D I S C U S S I O N P A P E R

Circling Approach

Part II – "Issues Identified"

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INTRODUCTION

Context

The purpose of this paper is to provide information on the operational safety issues associated with circling approach.

This is Part II of a Discussion Paper on the subject -"Issues Identified" and is based upon the responses received to the questions outlined in Part I of the paper - "Raising the Questions". The questionnaire was widely distributed to aviation safety professionals world-wide, including flight crews with direct personal experience of carrying out such approaches during routine line flying.

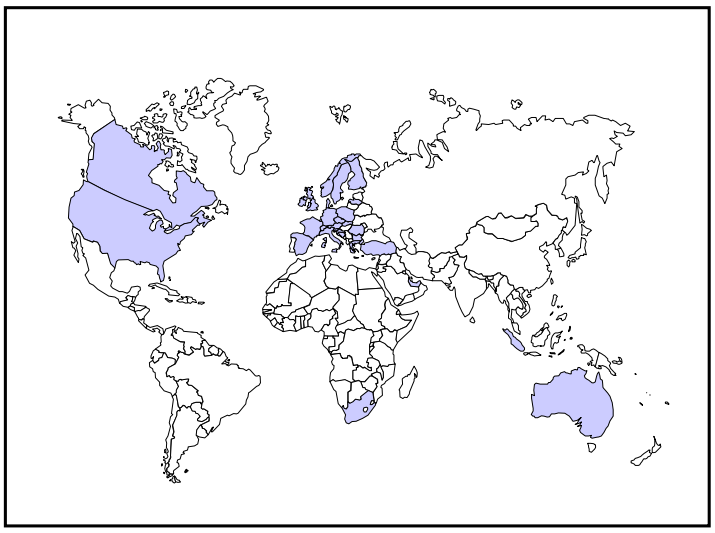
The information herein is intended to form the basis for a discussion at Flight Safety Foundation European Advisory Committee (FSF EAC). The responses summarised and quoted has not been independently verified.

The original questions covered the specific subject of circling approaches and go arounds, to the wider issues affecting go-around in general. However, since the feedback received mainly related to circling approaches and any subsequent go-around the focus will be entirely on these matters. This should not be taken to imply any judgement on relative priority, but simply a decision to concentrate on the material received

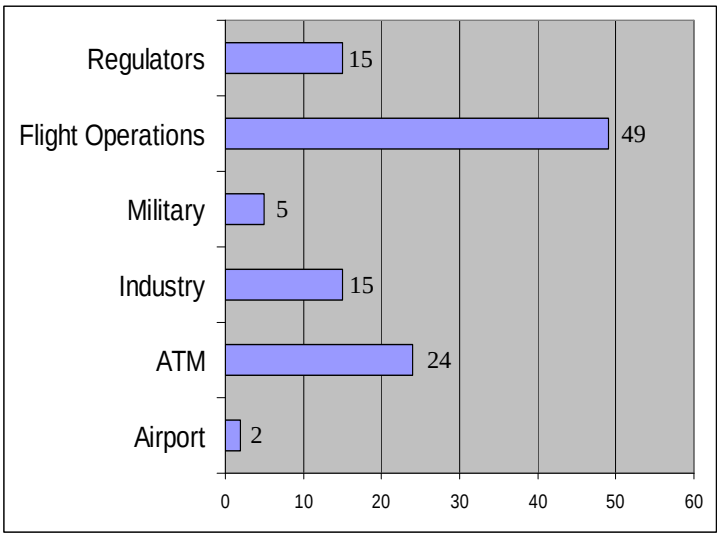
Notwithstanding this, it is acknowledged that the conduct of go arounds in general raises many other safety issues and may warrant a separate and specific initiative.

Responses received

In total there were 110 responses received to the questionnaire. The majority of the respondents were from Europe, USA, Canada and Australia. The geographical distribution of the respondents is shown on the figure below:



The expertise of the respondents cover wide is and can be considered to be representative for the study questions. Majority of the respondents are active pilots (denoted as Flight Operations on the figure) – 49.



THE RISK

Feedback was received that Flight Safety Foundation controlled flight into terrain (CFIT) studies have shown that runway aligned approaches (LNAV only) are some 25 times safer than circling approaches and that once some form of vertical guidance is added to these, then the safety margin is increased again by some 8 times.

It is of concern that, in commercial aircraft accidents associated with circling approach during the **last two years, there were in total at least 304 fatalities**:

- A321, Islamabad Pakistan, 28 July 2010, 152 fatalities.
- A310, Comoros, 30 June 2009, 152 fatalities.

Another accident during circling approach for the last decade is:

- B767, Busan, Korea, 15 April 2002, 129 fatalities.

Some other accidents during circling approaches of non-revenue or non-passenger flights duroing the last decade are:

- F20, Peterborough Airport, Ontario, Canada, 13 June 2000.
- SA227-AT, Beaver Island, MI, USA, 08 February 2001, 2 fatalities.
- BA146, Wamena Airport, Papua, Indonesia, 9 April 2009, 6 fatalities.

Also, it should be noted that almost all respondents **considered that the risk associated with a circling approach is much higher than that for other types of approaches**.

The reported exposure to circling approach varies both between aircraft operators and between members of flight crew within an aircraft operator. Circling approaches may be extremely rare for flight crews at major air carriers (possibly not more than once to twice per year). At least one respondent indicated that the effort required to reduce the risk to that of a straight in approach may not be justified and was considering whether circling approaches should be flown at all. Significantly higher exposure to circling approaches may apply for some charter, regional and low-fare operators and to some particular scheduled destinations.

The accident scenarios identified for circling are:

- A circling aircraft penetrates the obstacle clearance limits and collides with terrain or an obstacle.
- An aircraft performing a go around from a circling approach penetrates the obstacle clearance limits and collides with terrain or an obstacle.
- A circling aircraft enters a flight regime which is outside the prescribed flight envelope and there is no recovery from a consequent loss of control.
- An aircraft performing a go around from a circling approach enters a flight regime which is outside the prescribed flight envelope and there is no recovery from a consequent loss of control.
- An aircraft on, or going around from, a circling approach encounters another aircraft which results in mid-air collision.
- A circling aircraft confuses the intended runway and lands on another, occupied, runway which results in collision on the ground.

DEFINITION AND DESCRIPTION

ICAO Definitions and Procedures

A circling approach is an extension of an instrument approach procedure which provides for visual circling of the aerodrome prior to landing - ICAO *Procedures for Air Navigation Services - Aircraft Operations* (PANS-OPS, Doc 8168) Vol I, Part I, Chapter 1, Definitions.

When an aircraft intends to land on a runway for which no instrument approach procedure is available, it may make an instrument approach to another runway and, provided that the required visibility and visual references are available at the circling MDA/H and sustained, may manoeuvre visually for a landing on the active runway.

A circling approach will be specified in those cases where terrain or other constraints cause the final approach track alignment or descent gradient to fall outside the criteria for a straight-in approach or when landing on the instrument runway is undesirable, e.g. due to wind conditions or work in progress.

Where clearly defined visual features permit and it is operationally desirable, there is provision to prescribe a specific track for circling. Dedicated or existing features and accurate timing may be used to define the required track. It is important to note that a circling approach is quite different from a visual flight in a normal aerodrome traffic circuit.

ICAO Doc 4444 (PANS-ATM) does not specify details for the conduct of circling approaches comparable to those for visual approaches with the exception of minor provisions relating to phraseology.

The area in which obstacle clearance should be taken into consideration for aircraft carrying out a circling approach is called Visual manoeuvring (circling) area - ICAO Doc 8168 (PANS-OPS) Vol I, Part I, Chapter 1, Definitions.

The definition of this area is related to the aircraft speed category and makes additional assumptions about maximum wind speed and maximum bank angle or turn rate during turns. If an aircraft is flown whilst circling at a speed exceeding that assigned for the aircraft category, then any applicable limits must be based on those of the next higher aircraft speed category.

An obstacle clearance height for a circling approach is referenced to the aerodrome elevation and is used to define a corresponding MDA/MDH below which descent must not be made until:

- Visual reference has been established and can be maintained.
- The pilot has the landing threshold in sight and
- The required obstacle clearance can be maintained and the aircraft is in a position to carry out a landing.

It is recognised that e circling approach is likely to be different at different airports because of variables such as runway layout, final approach track and obstacles in the airport vicinity or transient variables such as prevailing wind and other meteorological

conditions. Therefore, there can be no single procedure designed that will cater for conducting a circling approach in every situation.

Circling approach is a type of instrument approach procedure different from straight-in approach – '*a circling approach will be specified in those cases where terrain or other constraints cause the final approach track alignment or descent gradient to fall outside the criteria for a straight-in approach*'– ICAO Doc 8168 (PANS-OPS), Vol I, Part I, Section 4, 1.2.3 – Types of approach.

The criteria qualifying a final approach as straight-in are provided in ICAO Doc 8168 (PANS-OPS), Vol II,Part I, Section 4, 5.2 – Alignment. This includes but is not restricted to an offset final approach track up to 5 degrees or the angle formed by the final approach track and the runway centre line not exceeding 30° for procedures restricted to Cat A and B aircraft and 15° for other aircraft categories.

Circling Approach guidance for AOC operators is contained in EASA TGL 44, ACJ to Appendix 1 to EU-OPS 1.430 and reproduced in the new EASA Implementing Rules for Operations. AOC holders.

Required visual reference

Respondents demonstrated a wide range of 'interpretations' of key terms related to circling approaches and there appears to be **widespread confusion about the meaning of the terms "circling approach", "visual approach", "circling to land" and "visual manoeuvring"**.

Although both visual approach and circling approach are executed by visual reference, there are important differences that do not seem to be well understood by all respondents.

A Visual Approach is defined in PANS-ATM (Doc 4444) as *an approach by an IFR flight when either part or all of an instrument approach procedure is not completed and the approach is executed in visual reference to terrain.*

From the definition it can be concluded that circling approach begins and is completed like an instrument approach procedure while visual approach is at least for a part not an instrument approach procedure.

Another important difference between a visual approach and a circling approach is the required visual reference.

For circling approach, after initial visual contact, the basic assumption is that the runway environment (i.e. the runway threshold or approach lighting aids or other markings identifiable with the runway) must be kept in sight while at the MDA/H for circling - ICAO Doc 8168 (PANS-OPS) Vol I, Part I, Chapter7. .

If such visual reference is lost whilst circling the missed approach for the instrument procedure should be followed.

A visual approach, on the other hand, is executed by **visual reference to terrain**.

However, **in case of ATC vectoring for visual approach** ICAO Doc 4444 provides in Chapter 8:

- *8.9.5.2 Clearance for visual approach shall be issued only after the pilot has reported the aerodrome or the preceding aircraft in sight, at which time vectoring would normally be terminated.*

The FAA allows the required reference for a visual approach to be either **the airport or the preceding aircraft** regardless of whether radar vectoring has initially been provided. The FAA also requires that the reported weather at the airport must be a ceiling at or above 1,000 feet and a visibility of 3 NM or greater. These meteorological minima are higher and therefore more restrictive than the required minimum visibility for many circling approaches even though circling manoeuvres are, by definition, more complex than those for any straight-in approach.

The reported practices of different aircraft operators regarding the minimum necessary visual reference differ and include for example:

- Maintaining runway threshold in sight at all times, or by day only
- By day - RWY (airfield) and by night - RWY lights.
- Defined by the Airport and /or Operator Regulator(s) - could be just airport environment or other local features.

When to descend?

Based on the received responses it may be concluded that **there is no common understanding on when the crew can commence descent** to touchdown from MDA(H).

Here are some of the interpretations:

- *Only when visual contact can be maintained and on the middle of the base leg, never earlier.*
- *Within 30 degrees from the final approach track*
- *This depends on whether visual or have achieved circling criteria. This is interpreted that you cannot descend below Circling Minima until you intercept the nominal approach angle, or you declare visual – in the latter case the crew become fully responsible for terrain avoidance.*
- *If the Circling minima are high (above 1500ft AAL - normal basic training circuit altitude) some operators ask crews to ensure that the aircraft remain within the protected area at all times. To achieve this it may mean descending before the base turn is commenced to ensure a normal descent angle to landing. Before leaving MDA certain criteria must be met. Ideally the RWY environment should be visual at every stage of the descent but practically this may not always be the case, particularly if the MDA is high or there is a prescribed track associated with the circling manoeuvre. The really important point is that we must assure ourselves that the predicted flight path of the aircraft will remain in a clear area at all times with regard to both weather and obstacles before a descent is commenced.*

- *The crew must maintain the MDA until the runway threshold has been positively identified by the PF and that a normal FPA can be achieved to land in the TDZ, a steep or a flat descent should not be attempted, if at any stage the visual cues of the runway are lost, a missed approach should be initiated*
- *Generally, crew should stay at circling MDA/ H until necessary for approach and landing; this is often on base leg. This is based on the height of MDA and the interception of a normal glide path.*
- *Fly at circling minima (AP and AT engaged) all the way to the end of the downwind leg and commence descent when turning bas.*
- *Landing threshold acquired by PF and the aircraft is in a position to carry out a landing.*
- *It is important that the descent is to be made in a way to allow for a stabilized approach.*
- *Some operators require that the MDA be maintained until the aircraft has manoeuvred to within a 30^0-degree angle of the extended runway centreline.*

ATC

Different aircraft have different minima (tail wind, cross wind), so in the sequence, the preceding aircraft may request a circling approach, while the succeeding aircraft may not.

ICAO procedures provide little provision for ATC in respect of circling approaches. ICAO DOC 4444 (PANS-ATM), Chapter 12, (12.3.4.16) contains only two examples of phraseology:

> i)* REQUEST STRAIGHT-IN (*or* CIRCLING APPROACH, LEFT (*or* RIGHT) TURN TO *(location)*);
>
> j) MAKE STRAIGHT-IN (*or* CIRCLING APPROACH, LEFT (*or* RIGHT) TURN TO *(location, runway, taxiway, final approach and take-off area)*) [ARRIVAL (*or* ARRIVAL ROUTE) *(number, name, or code)*]. [HOLD SHORT OF *(active runway, extended runway centre line, other)*]. [REMAIN *(direction or distance)* FROM *(runway, runway centre line, other helicopter or aircraft)*]. [CAUTION *(power lines, unlighted obstructions, wake turbulence, etc.)*]. CLEARED TO LAND.

It is reported that, if a circling approach is requested by the pilot, for example due to wind considerations in a very late stage (e.g. over the FAF), it can cause problems for the next aircraft in the sequence, resulting in extended and unexpected delays.

Such decisions may be potential precursors of an accident as in such cases it is likely that the circling element has not been adequately briefed or planned by the crew, which is now under significantly increased workload, probably in poor weather, with a low level of situational awareness. Late changes without ample time to review and brief the circling approach should be discouraged.

It was highlighted that there is a possibility that air traffic control officers (ATCOs) are not aware of the fact that they should not issue instructions, such as "extend downwind leg", which might cause an aircraft to leave the circling visual manoeuvring (circling) area that is provided for safe obstacle clearance. In this respect it was noted that ATCO confusion may exist between circling approach and visual flight rules circuit practices and procedures.

DESIGN DIFFERENCES

Description

The discussion below reflects some of the design differences between ICAO PANS OPS and USA Terminal Instrument Procedures (TERPS). The information has been based on the feedback provided by respondents and includes some document references.

ICAO procedures for circling approaches are described in ICAO Doc 8168 (PANS-OPS). These are the international criteria and are used throughout Europe and in most other countries world wide.

The US TERPS are described in FAA Directive No 8260.3B. US TERPS are used in the United States and in and some other countries in the Pacific Region Some NATO military procedures are also based on US TERPS.

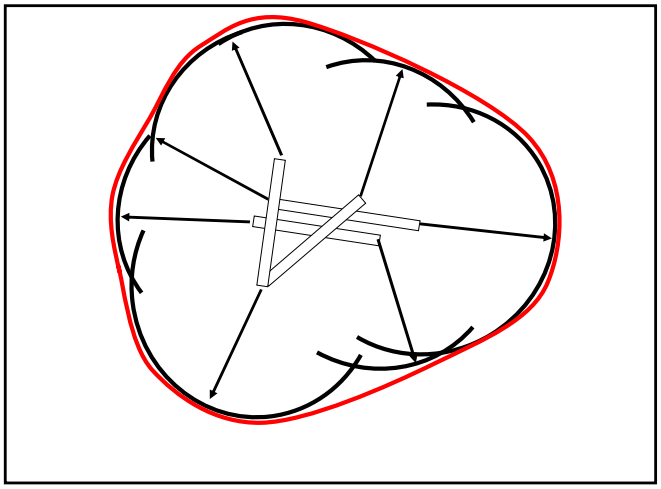
The differences discussed are confined to the subject of circling approaches and do not cover all the differences between the two provisions. In this specific context, the most significant differences are in respect of how the visual manoeuvring (circling) area is defined

It is essential that flight crews appreciate these differences. There is no need to know about specific design criteria but there are important general principles that differ including those affecting:

- The size of the visual manoeuvring (circling) area.
- The assumed radius of turn
- The Minimum Obstacle Clearance (MOC)

The limits of the permitted circling area are defined by drawing an arc from the centre of the threshold of each usable runway – see Figure 1.

Figure 1



The radius of the arc depends on the radius of the aircraft turn and is equal, for both PANS-OPS and US TERPS, **to two times the aircraft turn radius with an added straight segment**.

The parameters on which the aircraft turn is based are altitude, indicated air speed, wind, bank angle and flight technical tolerances. In this respect the size of the visual manoeuvring (circling) area varies with the category of the aircraft.

Speed assumptions

Aircraft performance differences have a direct effect on the airspace and visibility required for manoeuvres such as circling approach. The still air track of an aircraft in turn depends on its speed - the higher the speed of the aircraft the greater the turning radius. Therefore, the approach speed of the aircraft is an important parameter for determining the size of the visual manoeuvring (circling) area.

Categories of typical aircraft have been established to provide a standardised basis for relating aircraft manoeuvrability to specific instrument approach procedures. Both PANS-OPS and US TERPS group aircraft into approach categories based on a reference speed that is equal to the stall speed multiplied by 1.3. Aircraft categories for both design standards are identical and refer to indicated air speed:

Table 1

Categories	**Indicated air speed**
Category A:	less than 169 km/h (91 kt)
Category B:	169 km/h (91 kt) or more but less than 224 km/h (121 kt)
Category C:	224 km/h (121 kt) or more but less than 261 km/h (141 kt
Category D:	261 km/h (141 kt) or more but less than 307 km/h
Category E:	307 km/h (166 kt) or more but less than 391 km/h (211 kt)

To determine the visual manoeuvring radius, **PANS-OPS does not use the speed as indicated in the categories above but other, visual manoeuvring Indicated Air Speeds**:

Table 2

Speeds for procedure calculations in kilometres per hour (km/h)/ and in knots (kt)	
	Maximum speeds for visual manoeuvring (circling)
Category A:	185/100
Category B:	250/135
Category C:	335/180
Category D:	380/205
Category E:	445/240

Although the speed categories of both documents are identical and are both based on indicated air speed, there is one substantial difference. The difference is that for determining the size of the visual manoeuvring (circling) area PANS OPS uses different, higher speeds than the ones defining the categories above in Table 1. With all other conditions equal, this will result in larger radius of the defined arcs.

Both US TERPS and PANS-OPS convert indicated airspeed to true airspeed.

US TERPS converts the indicated airspeed into true air speed, as a function of the airport elevation above MSL and height above airport. The true air speed is used after, together with the bank angle, to determine the Circling Approach Radius.

Wind assumptions

PANS-OPS adds 46 km/h (25 kt) wind to the true airspeed (TAS) for each category of aircraft using the visual manoeuvring IAS. US TERPS does not explicitly refer to a wind assumption, but analysis of the formula for calculating the circling approach radius (the radius of the arc) shows that a 25 kt wind is always added as a constant.

In this way there is no assumption made for the direction of the wind but it is always added to the true airspeed before the calculation of the circling approach radius.

Bank angle assumptions

PANS-OPS assumes a constant bank angle for determining the size of the visual manoeuvring (circling) area. The value is 20° average achieved or the bank angle producing a turn rate of 3° per second, whichever is the lesser bank.

US TERPS differs from PANS-OPS by assuming bank angles dependent on aircraft category as follows:

- Category A: 25°
- Category B: 25°
- Category C: 20°
- Category D: 20°
- Category E: 22°

PANS-OPS assumes a bank angle which is equal to or lower than the one used by US TERPS. This will contribute in certain occasions to a higher turn radius for PANS-OPS and hence to a higher radius of the drawn arc and a larger visual manoeuvring area.

Minimum visibility

PANS-OPS assumes that the minimum visibility available to the pilot at the lowest OCA/H will be as shown in the table below:

Aircraft Category	Minimum visibility Km (Nm)
A	1.9 (1.0)
B	2.8 (1.5)
C	3.7 (2.0)
D	4.6 (2.5)
E	6.5 (3.5)

This information is not required for the development of the procedure, but is provided as a basis for the development of operating minima – in particular minimum In Flight Visibility (IFV).

US TERPS has an algorithm for determining the minimum visibility, which should not in any case be lower than:

Aircraft Category	Minimum visibility km
A	1.6
B	1.6
C	2.4
D	3.2
E	3.2

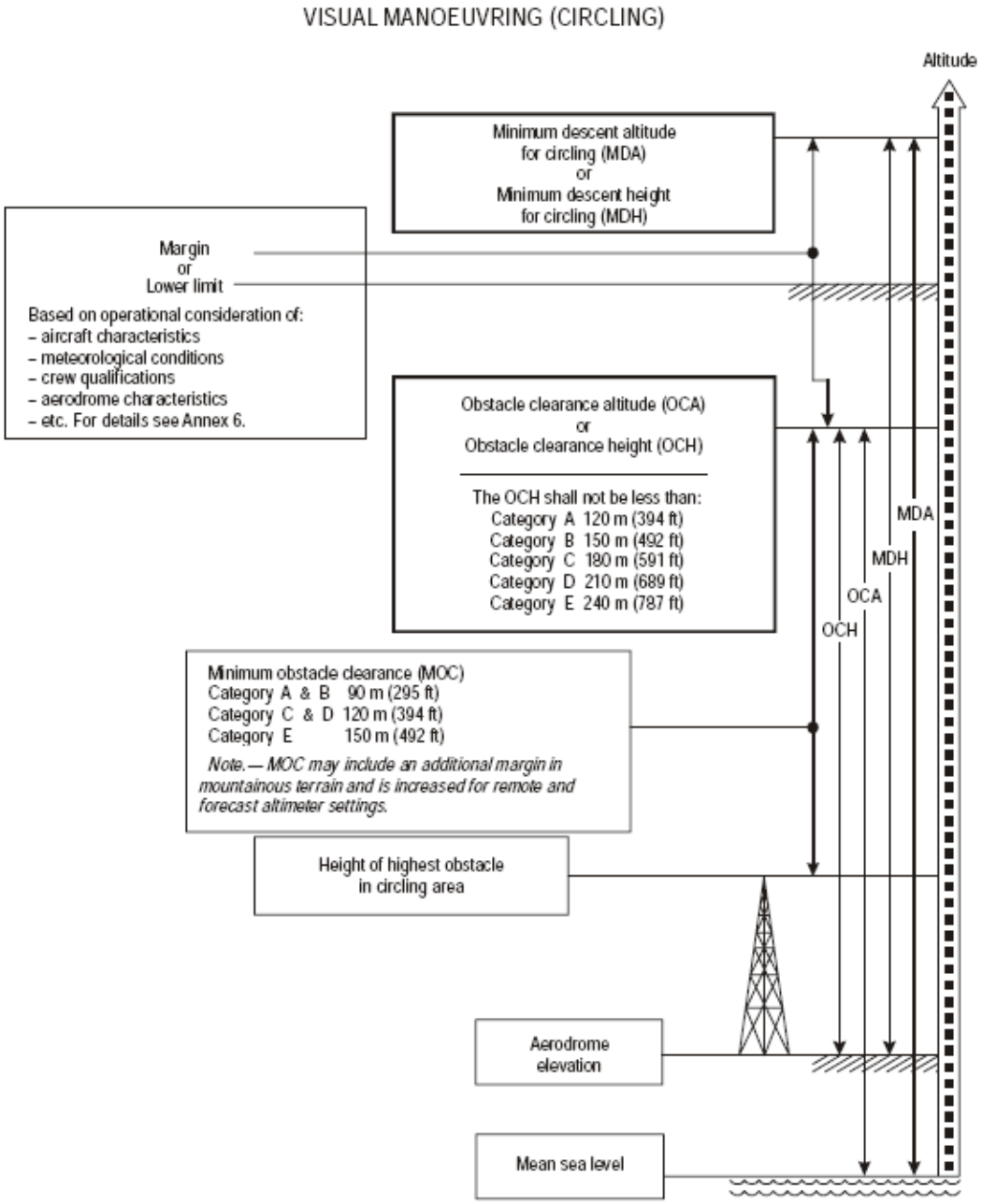
Obstacle Clearance

US TERPS provides a Required Obstacle Clearance (ROC) of 300 ft plus adjustments over the highest obstacle in the Obstacle Evaluation Area (OEA) which is equivalent to the 'Visual Manoeuvring Area' in PANS-OPS.

In PANS-OPS, the OCA/H for circling may not be not less than the one for the instrument approach procedure preceding to circling manoeuvre. To determine the circling OCH the higher of two values (see Figure 2) is selected, both of which vary by aircraft category:

- an MOC above the elevation of the highest obstacle in the circling area, which starting from 295 ft for Category A and increases to 394 ft for Category C and D aircraft and 492 ft for Category E aircraft
- The lowest permissible OCH above aerodrome elevation which starts from 394 ft for Category A and is 689 ft for Category D

Figure 2



PANS-OPS provides a higher obstacle clearance altitude, dependent on aircraft category compared to the constant 300ft for US TERPS

Both documents allow for a prescribed track for visual manoeuvring in those locations where clearly defined visual features permit, and if it is operationally desirable.

Evolution of US TERPS

The comparison so far in this paper is based on US TERPS, change 21 effective from 5 June 2009. It should be noted that US TERPS has been subject to changes over the years.

For example, as far as circling approaches are concerned, the differences for example between Change 21 and Change 18 effective from 15 May 2001 are particularly significant:

- One of the subjects that were changed, and which was introduced in change 21, was the radius to draw the circling area. The previous provision of TERPS, before change 21, define smaller radius, a constant per given aircraft category, as follows:

Aircraft Category	Radius (Miles)
A	1.3
B	1.5
C	1.7
D	2.3
E	4.5

- There were no 46 km/h (25 kt) wind assumptions. This affected the assumed aircraft groundspeed.
- The bank angle assumption to get to the radius above was not explicit.
- There was no correction for TAS increases with altitude.

The visual manoeuvring area defined by US TERPS versions older than Change 21 (2009) will be much smaller in size. It may not be clear whether published procedures have been revised to reflect that latest (2009) changes of TERPS or not.

CIRCLING APPROACH RISK CONTRIBUTORY FACTORS AND DEFENCES

Risk contributory factors

The following factors were considered to contribute to the adverse scenarios during circling approaches:

- Where, although in compliance with ICAO standards, **a flight may be performed at night without adequate terrain visual contact** because the required visual reference is not the terrain but the airport environment.
- Even if the terrain is visible **it is difficult to maintain terrain avoidance visually at night.**
- **The difference in the way aircraft operators interpret when to descend below MDA(H)**.
- **Procedural design differences** for circling approach that have operational significance (PANS-OPS vs. TERPS and between different versions of TERPS).
- The absence of **information identifying the design standard on the chart available to flight crew**.
- The **failure to specify on the chart the extent of the circling area**.
- **Inadequate flight crew initial and recurrent training requirements**.
- **Inadequate flight crew pre-flight preparation**.
- **Visual and somatogravic illusions** especially when performing circling approaches at night and/or over water.
- Circling approaches which have significant terrain risks but have **not been specified as prescribed track procedures**
- **The availability of supporting navigation infrastructure** like circling approach lights.
- **Adverse weather**, mainly in flight visibility close to minimum and strong winds / significant low level turbulence.
- **High terrain** or significant obstacles within or near the circling area;
- **High airport elevation leading to high true airspeeds** which reduce the time available to conduct the approach
- Aircraft operation beyond performance limits. Commercial aircraft are able to sustain level flight on one engine and accomplish a go-around on one engine from the landing configuration. At high elevation airfields and/or under high ambient temperatures, **certain aircraft types may require a specific procedure in order to assure level flight during an engine-out** circling manoeuvre and during a possible go-around from any point during the manoeuvring phase or landing phase (the aircraft type-specific operating manual should be referred to in order to assess possible limitations at critical airports in the operator's network).

Risk Management

The practices listed below were reported as means to manage identified risks:

Eliminating the hazard at source

Implementation of RNP approaches. It was also suggested that practically any straight in approach, including a non-precision approach, is better than a circling approach.

Universal implementation of ICAO procedural design criteria

Implementation of ICAO internationally agreed design of circling approaches, avoiding using other non-ICAO design standards.

Providing better Approach Chart Information

- Contoured and single colour-graded (green or brown) height bands on charts for all circling approaches where terrain is an issue
- Exceptions to ICAO provisions should all be clearly noted on approach charts[1].
- Include "Remain within x nm" on approach charts, especially when the procedure is not in accordance with PANS-OPS

Providing adequate information in the Operations Manual

At least the following information should be provided in the Operations Manual:

- The visibility limits for commencement/continuation of circling.
- The aircraft configuration at various stages of a circling approach.
- The use of flight control systems to assist in the positioning of the aircraft during the procedure.
- The prohibition of descent below circling minima until the landing runway threshold has been identified and the aircraft is in a position to continue with a normal rate of descent and land within the touchdown zone.
- The missed approach procedure.
- The design criteria used

Improved Flight Crew Training

- Better awareness for the design differences and their operational significance.

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[1] It is to be noted that the phrases 'PANS OPS' or 'TERPS' is normally printed on the left bottom corner of the Jeppesen chart. 'PAN-OPS' notation indicates that the State has specified that the instrument approach procedure complies with the ICAO PANS-OPS. 'TERPS' indicates that the State has specified that the instrument approach procedure complies with the United States Standard for Terminal Instrument Procedures. 'US TERPS' phrase is only printed for charts with effect from 21 of November 2003.

NATO procedure design instructions (STANAGS) require that a procedure plate identifies the procedure design system used to develop IFR procedures. It should be noted that the indicated 'TERPS' is not US TERPS but former NATO TERPS which is not exactly the same. NATO is using PANS-OPS for all newly designed procedures. Due to some military specifics this is called 'Military Instrument Procedure Design System or MIPS).

- Recognition that simulator visuals, especially day visuals, may limit the effectiveness of simulator training and that in some cases, restricted visual coverage of the simulator screens may also reduce the realism during a practice circling approach.
- The impossibility of including much circling approach training in routine recurrent simulator sessions because of severe pressure to complete specified regulatory tasks and manoeuvres. Any need for significant additional training needs additional simulator time.
- The generic 'International Recurrent Training Program' of one flight training provider addresses PANS-OPS vs. TERPS circling issues as a ground school topic and it was suggested that the ground school session could be linked with a dedicated simulator session.
- One operator with higher exposure to circling approaches (on average one per month per pilot) reported they consider circling approach as a 'Threat' and require crews to demonstrate proficiency in circling approaches in the simulator every 6 months
- Some operators who are based in territories using PANS-OPS procedure design provide additional training and awareness for crews likely to encounter TERPS-designed approaches as well.

Crew pre-approach preparation

Many respondents shared practices about crew pre-flight preparation and briefing. Some reflect the wide range of generic briefing practices amongst operators.

- It was noted that for some destinations the crew may reasonably expect before the flight to be faced with a circling approach, while for other airports, especially alternates, this expectation may not exist. Sometimes the likelihood of conducting a circling approach may become known only when nearing the end of cruise, after obtaining up to date ATIS information
- It was suggested that, if the level of risk is high, whenever there is even a slight likelihood of circling approach the issue to be properly included in the pre-flight briefing and preparation including a pre-flight risk review. This is particularly true if the wind is not clearly forecasted to make the non-circling runway to be the active runway.
- It was suggested that the pre-flight briefing and preparation should highlight the procedure, protected areas and circling approach peculiarities especially when they do not meet ICAO criteria.
- Some operators require crews to 'Double Brief' when performing anything other than an ILS approach. A 'Double Brief' is described as a brief for the approach procedure from the chart followed by a brief on how the approach will be flown.
- Some operators brief where flap and gear will be extended, AP and A/T modes used actions on becoming visual, actions if not visual. Crews are required to brief the G/A procedure including the point at which A/P and A/T will be re-engaged

- If the likelihood of conducting a circling approach is known at dispatch or before the top of descent, and if the circling pattern is part of the FMS navigation database, a suitable strategy may be for the flight crew to build the primary and secondary flight plans for a landing on the instrument approach runway and for the circling alternative. Some airlines build and publish FMS pre-planned circling approaches and have these approaches in their FMS databases. Without FMS and for situations of unexpected circling approach crew should have techniques developed to stay within the protected airspace.
- A practice was reported to create and insert in the FMS database manual points for and non-FMS aircraft.

Restrictions for circling approaches

- Some operators apply higher than mandatory minima. For example one operator reported restricting all circling approaches to minima of`1000ft MDH and 5000m flight visibility.
- Some operators do not permit circling approaches at night unless VMC conditions exist. In other words, a night circling approach is not flown using the published circling minima, but instead requires weather that permits a normal VFR traffic pattern.
- Also reported is the use the next highest category of minima. For example, aircraft are certified Category C for circling purposes must use the Category D circling minima.
- Some aircraft operators prohibit all circling approaches at night.
- Some operators which have destinations with a higher likelihood of a circling approach provide additional training for night circling approaches.
- Some operators reported a practice of restrictions per destination, based on destination risk analysis. For example, prohibiting circling at night due to the lack of ‘lead in’ lights.
- Some aircraft operators do not allow circling approaches using TERPS-designed approaches and others just prohibit circling approaches at night designed in accordance with TERPS.
- Some operators restrict circling approaches (or subsets of them such as night circling or prescribed track circling) to specifically qualified commanders, who may also be required to operate as PF for such approaches

Operator Risk Management

- Risk assessment of all routinely permitted circling approaches including designated alternates, should be done in such a way that the increased risk of circling compared to a ‘baseline’ straight in precision approach, could be identified in a way that allowed mitigations to be applied which would reduce any increased operational risk to that of the baseline.
- As long as TERPS Circling Procedures have to be used by operators based in non TERPS territories, they should be required by State Regulators to be

designated as Cat 'C' airfields so that specific awareness is trained in each case.

- It was proposed that risk management as part of the airline New Destination Process, which in some cases is overseen by the Regulator.

Flight crew coordination

Some respondents suggested practices to cope with the difficulty of obtaining and maintaining visual reference when PF is in the 'wrong' pilot seat to maintain full visual reference with the airport environment:

- Captain to fly circling approach with LH downwind. F/O fly circling approach with RH downwind
- The initial approach, break to downwind and the initial downwind legs are generally visually assured from the left seat. A briefing to the first officer to keep the runway in sight during the base turn must be done. The initial final turn is generally coordinated between the left PF and PNF until final turn is completed. The opposite can be achieved with a left hand circuit with the pilot in the right seat flying.
- Use the FO to call the turn and direct the captain to start/complete turns.

Use of Circling approach lights

ICAO recommends circling guidance lights to be provided when existing approach and runway lighting systems do not satisfactorily permit identification of the runway and/or approach area to a circling aircraft in the conditions for which it is intended that the runway will be used for circling approaches.

The location and number of circling guidance lights should be adequate to enable a pilot to:

- join the downwind leg or align and adjust the aircraft's track to the runway at a required distance from it and to distinguish the threshold in passing; and
- keep in sight the runway threshold and/or other features which will make it possible to judge the turn on to base leg and final approach, taking into account the guidance provided by other visual aids.

It is recommended that circling guidance lights shouldconsist of:

- lights indicating the extended centre line of the runway and/or parts of any approach lighting system; or
- lights indicating the position of the runway threshold; or
- lights indicating the direction or location of the runway;
- or a combination of such lights as is appropriate to the runway under consideration.

Circling guidance lights should be fixed or flashing lights of an intensity and beam spread adequate for the conditions of visibility and ambient light in which it is

intended to make visual circling approaches. The flashing lights should be white, and the steady lights either white or gaseous discharge lights.

The lights should be designed and be installed in such a manner that they will not dazzle or confuse a pilot when approaching to land, taking off or taxiing.

Examples provided by the respondents of helpful circling guidance lights are at KJFK (New York JFK) for runways 13R and 13L and at LPMA (Funchal, Madeira).

Another practice reported is from some Italian and Spanish airports which have a powerful Airport Beacon light to facilitate easy identification of the airport during any visual approaches

It was suggested that lights are particularly helpful at airports where visual reference may be insufficient for guidance during a visual circuit (e.g. when over water with possible mis-navigation towards a runway adjacent to the intended one).

GOING AROUND FROM CIRCLING APPROACH

What is the applicable procedure?

The majority of the respondents reported potential confusions associated with go-around from a circling approach.

ICAO clearly provides in PANS-OPS Doc 8168 Volume I, Part I, Section 4, Chapter 7:

- *7.4.1 If visual reference is lost while circling to land from an instrument approach, the missed approach specified for that particular procedure shall be followed. The transition from the visual (circling) manoeuvre to the missed approach should be initiated by a climbing turn, within the circling area, towards the landing runway, to return to the circling altitude or higher, immediately followed by interception and execution of the missed approach procedure. The indicated airspeed during these manoeuvres shall not exceed the maximum indicated airspeed associated with visual manoeuvring.*

- *7.4.2 The circling manoeuvre may be carried out in more than one direction. For this reason, different patterns are required to establish the aircraft on the prescribed missed approach course depending on its position at the time visual reference is lost.*

It is clear that there are two steps:

- Prior to reaching the MDA, the missed approach is the one specified for the published instrument procedure from which the circling has been initiated.

- After reaching the MDA, the missed approach starts with a climbing turn towards the airport and then rejoins the missed approach of the approach conducted prior reaching the MDA.

Some of the respondents reported that at multi runway airports (e.g. EHAM) it may not be operationally feasible to perform the missed approach for the initial instrument procedure. Therefore at EHAM the missed approach for the intended landing runway is specified[2]. ATC is also very restricted in giving instructions below minimum vectoring altitudes. “Open” clearances like “continue present heading and climb” are also not acceptable. The controller has very few “legal” tools for an aircraft below 9minimum vectoring altitude (MVA) or outside of published SID/approach/missed approach procedures. However, as long as the aircraft is in sight, more actions are potentially available, although this is often not the case during circling in marginal weather. So essentially, once below the MVA, the aircraft can not be given navigational assistance by ATC, unless declaring an emergency or for the relatively short period where it is visible to ATC

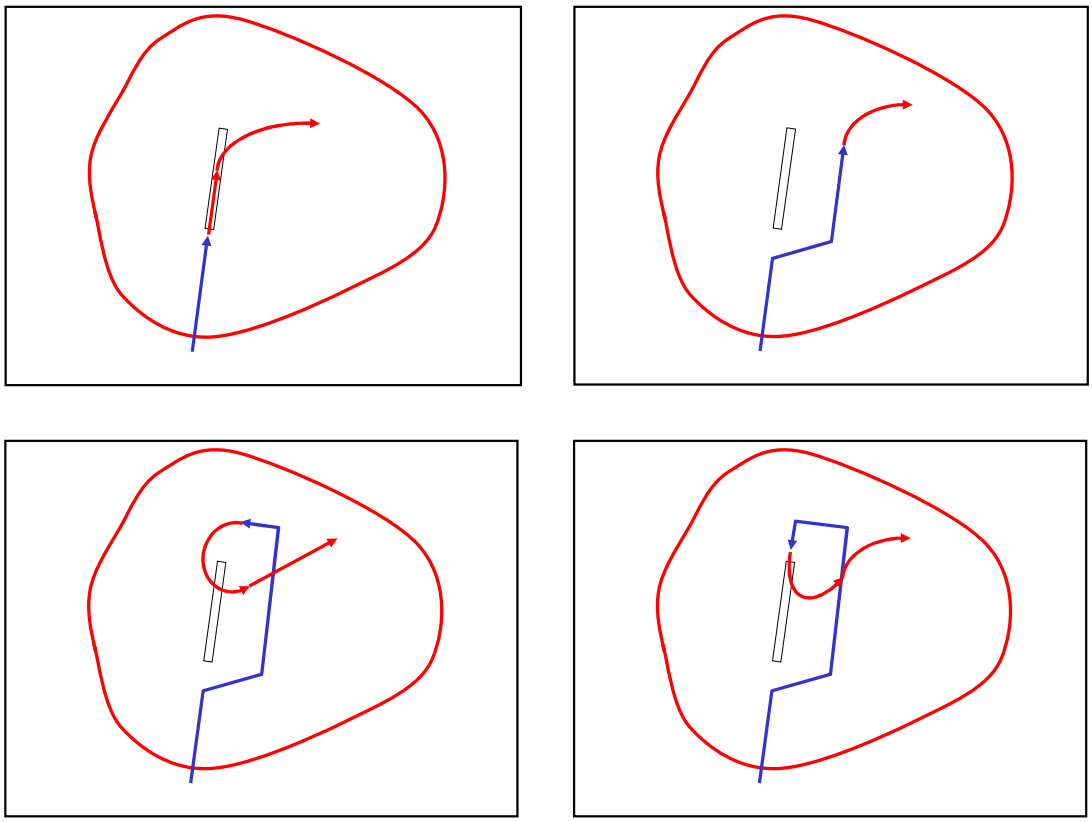
[2] See AIP The Netherlands AD2.EHAM 2.8.3 / 2.9.4.

Safety concerns

The transition from visual manoeuvring to the published instrument missed approach procedure was considered by many respondents to be inherently unsafe. The following issues were raised:

- ATC may be uncertain of how the crew will manoeuvre to join the instrument missed approach procedure.
- Re-entering cloud during the manoeuvre, losing visual reference, becoming disoriented and not properly performing the transition from the visual (circling) manoeuvre to the missed approach was reported as one of the biggest risks of circling approaches.
- If the aircraft is below the minimum vectoring altitude ATC may not be able to provide instructions. Best practice would be for an ATCO to reply to such a request by saying “Standard missed approach”, anything else could be inappropriate or a distraction to the pilot.

Depending on when and where the decision to go around is made, the initial climbing turn may allow aircraft to directly join the missed-approach course of the "instrument" runway; otherwise, the climbing turn may be continued - possibly for a full orbit - until the aircraft is suitably positioned to allow the missed approach track to be acquired. The uncertainty, associated with all these can be illustrated by the figure below:



One respondent suggested, that to overcome the above difficulties, there should be a standard visual go-around procedure developed and published (there is currently no such provision).

It was considered that the position of Missed Approach Point (MAPt) can have ‘safety significance’ because it is often close to the point where it may become apparent that the possibility of a circling approach will be precluded because of insufficient flight visibility. In this context, it was noted that some ATC units only allow one aircraft at a time to carry out a circling approach in order to avoid the possibility of two aircraft flying on opposing courses (one on final for landing, the other on initial approach to the opposite runway).