while Boeing is saying it isn’t making public the non-destructive and destructive testing regimes for the 787 in its run-up to certification, safety regulators around the world are taking a keen interest.

Airframes specialists say the Airbus A380 is an evolutionary step beyond the Boeing 747, but consider the Boeing 787 perhaps an order of magnitude beyond the first widebody.

Technological experience gained, at great cost, by Boeing with its failed Sonic Cruiser concept in the 1990s has been re-directed and refined for the 787. It incorporates, in addition to the extensive use of composites, the electric architecture, improved computation, and engine advancements that started life as Sonic Cruiser developments.

Boeing has racked up an impressive 420 sales or other commitments for the airliner, the best ever for a commercial program, including up to 115 for Qantas and its Jetstar subsidiary. Variants of the new 787 will operate non-stop from Australia to all major Asian destinations and on to Europe, to the South Pacific and the US west coast.

The extensive use of weight saving composites, mainly in the fuselage, tail and wings, is a major part of Boeing’s sales pitch claiming to deliver a 20 per cent fuel saving over conventionally built, similarly sized aircraft.

For the 787, these components are being made on a previously unknown scale – the world’s largest autoclave has recently been completed for Vought Aircraft at Charleston, South Carolina, to make the fuselage barrel sections. After taking more than 18 months to build, it will process components to a maximum pressure of 10.2 Bar at a maximum temperature of 232 degrees Celsius.

Manufacturing staff must take extreme care to ensure there are no gases trapped between layers, as these can become failure points – which is where Boeing struck a glitch with one of the first 10 huge composite fuselage sections that were made for testing.

Its working area of 9.26m by 23m, for a total vessel volume of more than 2,320 cubic metres, makes this the largest autoclave in the world. Fully loaded, it weighs more than 500 tonnes.
Composites are made by baking sheets of carbon fibre that are soaked with a resin. These sheets are laid over a forming stool to the required shape, and baked under great heat and pressure in an autoclave to make the solid section. Manufacturing staff must take extreme care to ensure there are no gases trapped between layers, as these can become failure points – which is where Boeing struck a glitch with one of the first of 10 huge composite fuselage sections that were made for testing.

The first seven test barrels were made successfully, with build and finish quality improving each time. However, on the eighth, which was planned to support certification testing, trials of a different mandrel, or forming tool, and production process led to some quality problems. The finished barrel was deemed unacceptable due to excessive porosity, partly caused by trapped gas or air. The ninth barrel cured was acceptable from a quality and porosity point of view.

A team of experts determined the root cause of the issue with barrel eight was tool leakage; Boeing was moving forward in the certification process with the production of a ninth and 10th barrel with the previously proven production method.

CASA specialists are closely following the deliberations of the US Federal Aviation Administration (FAA), the European Aircraft Safety Authority and the International Maintenance Review Board as they assess the 787, and the performance of its composite structures.

Because composites do not corrode or fatigue, the inspection of composite structures is often determined by the acceptable length of exposure to accidental damage . . .

US military tests on composites show that they can shatter with few obvious early warning signs. In one military test, a 6kg ball was dropped from varying heights onto a section of composite reinforced with 25cm square, 2.5cm inch thick stiffeners. Initially there was no indication of damage, with the sound of the impact remaining constant and no visible sign of impact, but as the test continued, the sound altered, stiffeners shattered and the composite delaminated.

Reassurances are expected from Boeing that such problems have been overcome, along with details of systems showing how initial delaminations can be detected at an early stage, long before they become catastrophic.

Another area of interest to safety regulators is the reactions between the new composites structures and water. If moisture got into the composite matrix, it is possible that it could be drawn inwards along exposed fibres if protective laminations were compromised. As a result structures could be adversely affected by the expansion/contraction of the freeze and thaw cycle.

Conductivity following lightning strike is regarded by safety specialists as another matter for attention, with arcing and sparking across gaps causing great heat. There are safeguards, but composite airliners will be flying high, and will be taking large numbers of strikes during their work lives of at least 20 years and 20,000 cycles.

Damage surveillance: Nevertheless, specialists note that composites have proven their safety over many years in the military and in pressurised vessels. However, it is unlikely that requirements for damage surveillance on the ground would be relaxed.

Operators will need to ensure they have systems that encourage damage reporting from staff, including reports of any significant impact to structures from cleaners, baggage handlers and other ramp staff. With composites you should not automatically be accepting.
that if there is no mark that there is no damage to the airframe.

All aeroplane structures (metal or composite) are subject to routine inspection for accidental damage, environmental damage (corrosion) and fatigue damage, with the interval at which the structure is inspected determined by the acceptable exposure to the most likely type of damage.

Because composites do not corrode or fatigue, the inspection of composite structures is often determined by the acceptable length of exposure to accidental damage (metal structure inspection intervals are almost always driven by the acceptable exposure to damage from environmental and fatigue related causes).

The 787 composite structure would require periodic visual inspection, possibly less frequently than the aircraft types it is replacing. Boeing says that the 787 structure has been sized to account for the strength loss that could be caused by less significant damage which may be undetected in a visual inspection.

Boeing has demonstrated by analysis and testing that these small, hidden damages do not grow over time, and expects that 787 operators will be able to leave these damages undetected and unrepaird for the life of the airplane.

This is the same criterion and maintenance practice that is already approved for the composite structure on the 777. For larger damages which are detectable visually, Boeing may specify a form of NDI inspection such as pulse echo to fully assess the damage.

Airbus responds: Airbus Industrie ... will study development of structural health monitoring technology specifically to check damage to carbon fibre reinforced composite structures.

Airbus Industrie has moved more conservatively into large-scale use of composites, but with the need to offer an airliner to compete with the Boeing 787 series and beyond, it has signalled its intentions with a research and development agreement with Japan’s Institute of Metal and Composites for Future Industries. They will study development of structural health monitoring technology specifically to check damage to carbon fibre reinforced composite structures. Airbus Industrie says the technology detects invisible strain or cracks through optical fibre used as sensors embedded in or bonded to the surface of composite structure aircraft.

It says the technology would immediately detect faults or abnormal transformations caused in the aircraft structure, even during flight, offering advantages such as improved safety and reliability or more efficient aircraft maintainability.

John Mulcair is a former News Ltd aviation writer; David Villiers is section head, airframes CASA.

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SAFETY CHECK

VFR OPERATIONS

1 A passenger on a regular public transport flight wishes to carry a small clinical mercury thermometer. Carriage of this item is:
   (a) Permitted provided it carried in checked (hold) baggage.
   (b) Permitted provided it is carried in its protective case as carry-on baggage.
   (c) Not permitted unless with the written approval of the operator.
   (d) Not permitted under any circumstances.

2 For the purpose of transport by air, dangerous goods are defined as those listed in:
   (a) The current edition of the ICAO publication Technical Instructions for the Safe Transport of dangerous Goods by Air.
   (b) Sub part B of CASR 92.
   (c) Subsection 23 (3) of the Civil Aviation Act 1988.
   (d) The IATA Dangerous Goods Regulations.

3 A MULTICOM is a:
   (a) Frequency of 126.7.
   (b) Frequency of 119.1.
   (c) Frequency of 123.45.
   (d) CTAF facility that can be used to provide information to aircraft operating at a non-towered airport.

4 A true airspeed of 220kt is entered in NAIPS as:
   (a) 220K.
   (b) K220.
   (c) N220.
   (d) N0220.

5 You hold a private licence and want to take six friends on a short cross-country flight and share the costs of hiring the aircraft. In the circumstances you:
   (a) May share the aircraft costs because the flight is regard as private.
   (b) May share the aircraft costs because the operation is not scheduled and the pilot is not paid.
   (c) May not share the aircraft costs because, with more than six persons on board, it is not regarded as a cost-sharing private flight.
   (d) May not share the aircraft costs because to do so in the case of any flight would make that flight a commercial operation.

6 A commercial pilot who is 65 years old must not act as pilot in command in commercial operation carrying passengers:
   (a) Under any circumstances.
   (b) Unless the flight crew includes a second pilot who is appropriately rated.
   (c) Unless a flight review or proficiency check has been successfully completed in the previous year.
   (d) Unless a flight review or proficiency check has been successfully completed in the previous six months.

7 A METAR “RF02.0/004.0” indicates that:
   (a) 2mm of rain has fallen in the previous 15 minutes and 4mm has fallen since 0600 local time.
   (b) 2mm of rain has fallen in the previous 10 minutes and 4mm has fallen since 0900 local time.
   (c) 4mm of rain has fallen in the previous 15 minutes and 2mm has fallen prior to that since 0600 local time.
   (d) 4mm of rain has fallen in the previous 10 minutes and 2mm has fallen prior to that since 0900 local time.

8 When reading back ATC clearances, instructions and information, in which of the following may only key elements be read back to indicate compliance?
   (a) An ATC route clearance.
   (b) An amendment to an ATC route clearance.
   (c) Clearance to land on, backtrack on, enter, cross or hold short of a runway.
   (d) An amended ATC route clearance with enroute holding.

9 When navigating visually in controlled airspace, you shall notify ATC if the aircraft deviates from the approved track by:
   (a) More than 2nm, or if navigating by an NDB ±5 degrees.
   (b) More than 1nm, or if navigating by an NDB ±5 degrees.
   (c) More than 2nm, or if navigating by an NDB ±3 degrees.
   (d) More than 1nm, or if navigating by an NDB ±3 degrees.

MAINTENANCE

1 The main reason for use of dry nitrogen instead of air for inflating tyres on some aircraft types is because:
   (a) The type of rubber used to allow tyres to meet the low temperature requirements of high altitude flight makes the tyres slightly porous.
   (b) Nitrogen preserves rubber.
   (c) Nitrogen preserves the aluminium/magnesium alloys from which wheels are made.
   (d) Air mixed with a gas liberated by overheated rubber forms an explosive mixture.

2 A fuel quantity indicator is calibrated in fractions of the usable fuel capacity and is found to be correct within 3 per cent. A calibration card is:
   (a) Not required because the error does not exceed 5 per cent.
   (b) Not required because the error does not exceed 7 per cent.
   (c) Required because the calibration is in fractions of capacity.
   (d) Required because the error is 3 per cent or more.

3 Unless overhaul manual procedures dictate otherwise, the transponder code that should be used for testing by maintenance personnel is:
   (a) 7500.
   (b) 0000.
   (c) 1200.
   (d) 2100.

4 The reason why some maintenance publications state that the use of petroleum-based solvents to clean the pins of aircraft electrical connectors is not recommended is that the solvent can:
   (a) Cause deterioration of the insulation material due to removal of the plasticiser.
   (b) Affect the adhesion of the gold plating on connector pins.
   (c) Cause carbon tracking of the insulation where the solvent washes contaminants into critical areas.
   (d) Cause stress corrosion of beryllium-copper springs on the receptacles.

5 A condition where minute movement between two metal parts clamped together under considerable pressure causes transfer of metal from one part to another is termed:
   (a) Gallling.
   (b) Fretting.
   (c) Flaking.
   (d) Burring.

6 A “shower of sparks” problem engine ignition system has:
   (a) 2 sets of breaker points, both of which must be open in order for a spark to be produced.
   (b) 2 sets of breaker points which are connected in series.
   (c) 1 set of breaker points and is connected to the aircraft bus during starting.
   (d) 2 sets of breaker points and is isolated from the aircraft bus during starting.

7 Metal contacts on a reverse current cut-out relay associated with a DC generator will open when the:
   (a) Magnetic flux due to the reverse current in the relay series winding opposes the flux due to the current in the shunt winding to the point where spring tensions releases the relay armature.
   (b) Magnetic flux due to the reverse current in the relay shunt winding opposes the flux due to the current in the series winding to the point where spring tension releases the relay armature.
   (c) Current in both windings becomes insufficient to hold in the armature.
   (d) Current in both windings becomes insufficient to hold in the armature.

8 In the repair of bonded structures, the use of phenolic microballoons:
   (a) Provides a filler to increase the density of the resin.
   (b) Reduces the density of the resin and make it more flexible thus lowering stress concentrations.
   (c) Thins the resin to increase penetration in recesses.
   (d) Delays the setting of the resin resulting in greater strength.

9 A potential hazard with certain composite aircraft is that Styrofoam:
   (a) Reacts rapidly with mineral hydraulic fluid.
   (b) Dissolves rapidly in 100LL avgas and mogas.
   (c) Dissolves immediately in 100/130 avgas.
   (d) Creates a fire hazard when in contact with synthetic greases.
For each of the following questions, assume the aircraft is fitted with this navigation equipment:

- 2 VORs.
- 1 fixed card ADF.
- 1 RMI (ADF).
- 1 DME.

1 Refer to ERC 2. You are tracking from Wonthaggi (WON) to Latrobe Valley (LTV) at 5,000ft (note that this is not a published track). What is the lowest altitude to which you may descend in IMC, and how is this determined?

   a) The lowest safe altitude (LSALT) that you have calculated for the route being flown – 3,100ft.
   b) The grid LSALT for the route being flown – 3,900ft.
   c) The minimum safe altitude (MSA) – 3,000ft – for LTV based on a positive fix from East Sale TACAN (paired 113.5) and LTV NDB.
   d) The MSA – 3,000ft – for LTV based on a positive fix from Melbourne DME and LTV NDB.

2 Refer to ERC 1. Which of the following choices would be a positive fix to establish the position “Jacka” (south of Cowes VOR/NDB) with the aircraft maintaining 5,000ft on a heading of 170 (M)?

   a) CWS VOR radial 160, CWS NDB 160 (RMI), NDB 170R (fixed card).
   b) WON NDB 032 (RMI) WON NDB 222R (fixed card) CWS VOR radial 160.
   c) WON VOR radial 211, CWS NDB 160 (RMI) CWS NDB 190R (fixed card).
   d) CWS VOR radial 160, Melbourne DME 70.
   e) Both (b) and (d) are correct.

3 Refer to TAC 3. You are tracking from Owens to Bendigo (BDG) at 6,000ft (note that this is not a published track). The LSALT is 4,700ft. What is the lowest altitude to which you may descend in IMC, and how can this be determined?

   a) The LSALT is 4,700ft and applies along the whole of the track line.
   b) The MSA is 4,000ft for BDG based on a positive fix tracking BDG NDB and crossing the Mangalore (MNG) VOR radial 250.
   c) The MSA is 4,000ft for BDG, tracking BDG NDB at 35 DME ML.
   d) The MSA is 4,000ft for BDG tracking BDG NDB and crossing the MNG VOR radial 238.
   e) Both (c) and (d) are correct.

   For questions 4-9 refer to Moorabbin (MB) NDB Approach Plate dated 29 September 2005.

4 You have been cleared to leave controlled airspace tracking via the ML 158 radial/MNB approach. Which of the following would define the IAF, with the aircraft on a heading of 170 (M)?

   a) ML VOR radial 158 at 13 DME ML only.
   b) ML VOR radial 158, MB NDB 112 (RMI) MB NDB 302R (fixed card).
   c) ML VOR radial 158, MB NDB 100 (RMI) MB NDB 302R (fixed card).
   d) ML VOR radial 158, MB NDB 112 (RMI) MB NDB 046R (fixed card).
   e) Both (a) and (d) are correct.

5 What altitude may the aircraft in Question 4 descend to in IMC having established the IAF?

   a) Only to the altitude authorised by ATC.
   b) Not below 2,000ft until established on final.
   c) Not below 1,400ft until established on final.
   d) MDA of 620ft (known QNH) for category A and B aircraft.

6 How will the aircraft in Question 6 establish the lead bearing (LB) position if the ML DME were to drop out?

   a) The LB cannot be determined without DME so a missed approach should be conducted.
   b) ML VOR radial 338, MB NDB 088 (RMI) MB NDB 278R (fixed card).
   c) ML VOR radial 158, MB NDB 076 (RMI) MB NDB 278R (fixed card).
   d) ML VOR radial 158, MB NDB 088 (RMI) MB NDB 278R (fixed card).

7 An aircraft is tracking via the Cowes (CWS) VOR 323 radial on a heading of 333 (M) for the MB NDB approach. What is the lowest altitude to which the aircraft may descend in IMC prior to reaching the IAF?

   a) Not below 2,100ft.
   b) Not below 1,400ft.
   c) 2,000ft being a hemisphere level for the track being flown.
   d) 4,000ft being a hemisphere level for the track being flown.

8 If you are using 2 NDBs to fix a position then the angle must be not less than 45 degrees and you must be within 30nm of each of the beacons being used. True or False?

   a) True.
   b) False.
**QUIZ ANSWERS**

**VFR**
1. (b) CASR 92.030 note 2 (L) which quotes portion of the ICAO technical instruction.
2. (a) Refer CASR 92.101 (1); general industry practice is to comply with the IATA DG regulations which will result in compliance with the Technical Instructions (ref. note 2 to the regulation).
3. (a) AIP GEN 2.2; answer (d) is a UNICOM.
4. (d).
5. (c) CAR 2 (7A)(b)
6. (d) CAR 1988 5.110.
7. (b) AIP GEN 3.5 para. 12.18.1.
8. (c) GEN 3.4 para. 4.4.1.
9. (b) AIP ENR 1.1 para. 19.2 and 19.6.

**MAINTENANCE**
1. (d) The gas is called isoprene; (a) is true but not relevant to the question; (b) & (c) may well be correct statements but are not the primary reason for nitrogen use. AD/WHE/4 refers.
2. (c) AD/GEN/46 requires calibration when the error exceeds 5% per cent, or the calibration is in fractions.
3. (d) By agreement with ATC a transponder code of 2100 should be used (ref. AD/RAD/47 and /43).
4. (c) One reference is the AACs (now discontinued) number 175-1. Also FACTS June 1984.
5. (a) Fretting is generally said not to involve metal transfer.
6. (a) The second “retard” set of points must be open. This retards the spark.
7. (a) Without the opposing magnetic fields the points would not open when generator output dropped.
8. (b) Microballoons are also regarded as a thixotropic agent which makes the resin easier to apply to vertical surfaces.
9. (b) Tests done by the Commonwealth Department of Aviation in 1986.

**IFR**
1. (c) ERC. 2; AIP ENR 1.1 – 34, para 19.5.1.
2. (e) ERC. 1. At 5,000ft you are still within ML DME range AIP GEN 1.5 – 6, para 2.2b.
3. (e) TAC 3. BDG NDB approach plate (b) is incorrect because magnetic variation has not been applied.
4. (b) MB NDB approach plate (c) is incorrect since an RMI shows track to station, irrespective of aircraft heading.
5. (c).
6. (d) Option (b) is incorrect because you are tracking away from ML VOR reference the 158 radial.
7. (a).
8. (b). Option (c) is incorrect since it gives a position line only.
9. (d).
10. (a) AIP ENR 1.1 – 34, para 19.5.1.
WHAT’S THE MESSAGE?

LAST ISSUE’S WINNER

A. Melbourne Centre, this is Bravo Zulu Alpha, currently 1500 above Moonah Links “FORE”!!!!
Wayne B. Thomas, Warburton, Victoria

B. Readers were stumped by this one – no winning entries. We are still open to suggestions. Specify ‘July-August B’ with your entry ($100 prize).

WRITE AN AMUSING CAPTION

A. What aircraft is this?
Answer below

B. Write an amusing caption of up to 25 words for pictures A or B. 2x $100 prizes for the best captions.
Send your entry to: Flight Safety Australia, GPO Box 2005, Canberra ACT 2601 or email to: fsa@casa.gov.au by November 22, 2006.

PICK THE PIC

A. What aircraft is this?
Answer below
A comparison of Australian civil fatal aircraft accidents: Far North Queensland in context

This research paper examined the number and rate of fatal accidents in Australia, Queensland and Far North Queensland involving aircraft with a maximum take-off weight of 11,000 kg or less between 1990 and 2005. The latest year available for exposure data (number of landings, flying hours) was 2004. The purpose of this paper was to examine fatal accidents in Queensland, and specifically Far North Queensland, and provide a context in which to view the results.

However, the examination of fatal aircraft accidents from a regional or state perspective raised issues that limited the conclusions that could be drawn from the results. These issues included the generally independent relationship between a fatal accident’s contributory factors and the accident location, the availability of suitable activity data and the low number of fatal accidents and fatalities in Australia. Hence, the results described below indicate what happened in a particular area of Australia as opposed to the level of aviation safety.

The inter-state analyses showed that between 1990 and 2005, the majority of the 318 fatal accidents involving aircraft with a MTOW of 11,000 kg or less occurred in Queensland (n = 102), NSW/ACT (n = 102) and Victoria (n = 37). In terms of fatalities, the highest number occurred in Queensland, where 225 of the 647 fatalities in Australia occurred. There were 0.9 fatal accidents and 1.9 fatalities per 100,000 landings in Queensland between 1990 and 2004, compared with the national rates of 0.7 and 1.3 respectively. Tasmania recorded the highest fatal accident and fatality rates of 1.8 and 4.1 respectively. However, the significance of these rates should be interpreted with caution due to the low number of fatal accidents and activity in Tasmania. Across Queensland, almost half the 102 fatal accidents occurred in the South region of the state with the remaining fatal accidents almost evenly distributed across the Central (n= 19), North (n = 19) and Far North Regions (n = 17). The South region of Queensland recorded the lowest fatal accident rate of all the regions, with 0.7 fatal accidents per 100,000 landings between 1990 and 2004. The Central and North regions both recorded 1.2 fatal accidents per 100,000 landings and Far North Queensland recorded a rate of 1.0.

Of the 225 fatalities in Queensland, South Queensland (83) recorded the highest number of fatalities followed by the Far North (64), North (42) and Central (36) regions between 1990 and 2005. However, South Queensland recorded the lowest fatality rate with 1.3 fatalities per 100,000 landings between 1990 and 2004. The Central, North and Far North regions recorded 2.3, 2.6 and 3.0 fatalities per 100,000 landings respectively. The Far North Queensland rate doesn’t include the 15 fatalities that occurred in the Lockhart River accident in 2005, which would further increase the North Queensland fatality rate. A fluctuation in fatality numbers, such as that arising from the Lockhart River accident, highlights the influence a single aircraft accident can have when fatal accident and fatality numbers are relatively low.

Reflecting on the ATSB’s aviation outputs for 2005–06

The ATSB instigated 84 investigations and released 93 final aviation occurrence and technical investigation reports. The Bureau received 7471 notifications of events classified as accidents and incidents and finished the financial year with 81 ongoing investigations.

High-profile aviation investigation reports released in 2005–06 included: the fatal Robinson R22 helicopter accident near Camden, NSW; the Piper Cheyenne accident near Benalla, Victoria; and the Piper Chieftain accident near Mount Hotham, Victoria. I noted in the last edition some of our aviation safety research and grant reports.

The ATSB also issued 22 safety recommendations including 18 formal aviation safety recommendations and four safety advisory notices. Significant aviation safety recommendations included those from the Lockhart River investigation and on Terrain Awareness Warning Systems for turbine-powered aircraft and helicopters.

Aviation safety messages continued to be well accepted, with operators, manufacturers and regulators undertaking 129 separately identified safety actions based on 45 different ATSB investigations. The ATSB itself also undertook 13 separate safety actions. Significant safety action included Airservices Australia enhanced training for controllers, upgraded software for The Australian Advanced Air Traffic System (TAAATS) and improved instructions for controllers relating to responses to route adherence monitoring alerts following the Benalla fatal accident.

The ATSB has made significant progress with the Safety Investigation Information Management System (SIIMS) aviation database replacement project which will facilitate more rigorous investigation analysis, evidence handling and project and risk management as it is rolled out within the Bureau in 2007.

Kym Bills, Executive Director
The Lockhart River fatal crash on 7 May 2005 involving Fairchild Aircraft SA227-DC Metro 23 aircraft, registered VH-TFU in which two pilots and 13 passengers died, was Australia’s worst civil aviation accident since 1968. The ATSB is methodically investigating the accident, but has been hampered by the extent of destruction of the aircraft and the lack of useable cockpit voice data and of any witnesses. To date, the ATSB has issued three factual reports on the Lockhart River accident, the most recent on 31 August 2006.

The 31 August factual report provides the status of the investigation since the last report and covers additional information such as new details about the aircraft, its engines and systems including the Global Positioning System and the aircraft’s airworthiness and maintenance. Additional factual information relating to wreckage and the aircraft, the flight data recorder, and a summary of survey and other research dealing with RNAV (GNSS) approaches is included.

The aircraft was being operated on an instrument flight rules (IFR) scheduled passenger service from Bamaga to Cairns with an intermediate stop at Lockhart River, Qld. At 11:43:39 Eastern Standard Time, the aircraft impacted terrain about 11 km north-west of the Lockhart River Aerodrome. At the time of the accident, the crew was conducting an area navigation global navigation satellite system (RNAV (GNSS)) non-precision instrument approach to runway 12. The aircraft was destroyed by the impact forces and an intense, fuel-fed, post-impact fire. There were no survivors.

The ATSB has found that the aircraft was operating normally at the time of the accident, with no defects or malfunctions evident. Due to low cloud in the area, the crew reported conducting a runway 12 RNAV (GNSS) instrument approach. During the approach, the aircraft entered the rainforest canopy on the north-western slope of ‘South Pap’, a heavily timbered ridge, approximately 11 km north-west of Lockhart River Aerodrome. The aircraft was in an approximately wings-level attitude, at a flight path descent angle of about 4 degrees, with the landing gear and wing flaps extended. The aircraft began to break up immediately after entering the rainforest and destruction of the aircraft was consistent with successive impacts with trees and large boulders during the impact sequence. The flight recorder revealed that the aircraft was on the correct track, but was more than 800 ft below the prescribed lowest safe altitude for that segment of the instrument approach.

The 31 August factual report also featured the findings from a linked ATSB report on the experience and perceptions of RNAV (GNSS) approaches in Australia from pilots who are currently using these approaches. The survey found that pilot workload was perceived as being higher for the RNAV (GNSS) approach than all other approaches except the non-directional beacon (NDB) approach, which involved similar workload levels. Respondents also indicated that they perceived the RNAV (GNSS) approach as safer than an NDB approach, equivalent to a visual approach at night, but perceived it as less safe than all other approaches included in the survey. Thirty percent of respondents reported that the runway alignment of RNAV (GNSS) approaches increased safety.

As the Lockhart River investigation is ongoing, in accordance with international convention, the report does not contain any analysis or findings relating to the factual information. The analysis and findings of the investigation will be provided in the final report. The continuing investigation will include further work in the following aspects of the accident: the operator’s management processes, standard operating procedures, flight crew training and checking, and document control; regulatory oversight of the operator’s activities, including approvals and surveillance undertaken; and the design and chart presentation of RNAV (GNSS) approaches. Further safety action may also arise from this ongoing investigation and associated research.
Drugs and alcohol use by pilots

Drug and alcohol use in pilots can have a detrimental impact on aviation safety. Important cognitive and psychomotor functions necessary for safe operation of an aircraft can be significantly impaired by drugs and alcohol. The purpose of this study was to determine the prevalence and nature of drug and alcohol-related accidents and incidents in Australian civil aviation. A search of the Australian Transport Safety Bureau’s accident and incident database was conducted for all occurrences in which drugs or alcohol were recorded between 1 January 1975 and 31 March 2006. There were 36 drug and alcohol-related events (31 accidents and five incidents). The majority of these occurrences were related to alcohol (22 occurrences). The drugs identified included prescription drugs, over-the-counter medications and illegal drugs (including heroin and cannabis). Drug and alcohol events accounted for only 0.02 per cent of all the occurrences listed on the Australian Transport Safety Bureau’s database. Drug and alcohol-related accidents accounted for 0.4 per cent of all accidents. Furthermore, 89 per cent of drug and alcohol occurrences resulted in an accident, with the proportion of these 32 occurrences that resulted in an accident quite high, at 86.5 per cent. Fatal accidents accounted for 67 per cent of all drug and alcohol occurrences. The results of this study show that the prevalence of drug and alcohol-related accidents and incidents in Australian civil aviation is very low, but that the related accident and fatality rates are high. The planned introduction of a mandatory drug and alcohol testing program into the Australian civil aviation industry will provide a more prescriptive approach to the issue of drug and alcohol use in pilots. Education and training remain important elements of an overall approach to reducing the significant impact of drug and alcohol use on flight safety.

Mid-air collision

Occurrence 200506443


The instructor and student on board one of the aircraft were conducting circuit training at Coldstream Aerodrome. The instructor reported that the aircraft had climbed above the nominated circuit height of 1,500 ft above mean sea level (AMSL), but was not certain of the maximum altitude their aircraft ultimately reached.

After the collision the instructor had initially considered an off airport landing; however, after some degree of control was regained he felt confident enough to return to Coldstream Aerodrome. The right wing leading edge and the vertical stabiliser of the aircraft sustained substantial damage in the collision.

The instructor and student onboard the other aircraft were returning to Lilydale Aerodrome after a period in the local training area. While transiting from the training area to Lilydale the aircraft overflew the Coldstream Aerodrome circuit area. After the collision, the instructor on board the aircraft took control of the aircraft and continued on to Lilydale Aerodrome located a short distance to the north-west. The aircraft sustained minor damage to the left wing tip, left aileron, and engine cowl and nose gear.

The local instructions for aircraft operated at Coldstream Aerodrome indicated a circuit altitude of 1,500 ft AMSL and an overfly altitude of 2,000 ft AMSL. The instructor reported that they overflew the Coldstream Aerodrome circuit area above 2,000 ft AMSL, which was consistent with the unverified radar data.

Following the collision, the instructor pilots landed their aircraft safely and none of the pilots were injured.

Tail strike on takeoff

Occurrence 200500382

On 1 February 2005, a Boeing Company 737-838 (737) was being operated on a scheduled passenger service from Sydney, NSW, to Darwin, NT with two pilots, five cabin crew and 151 passengers. The pilot in command (PIC) was the pilot flying for the take-off. At 1931 Eastern Daylight-saving Time, during lift-off from runway 34 Left (34L), in gusty crosswind conditions, the PIC and copilot felt the aircraft’s tail strike the runway. They queried the rear cabin crew, who confirmed that there was an unusual noise during the aircraft’s rotation. The pilots performed the 737 Quick Reference Handbook (QRH) Non-Normal Checklist for tail strike on takeoff. Following completion of the checklist, the PIC elected to return to Sydney for an overweight landing. An engineering inspection confirmed that the aircraft had sustained a tail strike during the takeoff. A crushable cartridge, fitted to minimise damage to the aircraft during a tail strike, was damaged and required replacement.

The investigation found that while the PIC needed to react quickly and precisely to manage roll in the gusty crosswind conditions, a more measured input of pitch control was required during the aircraft’s rotation to maintain the allowable tail clearance margin. This occurrence highlights that during a takeoff manoeuvre, tail clearance margins can reduce to the point where a tail strike will probably occur if the recommended rotation rate is exceeded.

On the 25 January 2006, the operator advised the Australian Transport Safety Bureau they had developed a New Technologies training segment effective 18 January 2006. That training includes the use of the Heading Guidance System (HGS) on the Boeing 737 which will enhance situational awareness during takeoff and landing.
On 25 June 2004, the Australian Transport Safety Bureau (ATSB) released its final investigation report into an accident which occurred on 27 November 2001 at Toowoomba aerodrome, Qld, involving a Beech Aircraft Corporation King Air C90 aircraft, registered VH-LQH, which experienced an engine failure shortly after takeoff. The aircraft was destroyed and all four occupants sustained fatal injuries.

The report (200105618) including ATSB recommendations is available on the ATSB website (www.atsb.gov.au). The factors which contributed to this accident were primarily maintenance-related. Since the accident, CASA has made changes to the requirements of AD/ENG/5 and to the processes for assessing the suitability of maintenance controllers.

In September 2005, a coronial inquiry into the accident was commenced. During that inquiry, new information was brought to the attention of the ATSB. As a result of this new information, the ATSB formally reopened the investigation on 11 November 2005 in accordance with Paragraph 5.13 of Annex 13 to the Chicago Convention through Section 17 of the Transport Safety Investigation Act 2003, to assess the matters raised and their significance to the original ATSB investigation findings.

As part of the reopened investigation, the ATSB’s principal failure analyst was requested to review and comment on the evidence and analysis relating to the primary failure event for the left engine. The Transportation Safety Board of Canada (TSB) was also requested to review its original analysis. In light of a further review of the evidence, the ATSB has reconsidered its original finding that the initiating event of the engine failure of VH-LQH was a blade release in the compressor turbine and proposes that an alternative possibility could have been that the initiating event occurred in the power turbine. Notwithstanding this possibility, in either scenario, the remainder of the findings and safety recommendations contained in the original ATSB report are still relevant.

### Engine failure

**Occurrence 200507077**

On 27 April 2006 at about 1530 Eastern Standard Time, a Cessna Aircraft Company U206G (206) aircraft was being operated on a non-scheduled passenger flight from Warraber Island to Mabuiag Island, in Torres Strait. On board were a pilot, six passengers and luggage. Shortly after touchdown during the landing on runway 15 at Mabuiag Island, the aircraft commenced to veer to the left. The pilot was unable to maintain the aircraft on the runway and it continued to veer left, skidding sideways on the grass verge through a fence and into a lagoon. The pilot and passengers were able to safely vacate the aircraft.

### Runway excursion

**Occurrence 200602189**

On 27 April 2006 at about 1530 Eastern Standard Time, a Cessna Aircraft Company U206G (206) aircraft was being operated on a non-scheduled passenger flight from Warraber Island to Mabuiag Island, in Torres Strait. On board were a pilot, six passengers and luggage. Shortly after touchdown during the landing on runway 15 at Mabuiag Island, the aircraft commenced to veer to the left. The pilot was unable to maintain the aircraft on the runway and it continued to veer left, skidding sideways on the grass verge through a fence and into a lagoon. The pilot and passengers were able to safely vacate the aircraft.

### Near collision on ground

**Occurrence 200506646**

At approximately 2200 Eastern Daylight-saving Time on 15 December 2005, the pilot of a Piper PA-31-350 Chieftain aircraft, registered VH-HJS, was approaching Bankstown Airport to land on Runway 11. Following touchdown, the pilot of the Chieftain noticed another aircraft on the right side of the runway and took avoiding action by manoeuvring to the left, off the runway sealed surface and on to the grass, to prevent a collision. The pilot of the Chieftain reported that the other aircraft appeared to have only a dim tail light on at the time.

Subsequently, the other aircraft was identified as a Piper PA-28-151 Cherokee aircraft, registered VH-LMY. The pilot of the Cherokee had completed a number of night circuits at Bankstown and reported that he was taxiing on runway 11 following a full stop landing.

At the time of the incident, Bankstown Airport was operating as a Common Traffic Advisory Frequency (R) (CTAF – radio required to be carried and used).

The Australian Transport Safety Bureau reviewed the recorded frequency channels for the Bankstown CTAF (R). The recordings indicated that the pilot of the Chieftain had broadcast his intentions on the Bankstown CTAF (R) during the approach. In addition, transmissions from other traffic and the Bankstown Aerodrome Frequency Response Unit (AFRU) were recorded.

However, there were no recorded transmissions from the pilot of the Cherokee on the Bankstown CTAF (R).

As a result of this occurrence, the Civil Aviation Safety Authority (CASA) has advised the Australian Transport Safety Bureau that they intend to take the following actions:

- CASA will consider whether ‘beep back’ equipment should be mandated for all Common Air Traffic Advisory Frequency (CTAF) and CTAF (R) aerodromes and whether a full tower service when night circuit training is taking place should also be mandated, especially during ab-initio circuit training by solo students.

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**SEPTEMBER–OCTOBER 2006 FLIGHT SAFETY AUSTRALIA 59**

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**Australian Transport Safety Bureau**

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Fundamental changes are being made to aviation safety regulation in Australia. These changes result from several years of hard work and thinking within CASA about how to achieve better safety outcomes, while lifting unnecessary burdens on the aviation industry.

At the heart of the changes being implemented by CASA is a fresh definition of the relationship between the regulator and the industry. CASA must not be seen or act as a “nanny-regulator”. CASA cannot and should not take complete responsibility for safety outcomes. It is obvious that CASA does not fly or maintain aircraft, manage aerodromes or train pilots and engineers.

Yet in the past there has been a mindset, both within CASA and some people in the industry, that safety was primarily the concern of the regulator and the regulations. For some years safety and operational professionals have recognised that this mindset is flawed and naive.

Nevertheless, many people are still focusing on compliance with the regulations, not whether CASA and the industry are achieving the best possible safety outcomes. This blinkered view grew up in the early days of aviation when the regulator did indeed hold-the-hand of industry whenever safety issues had to be addressed.

In the 21st century it is certainly no longer a viable approach to safety as it is simplistic and not based on any analysis of the ever changing risks the aviation industry faces. Indeed, risk analysis is one of the keys to understanding why CASA must change the way it works with industry.

Risk cannot be managed solely by measuring whether regulatory standards are being met or not. Risk management has to be focussed on the safety outcomes, not the processes.

All this means both CASA and people in the aviation industry have to think more critically and deeply about safety and whether or not risks are currently being managed in the best possible ways.

The good news is that CASA has developed a plan to change the way it operates and behaves to embrace these concepts of risk management and safety outcomes. However, CASA cannot do this alone and the Australian aviation industry has to accept the challenges being thrown up by this new approach to safety.

Responsibility: People in the industry must accept they have the core responsibility for managing their own safety risks. Air operators, maintenance organisations, aerodromes and training organisations – large and small as well as individuals – must identify their own safety risks and develop systems to manage those risks.

Many organisations already do this, some better than others, while there are still more that have yet to understand and accept this responsibility. While CASA cannot manage the day-to-day operational safety risks of industry, there is, of course, much we can and will do to support and foster risk management across the various sectors of aviation.

CASA will still be the safety gatekeeper by using entry control mechanisms, such as issuing air operator certificates, certificates of approval, licences and other permissions.

These mechanisms make sure that organisations and people entering the aviation industry meet the minimum required safety standards and where necessary have appropriate safety systems in place. In other words, that they accept their responsibility to actively manage their own risks.

With aviation organisations being required to manage their own safety risks, CASA will take an even harder analytical look at prospective industry participants during the entry control process.

At the other end of the regulatory spectrum, CASA will continue to remove organisations or people from the industry who are unable or unwilling to accept their safety responsibilities. This will be done promptly where organisations or people demonstrate they do not have the capability to deliver the safety outcomes CASA and the community expect.

But between entry control and enforcement, CASA will take a very different approach to its role. CASA’s main emphasis will be on helping organisations and people to manage their own risks, by using motivation and education.

Although the amount of industry surveillance has and will continue to increase, there will be far less emphasis on getting involved in the operational detail of organisations through issuing administrative notices such as requests for corrective action, as this is in effect CASA doing the work of managing safety for industry.

Instead, CASA will look at the risk management systems organisations have developed and implemented and assess...
whether they are adequate or suitable.

Organisations and individuals must also be given the ability to accept more responsibility for safety by reducing the number of permissions CASA issues. If you are operating successfully and properly managing risks, you should not need to come to CASA for many of the permissions that are currently required.

In short, CASA will not be knocking on your door armed with the regulations and a plan to dig around until breaches are found.

When CASA carries out an audit or other surveillance the focus will be on your safety systems, safety culture and how you manage your risks. This does not mean CASA will stop examining how you are operating. Audits and surveillance, for example, will still include observations of line-flying, maintenance work and training.

But this will be done as a way of measuring the practical outcomes of safety systems – not as an end in itself. If shortcomings in your safety systems are found, CASA will help you to improve through safety education and sup port, although you will have to do the hard work to reach acceptable standards.

Failure by anyone in industry to accept and act on their safety responsibilities will continue to bring appropriate action from CASA, as the role of the safety policeman cannot and will not be abandoned. It should be very clear the new approach to managing safety risks is certainly not about the regulator lowering standards or walking away from its role as the safety watchdog.

However, the watchdog will be taking a far more sophisticated approach to achieving safety outcomes: one that will reduce unnecessary burdens on the aviation industry, while working towards an even better air safety record in Australia.

**MOVE TO EUROPEAN MAINTENANCE RULES**

New rules will provide more flexibility, says John Gratton.

New European-style maintenance rules, due to be implemented in the next few months, will not actually change the way you do maintenance. They will, however, provide a regulatory format that is outcome-based, rather than detailed and process driven.

European safety rules are supported by specifically targeted guidance material called acceptable means of compliance (AMCs). AMCs give industry one or more options of achieving the outcome of the regulations, but are not binding. This gives industry organisations maximum flexibility in the way they wish to conduct their business.

To speed up the introduction of the new outcome-based approach, CASA is making some changes to civil aviation orders (CAOs) ahead of the lengthy process of drafting new regulations. The changes will deliver the flexibility that the European rule set provides.

Existing CAOs will be left in place exactly as they are, and an alternative CAO will be drafted for those organisations and people who wish to use the new, more flexible system. This will allow industry to move to the new and advantageous structures.

When the new regulations are finished they will give exactly the same result as the new CAO, so industry will only have to transition once.

To make sure that all stakeholders have a chance to comment on this overall process, a notice of proposed rule making (NPRM) is due to be issued in October. The NPRM will describe the outcomes that have been discussed with industry for the areas of maintenance policy, maintenance organisations, licensing and training. The NPRM will be available on the CASA website (casa.gov.au).

**TRANS-TASMAN RECOGNITION**

A ustralian legislation for the New Zealand Mutual Recognition Bill has now been passed through Australian Parliamentary processes and will become operational within the next six months.

The Bill allows Australia and New Zealand to mutually recognise air operator’s certificates for aircraft with more than 30 seats or weighing more than 15,000kg.

The passage of the legislation through the Australian Parliament is the final step in allowing mutual recognition to proceed and is the result of a long international and interdepartmental effort dating back as far as 1993.

Former Transport Minister Warren Truss says mutual recognition will deliver savings to operators through the removal of unnecessary regulatory hurdles.

“Under the legislation, eligible airline operators will be able to use aircraft in Australia and New Zealand without the need to be issued with air operator’s certificates (AOC) from both civil aviation authorities,” Mr Truss says.

“This will cut down on red tape and will be achieved through a new type certificate, known as an AOC with ANZA (Australian and New Zealand Aviation) privileges.

“While there may be some differences in detail, the safety standards in Australia and New Zealand are compliant with international requirements and achieve the same safety outcomes.”

Measures have been built into the Bill to ensure that safety is maintained at the current levels. An operator with ANZA privileges will still have their activities and safety oversight monitored by their home regulator.

The only change is that airlines will no longer have to duplicate regulatory processes in order to operate in both countries.

The Bill was signed off by the Governor-General on September 16 and will be operational by March next year.

The mutual recognition initiative is seen as a major step forward in the integration of the trans-Tasman aviation market and marks an historic development in the aviation relationship between Australia and New Zealand.
Recent falls in jet fuel prices mask real concerns about the long-term efficiency of the airline sector, says Peter Harbison.

Aviation fuel has become the single largest expense item for many airlines over the past couple of years, as higher demand and political uncertainty have pushed up the price of oil.

From levels below US$40 a barrel in August 2004, oil peaked at just under US$80 on July 14 this year. Since then, the trend has been markedly downwards, with jet fuel spot prices tumbling as a result (see graph).

Forecasting longer term oil prices is a precarious exercise. The variables, led by global economic activity, political uncertainty, and access to new reserves, can generate widely differing outcomes. However, over the next decade, it appears inevitable that the assumption of ready access to limitless fuel at reasonable prices will be replaced by an urgency to reduce consumption and to find alternative sources. It is likely that this trend will amplify as environmental forces become more aggressive towards the airline industry.

Higher jet fuel prices have forced a major rethink in the way the airline industry is heading. The prospect of oil at over US$100 a barrel has led some analysts to doubt the very survival of the industry in its current form. **Yields up:** Paradoxically, though, higher prices have not been all bad for the sector. Many airlines in the Asia-Pacific region have remained profitable over the past two years as a result of the increased financial discipline that higher fuel prices have forced upon them.

For the first time in over a decade, some airlines have actually achieved improved yields (measured by the average price a passenger pays per kilometre travelled). They have achieved this by limiting capacity growth, disavowing market share battles in favour of profits, and imposing fuel surcharges on ticket prices.

Profits have been aided by strong economic growth, led in this region by China and supported by continuing strength in the US economy. Without this boost in demand the impacts of higher fuel costs on the industry could have been very different.

The oil price surge has also coincided with the assumption of ready access to limitless fuel at reasonable prices [is likely to] be replaced by an urgency to reduce consumption and to find alternative sources.

Market liberalisation and more competitive conditions, pushing some of the older national flag carriers to reduce – or even cease – flying on unprofitable routes as they strive to achieve better financial results.

Airlines have also accelerated orders for new, more fuel-efficient aircraft, shedding older types earlier than previously planned. While this move is intended to reduce fuel costs significantly, it has also increased capital requirements at a time when equity markets are increasingly restless about the sector.

As oil prices have slipped, one ominous sign has reappeared – the prospect of a serious economic downturn. In fact, one of the key reasons for the largely unexpected oil price slide has been a slowing in demand, implying that the recent, unusually long period of economic growth may be coming to an end.

A nudge into slower economic growth would reduce consumer spending on discretionary items like air travel, just as much of the new aircraft orders come into service. And there is no industry more sensitive to an economic downturn than the airline business.

Many airline analysts argue that the 60-year-old international aviation system is in serious need of an overhaul. They say that there are too many international airlines and, despite the serious lack of profitability for many, unnecessary barriers to consolidation and merger continue, most notably on foreign ownership.

These constraints make it nearly impossible for a national airline of one country to merge with another country’s carrier. In Europe, Air France and Dutch carrier KLM have embarked on a ground-breaking merger, but it will be some years before others outside Europe can imitate the move. Economic pressures may force some airlines to consider exiting the market, but this will be resisted given the protective attitudes of many governments towards their national carriers.

Airlines will continue to look for cost savings around the margins, such as improved air traffic procedures. But this is unlikely to be sufficient to avoid a big shift in fuel usage by the middle of the next decade, when higher fuel prices are likely to set in as a long-term reality.

Peter Harbison is the executive chairman of the Centre for Asia Pacific Aviation.

**JET FUEL AND CRUDE OIL (US$/BARREL)**

The long view: While the recent falls in the prices of crude oil and jet fuel have been steep, information compiled by the International Air Transport Association (IATA) shows the long-term trend is up.