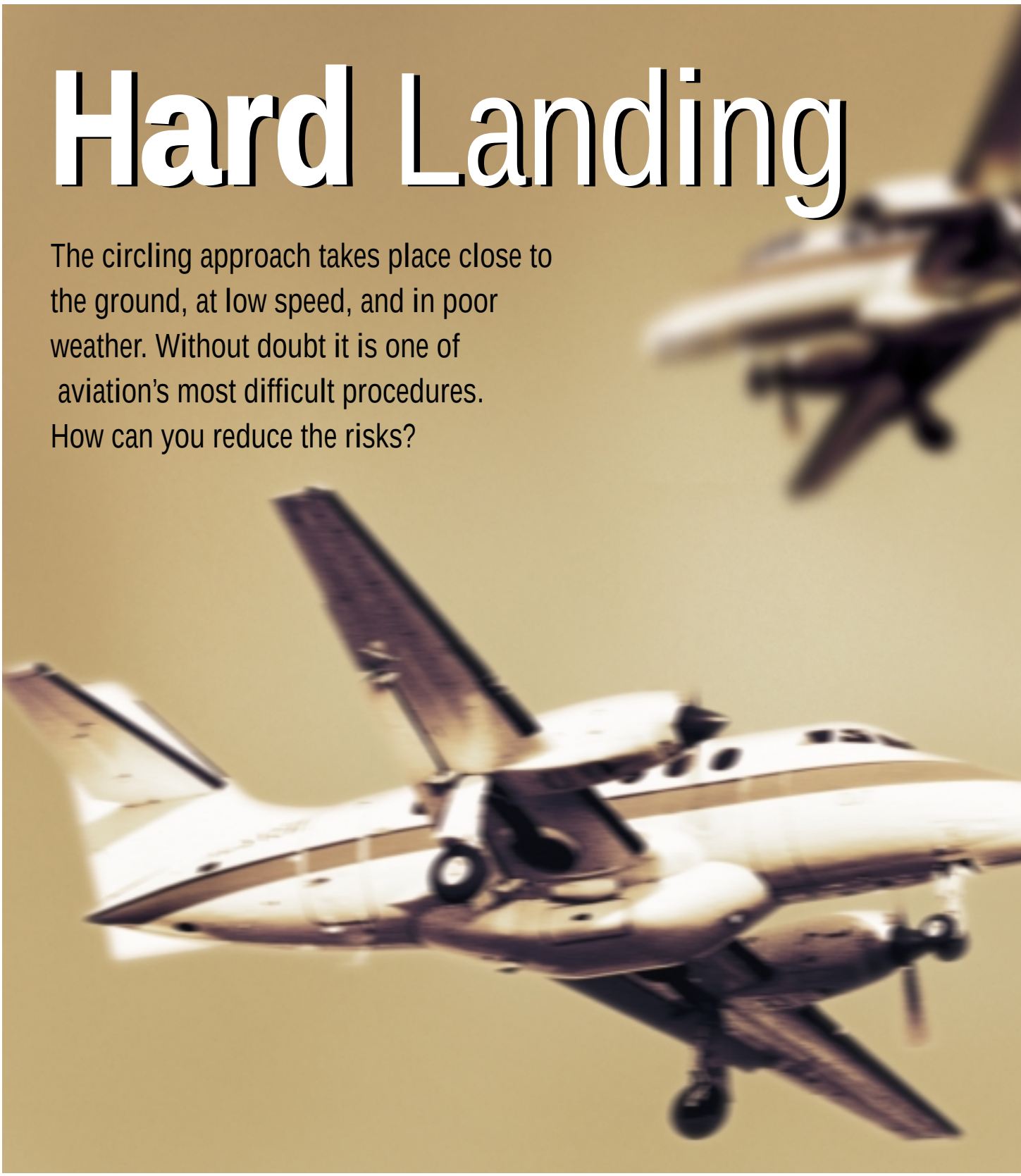
Hard Landing

The circling approach takes place close to the ground, at low speed, and in poor weather. Without doubt it is one of aviation's most difficult procedures. How can you reduce the risks?



Brent McColl and Andrew Warland-Browne

AT 7.16PM on Friday 11 June 1993, a Piper Chieftain with seven people on board – two pilots and five passengers – began a visual circling approach at Young aerodrome in NSW. Conditions were far from ideal. It was dark, there was light rain and there were significant patches of cloud below the minimum descent altitude (MDA).

To remain clear of the cloud base the pilot descended to 2,000ft AMSL, 750ft above the aerodrome elevation and 400ft below the MDA.

The aircraft passed over the northern end of the runway heading east, and soon after made a right turn to the south as if joining the right downwind leg for runway 01. South of the aerodrome, the aircraft made two right turns and headed north as if joining downwind for the reciprocal runway. At some point the aircraft left 2,000ft on a slow descent. The Australian Transport Safety Bureau (ATSB) later hypothesised that it was possible that "once the pilot-in-command had deliberately descended below the minimum descent altitude to remain clear of cloud, further descent was unintended... A further possibility is that...the pilots were distracted by having to deal with a landing gear malfunction." The ATSB were unable to prove conclusively that the aircraft suffered landing gear problems but there was some evidence to suggest that this might have been the case.

Abeam the aerodrome the pilot once again turned to the east, overflew the aerodrome and joined downwind for 01 for the second time.

Shortly after, the aircraft turned onto an apparent base leg and crashed into trees 275ft above the elevation of the airport. All seven occupants of the ill-fated flight were killed.

"Once visual, and having decided to make a landing approach," reported the ATSB, "the pilot-in-command descended below the minimum descent altitude of 2,400ft in order to maintain visual reference... Having descended below 2,400ft, the minimum obstacle clearance provided at circling altitude was no longer guaranteed."

The circling approach is one of aviation's most hazardous procedures. A report published by the International Civil Aviation Organization several years ago concluded that straight-in approaches (those aligned with the landing

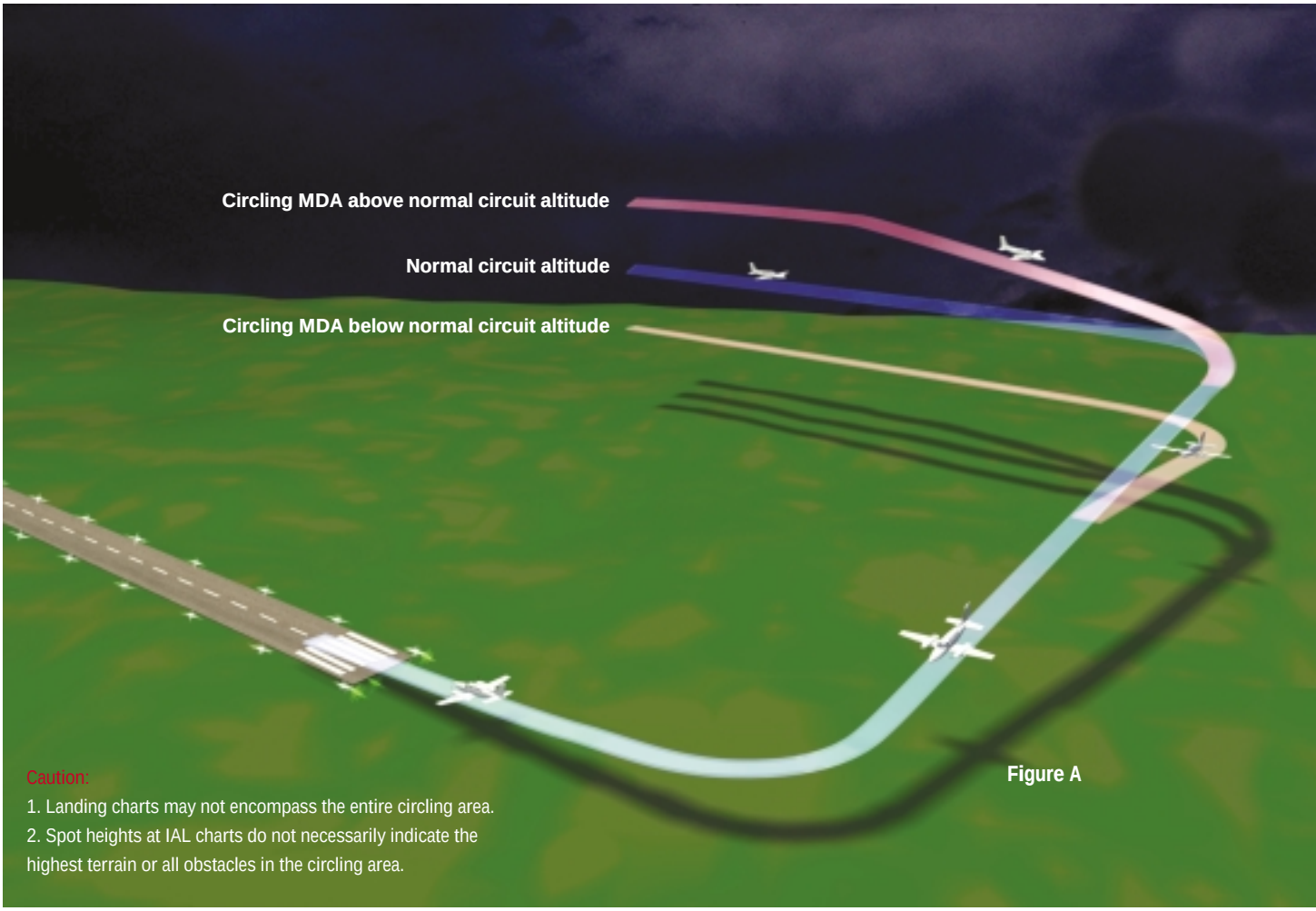


Figure A

IMAGE BY DEAN COVELL

runway) are 25 times safer than traditional circling approaches. Equally damning, some airlines do not permit visual circling because of the increased risk of controlled-flight-into-terrain accidents.

While the number of airports offering straight-in approaches has increased dramatically with the advent of GPS non-precision approaches, there are still many airports in Australia and around the world where visual circling is required.

The risks can be reduced, but there are no shortcuts: safe circling approaches demand detailed pre-flight planning, practice, a high degree of situational awareness, discipline, and a willingness to execute a missed approach at the first sign of trouble.

Circling basics: Circling begins with the aircraft established clear of cloud in the circling area.

From there it is up to the pilot to manoeuvre the aircraft into position for landing. This may involve one turn or several, and it should be similar to a normal visual circuit.

Each circling approach is different and is affected by a range of factors including the alignment of the instrument approach and the runway, the location and height of the surrounding terrain, and the weather around the airport. At some airports there are areas where circling is not permitted, say to the east of a north-south runway.

	Performance category	Approach speed	Radius of circling area	Obstacle clearance	Max speed for circling
New criteria	A	up to 90kt	1.68nm	300ft	100kts
	B	91-120kt	2.66nm	300ft	135kts
	C	121-140kt	4.20nm	400ft	180kts
	D	141-165kt	5.28nm	400ft	205kts
Old criteria	N/A	< 175kt	3.00nm	400ft	-

Figure B: Circling limitations for new-criteria instrument approach charts.

Although circling is something that is only done by instrument pilots, it is strictly a visual procedure. Visual contact with the runway must be maintained at all times and visibility must be greater than or equal to the minimum specified on the instrument approach chart. If visual reference is lost at any stage you must carry out a missed approach. No ifs, no buts, no excuses. You must start again at the minimum safe altitude or divert to another airport.

Circling area: Circling can only be performed within a specified boundary known as the circling area. The dimensions of the circling area vary depending on the performance category of the aircraft and whether the airport is served by a new- or old-criteria approach chart.

To work out if a chart is new- or old-criteria, look to see if the minima are identified by aircraft category (A, B, C and D). If they are, the chart is new-criteria. If there is only one minima, the chart is old-criteria.

For new-criteria charts, the circling area is based on arcs centred on the threshold of all usable runways. These arcs are then joined by

Circling Basics

- The aircraft must be maintained within the circling area.
- Visibility along the intended flight path must be greater than or equal to the minimum specified for circling.
- Visual contact must be maintained with the landing runway threshold, approach lighting or other markings identifiable with the landing runway.
- If any of these criteria cannot be maintained a missed approach must be executed.

Descent in the circling area

A pilot may descend below the MDA if:

- By night or day, the aircraft intercepts a position on the downwind, base or final leg of the normal landing traffic pattern, and,from this position, can complete a continuous descent to the landing threshold using normal rates of descent and angles of bank. The aircraft must maintain an obstacle clearance along the flightpath not less than the minimum for the aircraft performance category until the aircraft is aligned with the runway.
- By day only, the pilot can maintain visual contact with obstacles along the intended flightpath and maintain an obstacle clearance not less than the minimum for the aircraft performance category until the aircraft is aligned with the landing runway.

tangents. The radius of the arcs vary according to aircraft performance category (see Figure B).

Looking at Portland in Figure C, you can see how the circling area is defined. Using the inner Cat B example, arcs centred on each runway threshold are drawn with a radius of 2.66nm. Straight lines then connect each arc forming the circling area shown in light grey. Also shown is the slightly larger Cat C circling area at 4.2nm which allows for the larger turning radius of faster Cat C aircraft types.

Note the high terrain indicated on the Portland chart just 3nm to the northwest of the field (indicated by the 752ft spot height). This is just outside the Cat B circling area but inside the Cat C and D circling areas. A circling restriction is noted at the bottom of the Portland chart.

The circling area for old-criteria charts is calculated by drawing a 3nm arc from the Aerodrome Reference Point (ARP). The exception to this rule comes if one of the runways is longer than 1,800m. In that case the circling area is defined by 3nm arcs centred on the runway thresholds and joined by tangents. (Figure D.)

Circling altitude and descent: Visual circling begins at or above the circling Minimum Descent Altitude (MDA). The MDA is specified on the Instrument Approach Procedure chart.

There are two types of MDAs: a circle-to-land MDA and a straight-in landing MDA. The straight-in landing MDA is only applicable if the landing runway centreline is aligned with the final approach segment of the instrument approach. (Aligned in this context means within ±30° of the final approach segment for Category A and B aircraft or within ±15° for Category C and D aircraft.) You may only descend to the straight-in MDA if a straight-in landing is intended. If a circling approach is required you cannot descend below the circling MDA.

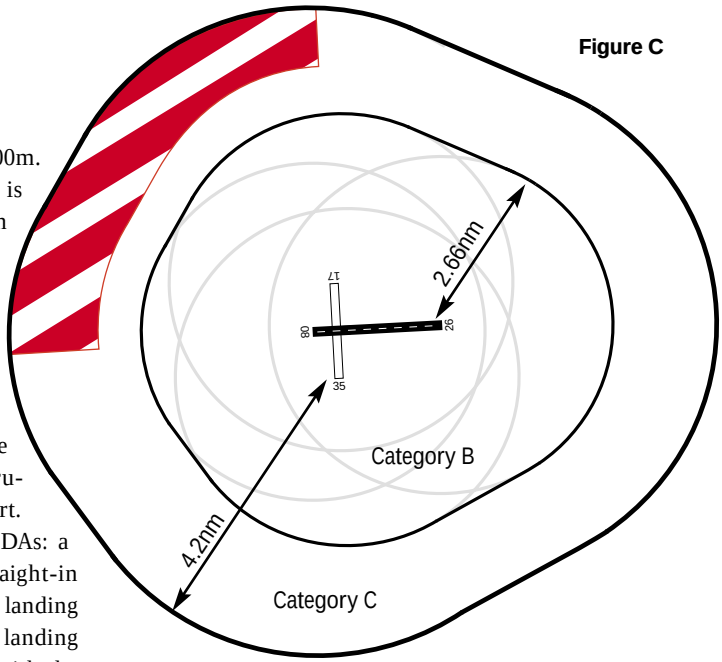
At the time of the Monarch accident, some pilots believed it was legal for them, once they became visual in the circling area, to immediately descend to the minimum obstacle clearance height (between 300ft and 400ft, depending on the aircraft's performance category and whether or not the chart is new or old criteria.) Pilots are still permitted to do this in daylight, but AIP now describes more clearly the procedures required of the pilot to avoid flying into unseen obstacles at night.

Australian AIP procedures now state that, at night, and among other requirements, descent below the circling MDA must not take place until the aircraft intercepts the normal descent profile on either the downwind, base or final leg of the pattern. From there, the descent to touchdown must be completed using normal rates of descent and angles of bank. (Figure A)

When you consider the alternative – night flying with 300ft between you and the tree tops – the new rules begin to make a lot of sense.

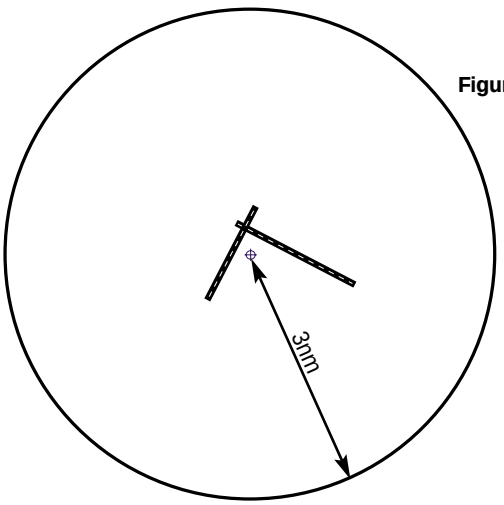
In daylight and when obstacles along the flightpath can be seen you have the

Figure C



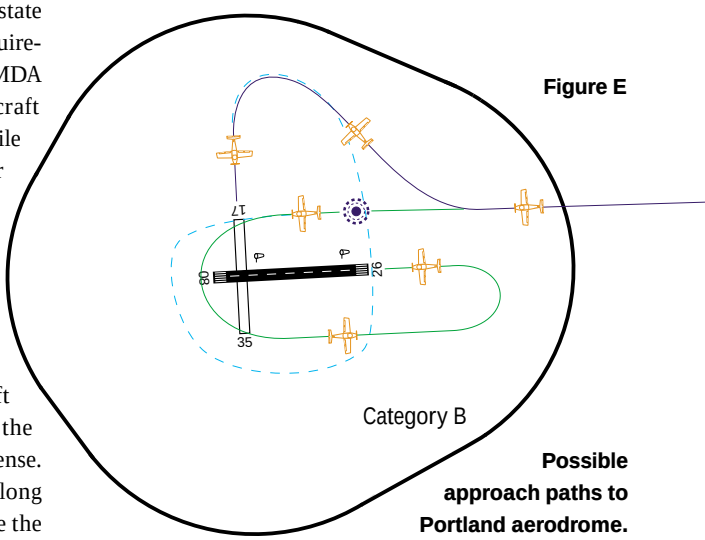
Portland's Cat B and C circling area dimensions compared. Note the circling restriction 3nm north of runway 08-26 and west of 17-35.

Figure D

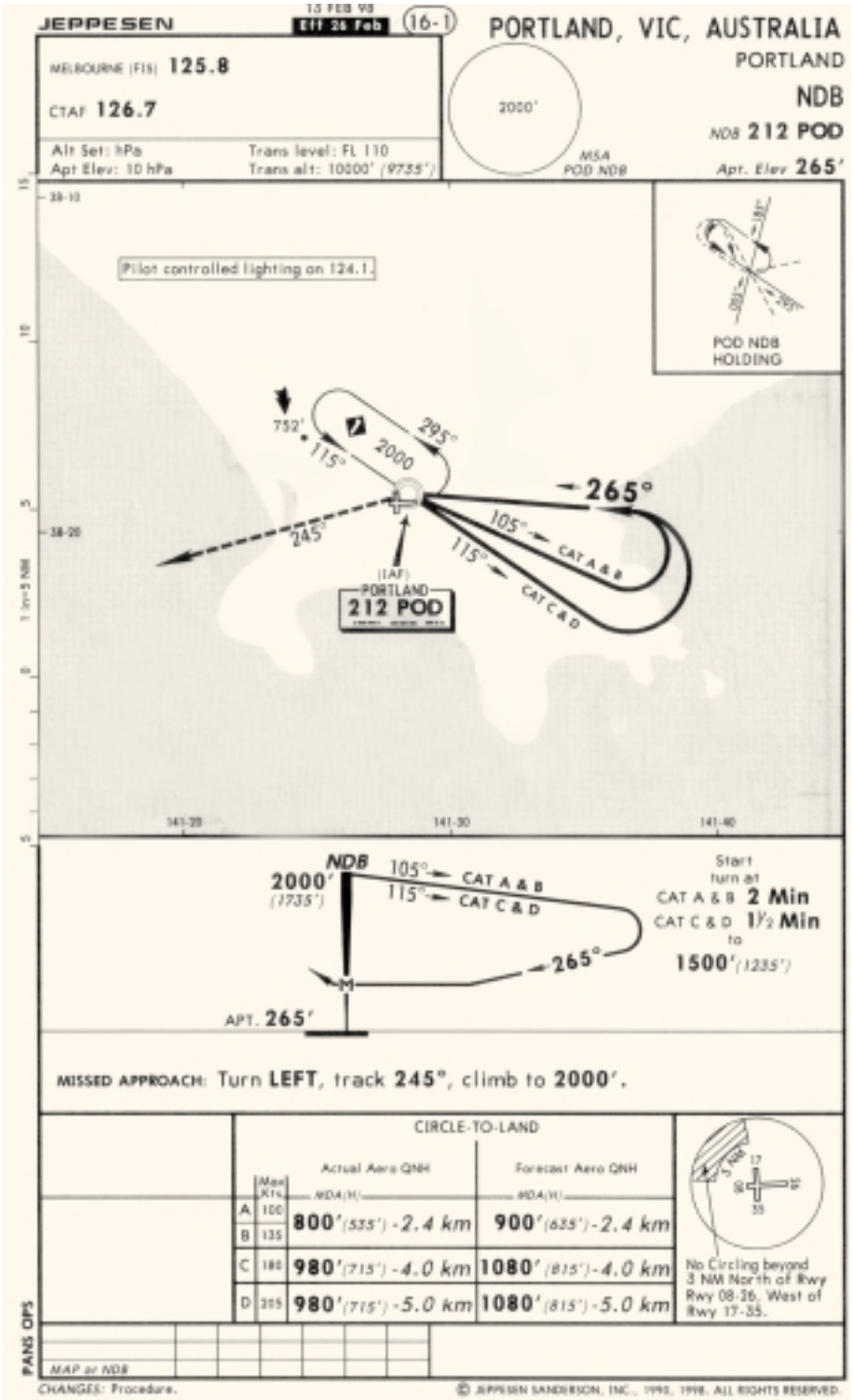


The circling area for an old-criteria instrument approach chart. The circling area is calculated by drawing a circle with a radius of 3nm centred on the aerodrome reference point.

Figure E



Possible approach paths to Portland aerodrome.



option of descending to the minimum obstacle clearance height from any location within the circling area, provided the minimum obstacle clearance height can be maintained. Even so, if the cloud base is above the MDA it is good airmanship to postpone the decent until you intercept the normal approach path.

Plan your approach: Consider a circling approach into Portland, Victoria, on a typical Portland winter's day. A front moving east at 20kt is forecast to arrive at Portland around the same time as you, bringing broken cloud at 1,000ft, 3,000m visibility in drizzle and a wind change from 300° at 15 kt to 190° at 25 kt. Add to that intermittent lowering of the cloud base to 400ft and visibility down to 2000m in drizzle and a circling approach looks almost certain. You will also require an alternate. Furthermore, if intermittent conditions are experienced, they will dictate a missed approach and possible diversion to your alternate.

As a prudent pilot you will have planned for the missed approach and the flight to the alternate. You will also have planned whether you had sufficient fuel to conduct a further approach to Portland or whether you had to immediately divert.

Using the forecast wind for your destination, take out the approach plates for the airport and start examining your options.

Let's assume you are flying a Piper Chieftain (a category B aircraft) and you expect to land well before night fall. The circling MDA is 900ft AMSL on forecast QNH (635ft Above Aerodrome Level (AAL)) and you require 2.4km visibility.

As long as you remain in the circling area and keep clear of obstacles you are permitted to manoeuvre as required to align the aircraft with the intended runway. (Note: In VMC, you should conform to the published circuit direction.) On arriving in the circling area your objective is to sight the intended runway and keep it in sight as you manoeuvre for a landing.

When you plan your circling approach, you should be aware that it is far more difficult to keep the runway in sight if you put it on the right-hand side of the aircraft. Wherever possible plan to fly the approach with the runway on your left. With this in mind, some possible flight paths are shown in Figure E.

In the event of a southerly I have chosen a track which will intercept a left base for runway 17. However, if the wind is a westerly I would plan to track upwind for runway 26, with a left turn to join a left circuit. In both cases, the approach has been designed to keep the runway in sight throughout, while giving me the opportunity to catch a glimpse of the primary windsock at the intersection of the two runways.

Cloud permitting I will remain at 900ft on area QNH (the circle-to-land MDA) and only descend when I am established on the normal descent profile. The MDA is 635ft AAL so I can expect to intercept a normal descent profile somewhere on late base.

Sounds good in theory but what if I start to encounter lower cloud patches at the MDA?

It's a daylight approach so I can legally descend to the minimum obstacle clearance height (300ft for Cat B aircraft) as long as I maintain visual contact with all obstacles along the intended flightpath.

But how do I determine the height of obstacles in the circling area so I can calculate a safe

altitude that ensures I don't cut into the minimum obstacle clearance height?

There are no obstructions noted on the airport diagram but we know there is a spot height on the Jeppesen NDB chart to the north-west at 752ft AMSL. But AIP ENR 1.5 - 2 (1.7.2) tells us that, "spot heights on approach charts do not necessarily indicate the highest terrain, or all obstacles in the circling area".

If you're getting that sinking feeling right now, you are not alone. How can we plan our descent below the circling MDA when we lack a reliable representation of the obstacles?"

The AIP states: "Before commencing an instrument approach, pilots should familiarise themselves with the location and altitude of obstacles in the circling area by studying an appropriate topographic map".

Given that five nautical miles is represented as less than one centimetre on a WAC chart, it could hardly be considered an "appropriate topographic map" for this purpose. The VTC, with its larger scale, offers a narrower focus, but the topographic information is limited and VTCs are not available for all airports.

A better option is to purchase a large-scale topographic map of the area (scale greater than 1:100,000) from a specialist map shop. Maps ranging in scale from 1:100,000 to 1:25,000 are widely available. A map of this scale will help you construct a more-refined mental picture of the surrounding terrain, however it is not, in itself, a guarantee that you will know about every possible obstacle.

If you do decide to descend below MDA prior to intercepting the normal approach path, you will have to rely on visual cues to ensure obstacle clearance.

To descend or not to descend? Studying the Portland instrument approach chart, the aerodrome chart and a suitable topographic chart, we can see that the terrain inside the Cat B circling area is reasonably flat and clear of obstacles. However, a map designed for use by bush-walkers does not meet the same standards of currency and accuracy as say a WAC chart or a VTC. Which takes us back to the original question: "How can we plan our descent in the circling area when we lack a reliable representation of the obstacles?"

Our recommendation would be that you do not leave the circling MDA until you can maintain a constant 3° descent profile all the way to the runway. This is the safest way we know to ensure obstacle clearance.

Of course the decision is yours alone and legally you may descend below the MDA in daylight hours, with vision of 2.4km, if you believe you can maintain obstacle clearance. If you do take this course of action though, make sure you are happy that you can see 2.44m or carry out a missed approach.

Missed approach: If you lose visual reference while circling, you must execute a missed approach as specified on the approach chart. Irrespective of your location in the circling area you should climb towards the landing runway, intercept the missed approach track overhead the runway and continue climbing until you reach the altitude specified in the missed approach procedure.

Better safe... The circling approach is a high-risk manoeuvre. It takes place close to the ground, at low speed, and in poor visibility. It is also a very difficult manoeuvre to practise.

Perhaps more than any other manoeuvre, it requires detailed planning, and strict adherence to the procedures outlines in the AIP. Above all, you must be prepared to shoot a missed approach if the workload becomes unmanageable or you simply feel uncomfortable with the approach.

Once established above the minimum safe altitude you will have time to collect your thoughts and evaluate whether or not you should divert to an alternate. While your passengers may not be thrilled about being dropped off miles from their intended destination, you can take comfort in the knowledge that you might have just prevented a repeat of the tragedy that claimed seven lives on 11 June 1993.

Brent McColl is an IFR multi-engine instructor and regional airline pilot. Andrew Warland-Browne is an IFR instructor and CASA safety education specialist.

PHOTO COURTESY: ATSB

The aftermath: **The tail section of Monarch Airlines' Piper Chieftain, VH-NDU, which crashed during a circling approach in 1993. All seven people on board were killed.**