The Circling Approach in Theory and Practice

A handout based on the circling approach for RWY 07R at Addis Abeba, Ethiopia.

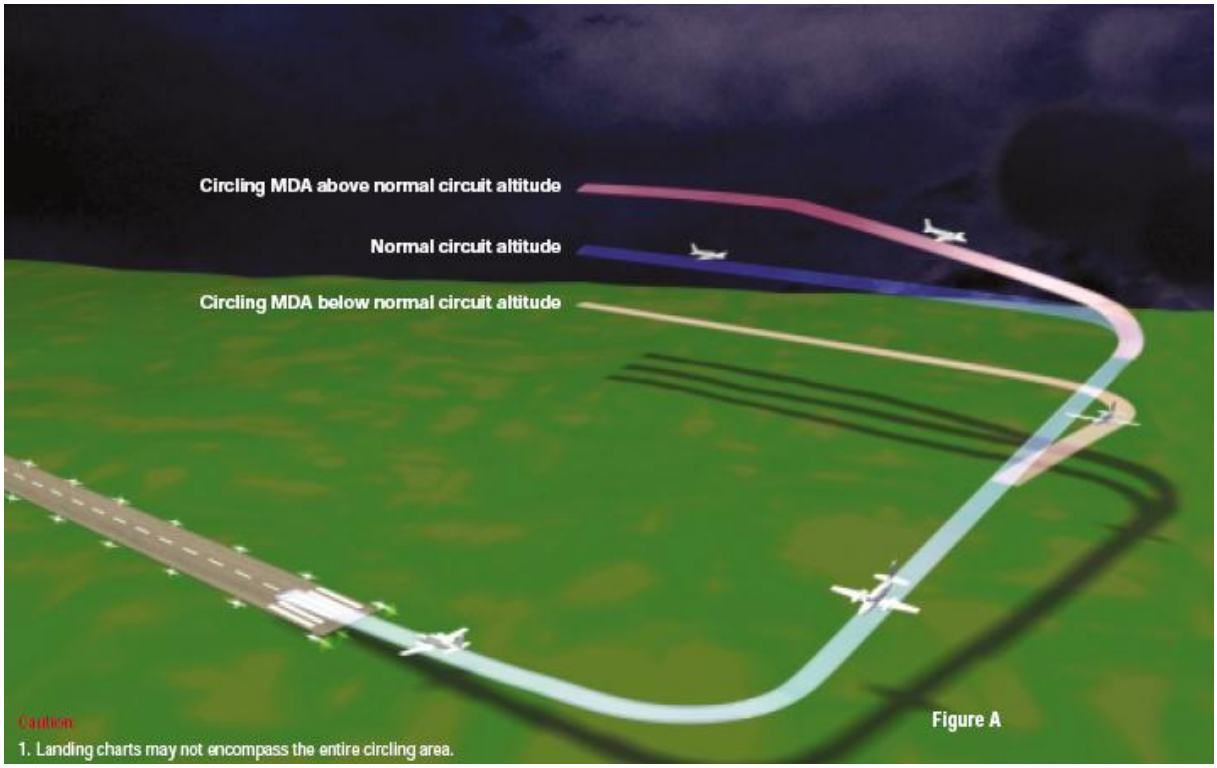

Figure A

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Introduction

A circling approach is an approach procedure which in general is only rarely flown. Possibly as a direct consequence of this, it can be shown that operational knowhow of circling approaches is markedly reduced. Knowledge how to fly these procedures with sufficient accuracy is no longer commonplace. Originally this briefing was written specifically for the B767. It is felt however that the contents is valid for all cat C and D aircraft types.
Current manuals and FCOM's are limited in description in theory and procedural execution of circling approach procedures. This briefing is an effort in correcting this shortcoming, specifically to increase the awareness of timing corrections which are needed to correct for the influence of wind. It is intended to supply additional information on top of the procedures that can be found in the operator's manuals and/or FCOM's.
Use of this information will be at all times the user's personal responsibility.

The circling approach procedure for Addis Abeba is well suited for this briefing since it will cover both the standard circling approach aspects as well as specific effects for a high altitude airport.

1. The operation into Addis Abeba is influenced by strong seasonal south-easterly winds which, if the GNSS approach for RWY07R cannot be used dictates a circling approach from the ILS approach to RWY25R.
2. High terrain surrounding the airport introduces the risk of a valid GPWS warning if the circling approach is not executed in the proper way (altitude, timing and tracking).

Circling approaches introduce relatively high workloads during all stages of the maneuver, especially on high altitude airports like Addis Ababa in view of the high True Air Speed. In this respect it is worthwhile to review the accident to an Air China B767 during approach to Busan, Korea on April 15th 2002. For additional information consult the Aviation Safety Network website via Aviation Safety Network: http://aviation-safety.net/database/record.php?id=20020415-0

"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 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.
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."

Source: **FLIGHT SAFETY AUSTRALIA, SEPTEMBER-OCTOBER 2001**

	Performance category	Approach speed	Radius of circling area	Obstacle clearance	Max speed for circling
ICAO STANDARD	A	up to 90kts	1.68nm	300ft	100kts
	B	91-120kts	2.66nm	300ft	135kts
	C	121-140kts	4.20nm	400ft	180kts
	D	141-165kts	5.28nm	400ft	205kts

Explanation

Assumptions:

1. The circling approach is explained using the Addis Ababa airport situation.
2. Circling configuration as per FCOM for your aircraft type.
3. IAS during initial approach and circling is 150 kts = 177 kts TAS
4. For calculations a Zero Wind condition is assumed therefore TAS = GS
5. TAS 177 kts eguals a horizontal distance of approximately 3 nm/min
6. 3º glidepath achieved with 900 ft/min ROD (GS x 5 + 50 = 900 ft/min)

Circling approach

A circling approach is an instrument letdown procedure (a so-called cloud break procedure) followed by a visual segment for landing, in general to a different runway than that of the instrument approach. It cannot be considered identical to a visual circuit. A circling approach is an instrument approach and can be flown as such. Only when descending below the MDA is the remainder of the approach and landing considered to be a visual maneuver. ***see note**

A well executed circling approach depends on preparation and planning. Consideration must be given to terrain, obstacles, instrument procedure, landing runway, go-around procedure, NOTAMS and local regulations. Also it is vital to think about who will fly the approach, which pattern will be flown, what the rates of descent and timings will be and when descent from the MDA must be initiated.

Autoflight

Maximum use of autoflight during circling will optimize monitoring of the approach by both pilots. Disengaging the autoflight system should only occur when starting descent below MDA. It is important to note that it may be specified in your company manuals that it is required to have visual contact with the runway during a circling approach. Also it is a requirement to have the runway in sight when leaving MDA. Obstacle clearance, which is minimum 400 ft during circling, is no longer assured from that point onwards and is the pilots responsibility.
It must be realized that:

- If visibility is limited and/or cloud height is near minimums for a circling maneuver
- Or operation is conducted at night time
- Or when knowledge of terrain and critical obstacles is limited
- Or any combination of the above

the operational risks of the circling maneuver will increase drastically.

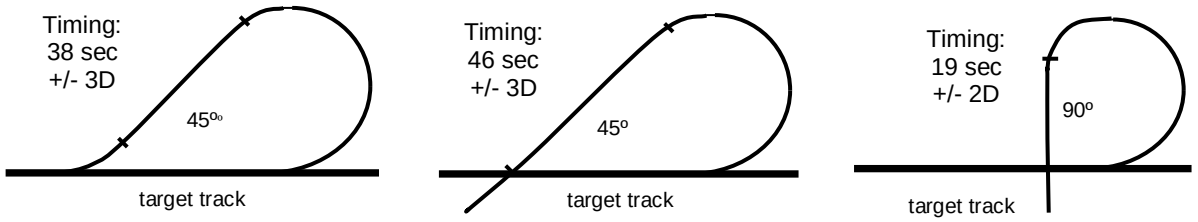
In case visual reference is lost a go-around is the only remaining option!

* **note:** This is an apparent discrepancy with the article of Flight Safety Australia where the focus is on maintaining those conditions to finish the approach visually. This briefing focuses on the fact that an accurately executed circling procedure - flown by reference to instruments – will give the highest probability of a correct lateral and vertical position to a safe visual final approach. Especially in the last part of the approach, the visual maneuvering, it is essential that the Pilot Monitoring will closely watch over rate of descent and correct visual glidepath. In this sense it is comparable to the final visual segment of any non-precision approach.

The circling pattern

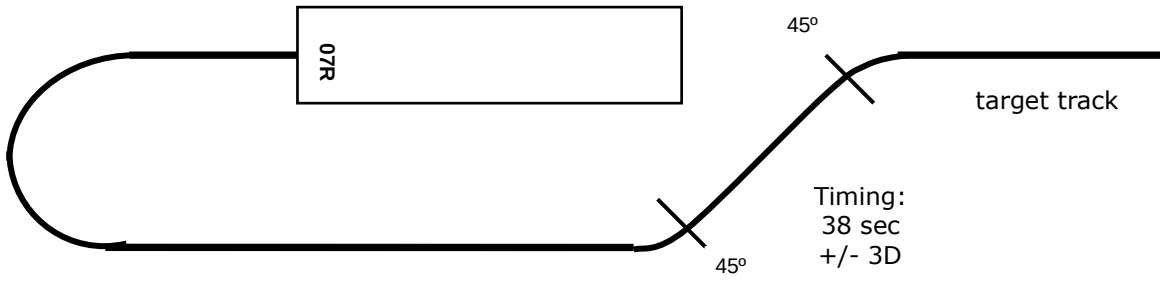
If no local rules apply considering the side of the downleg of the circling maneuver in relation to the landing runway it is advisable to be on the downwindside. In that case the base turn will be into the wind. The advantage will be that a possible overshoot of final is less likely than while maneuvering to land with a wind component in your back.

If the pattern direction has been determined the next step is to plan the route toward the downwind position for the landing runway.The following procedure turns are good tools to be considered:



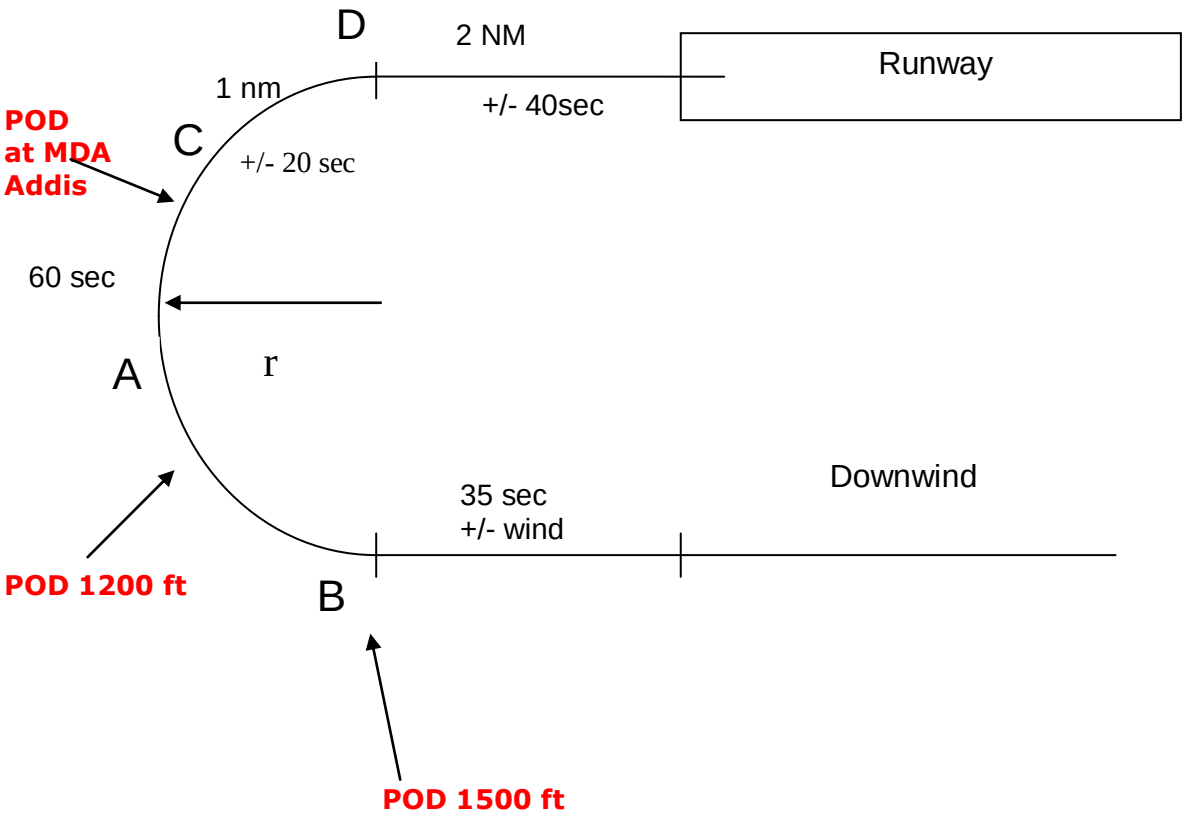
The "target track" in these figures is for example the runway track. Turns are standard rate-one turns at 25º angle of bank. The depicted courses are in fact tracks, therefore corrected for possible drift.

The first procedure is very useable in Addis Abeba to establish on a proper downwind distance in relation to the landing runway. While on the ILS for RWY25L establish the amount of Drift (difference between heading and localizer track) When on the circling MDA turn 45º in a southerly direction. When on this heading start timing. Timing is based on 38 seconds +/- 3x Drift .
Thereafter turn to establish downwind <u>track.</u>

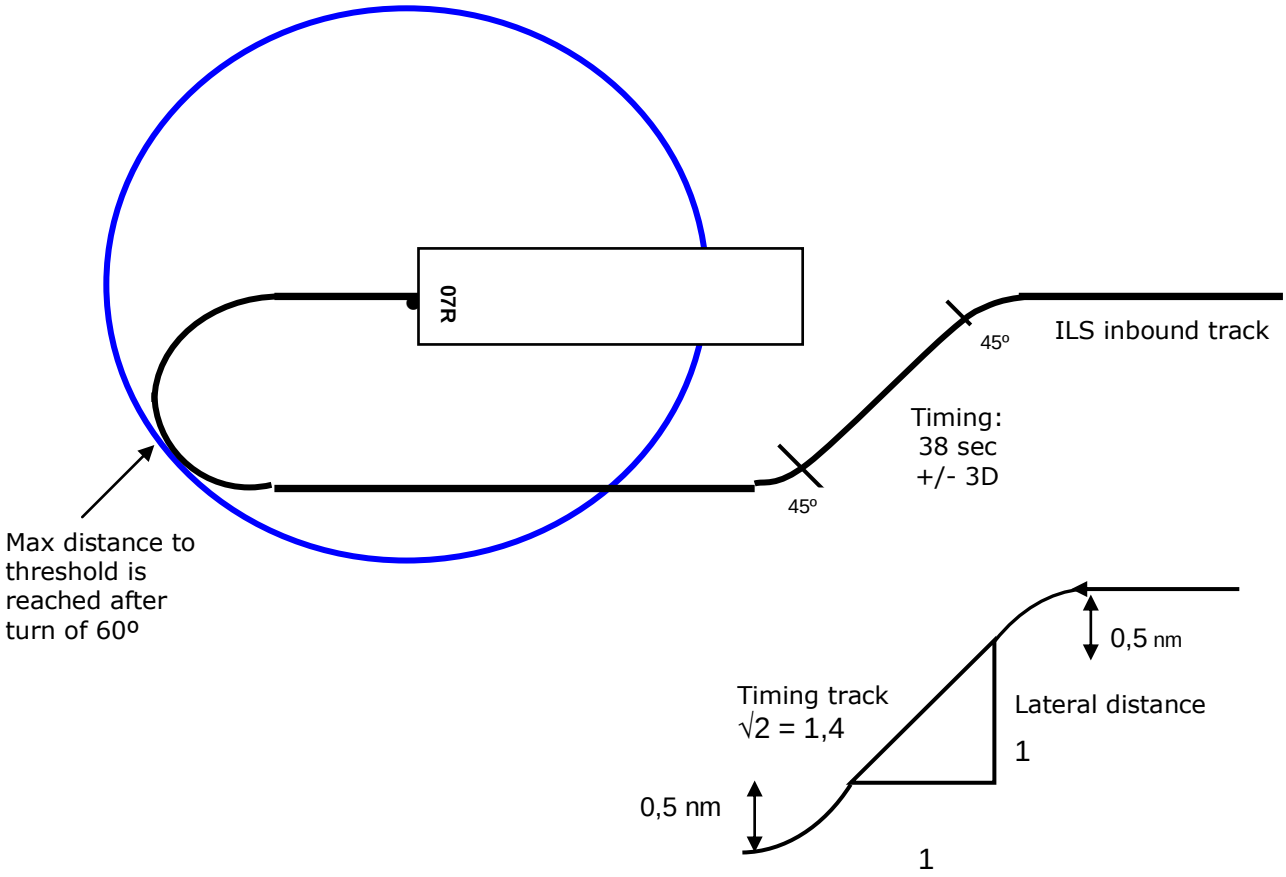


Point of Descent during the circling approach at Addis Ababa

The position of this point can be calculated as well. POD depends on the circling altitude.
In this example we will use three examples: a circling from 1000 ft HAA , from 1200 ft HAA and finally from 1500 ft HAA.
The required Vertical speed is set at 900 ft/min. This assumes a Groundspeed of 150 kts IAS resulting in a TAS of 175 kts. To maintain the 3º visual glidepath a rate of descent is required of 5 x GS + 50 = 850 + 50 = 900 ft/min.
A 3 degree Glidepath is 300 ft/nm. Therefore from 900 ft HAA a distance of 3 nm is flown. This is close to position C.
In the drawing the 1200 ft and 1500 ft POD's are shown as well.



Some pilots tend to use the NAV display to verify the correct downwind distance while circling. However the large difference in TAS between airports on sea level and high altitude airports like Addis will cause a significant difference in downwind distance.
From the timing used during circling the exact distance from the runway on downwind can be calculated as follows:

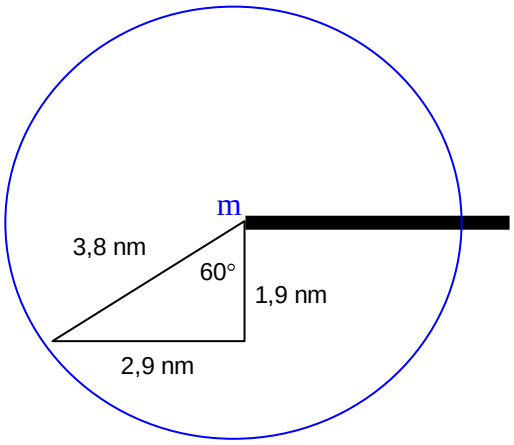


Timing : The airplane performs two turns with a 45° track change. Both turns will create a lateral displacement of 1 nm in total. The displacement on the timing track can be calculated as follows: If TAS is 180 kts this corresponds to 3 NM/Min. Timing 38 secs = 1,73 NM
The timing track distance and lateral distance relate as 1,4 to 1 (see drawing)
The lateral displacement is 1,7 / 1,4 = 1,2 NM. Total distance to the runway when on downwind is thus 2,2 NM.
The difference compared to the sea level distance will give the illusion of a wide downwind distance!

It must be stressed that an accurate timing will provide the optimum distance on downwind. This will create the best circumstances for a successful circling and avoid a possible overshoot of the final track.

Maximum distance from the threshold

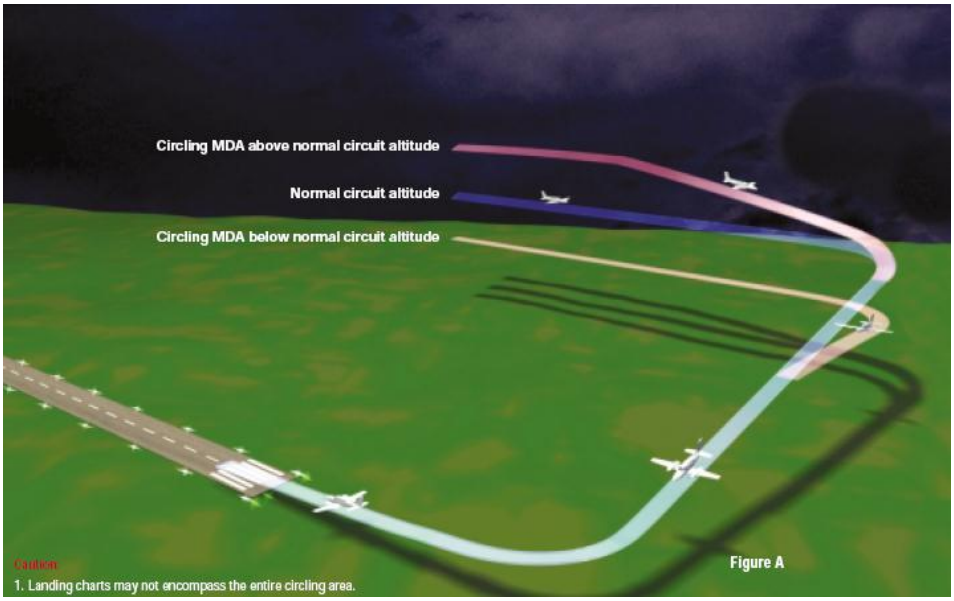
By drawing a circle from the threshold it becomes clear that the max distance is reached after the aircraft has completed 60° of the turn to final. It can be seen that this distance is 3,8 nm. This is within the circling area of 4,2 nm for cat C aircraft or 5,3 nm for cat D aircraft.



Conclusion:

Timing on downwind has to be accurate to avoid leaving the circling area
In order to retain visual contact with the runway at least 3,8 nm or 7 km visibility is required.
If a 1500 ft HAA circuit with corresponding timing is flown instead of a circling maneuver there is a significant risk of leaving the protected airspace of the circling maneuver
The obstacle clearance during circling of 400 ft is only available at MDA within the circling area.
If circling is done at a higher altitude than MDA the aircraft must still remain within the circling area.

To get a full understanding of the possible critical aspects of the circling area consult the approach chart for the ILS approach for RWY29 at Genoa (LIMJ) which is attachment 2 of this briefing. Observe the differences in circling altitude between a category C and category D aircraft. The difference is of course due the different circling areas and the terrain altitude difference. The cat C aircraft has a circling area of 4,2 nm. The cat D aircraft circling area is 5,3 nm. The published MDA's are 1360"and 2860"respectively. It is immediately obvious that an overshoot of the circling area by a cat C a/c will make a accident very likely.

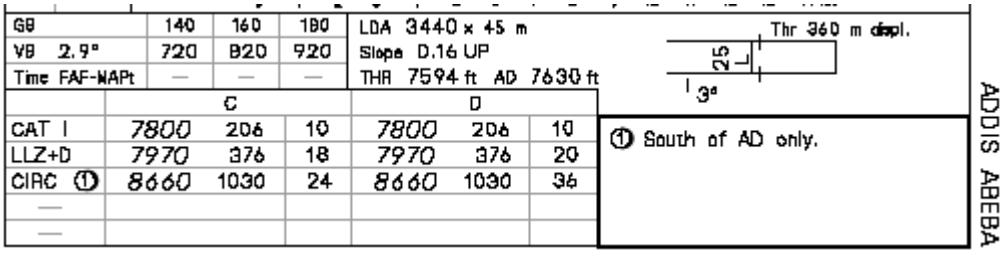


The Point of Descent will be reached earlier if circling above circling MDA while the lateral path remains unchanged.

FAQ circling approach Addis

See Attachment 1 ILS Approach RWY25L Addis Abeba

Actual weather : W/V 100/20 - VIS 5000 m - OVC 1600 ft - TEMP 20 / 10 - QNH 1007



GS		140	160	180	LDA 3440 x 45 m			
VS 2.9°		720	820	920	Slope 0.16 UP			
Time FAF-MAPt		—	—	—	THR 7594 ft AD 7630 ft			
		C			D			
CAT I		7800	206	10	7800	206	10	
LLZ+D		7970	376	18	7970	376	20	
CIRC ①		8660	1030	24	8660	1030	36	
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Questions:

1. At which point is the start of the circling approach?
2. What is the distance to the runway when the aircraft is at the circling MDA of 1000 ft HAA ?
3. Is the runway visible at this point ?
4. Is it allowed to continue in level flight until the runway is in sight?
5. Is it allowed to circle at a greater altitude than MDA if weather conditions are CAVOK ?
6. What is the true altitude when leveling off at circling MDA when airport temperature is 20°C?
7. Is it allowed to adjust the MDA in case of temperature deviation from ISA?
8. If circling is performed at an height of 1500 ft HAA what is the required timing when abeam the threshold from the landing runway?
9. Is a visual circuit allowed instead of a circling maneuver?
10. Is a visual circuit allowed at 1500 ft HAA if this requires a standard timing of 45 seconds?
11. Is the circling procedure limited by the size of the circling area?
12. The aerodrome information contains a note indicating the Papi cannot be used when more than 4 nm from the threshold. Is this note relevant while circling?
13. Is it possible to keep the runway in sight if the visibility is at circling minimums (3600 m) ?
14. If visual contact is lost during circling a goaround is mandatory. Is this correct?
15. Final flapsetting is selected at which point during circling?

Answers:

1. Circling approach can be commenced when entering the circling area. For a cat D aircraft this will be at 5,3 nm from a runway threshold reference point. When circling at 1000 ft HAA the a/c will be at 3,3 nm from the instrument runway and is circling always possible. This also shows that at altitudes over 1500 ft HAA the circling maneuver must be delayed in order to the circling area first.

2. A 3 degree glidepath is equivalent to 300 ft/nm. ADD circling is at 1000 ft HAA which means 3,3 nm to the touchwdown point of the ILS runway.

3. During circling at the MDA of 1000 HAA the a/c is at 3,3 nm from touchdown. This equivalent to 6 km. The minimum required visibility is 3600 nm wich is 2nm. In order to observe the runway the a/c has to continue inbound on the localizer. However during circling when at downwind visual contact with the runway will be lost when the visibility is only 3600 m. A minimum of approximately 7 km is needed to ensure visual contact with the runway at all times while circling. See the answers of questions 11+14.

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4. Yes if remaining within the circling area. Obstacle clearance of 400 ft is guaranteed within the circling area.

5. Yes. The circling maneuver and timings must be executed conform FCOM specifications in such a way that the aircraft remains within the circling area . Extending downwind is therefore not allowed in order to retain obstacle clearance.

6. If landing at ADD with the proper QNH the altimeter will indicate the airport elevation. This means that the temperature deviation from ISA is already included in the QNH. The only correction would be concerning the column of air between the airport and the aircraft while circling (1000 ft)
<u>However the correction of the altimeter if OAT is above ISA is not permitted.</u>

7. Correction of the MDA in case of temperatures <u>above</u> ISA is <u>not</u> permitted.

8. Unchanged (35 sec +/- wind correction)

9. Yes but timing of the horizontal path must be based on the circling timing. See answer nr 5

10. No. See answers 5 + 9

11. No: theoretical maximum distance is about 3,8 nm if the correct timings are applied.

12. No. As soon as the Papi is visible the aircraft is no further away than 3 nm from the runway.

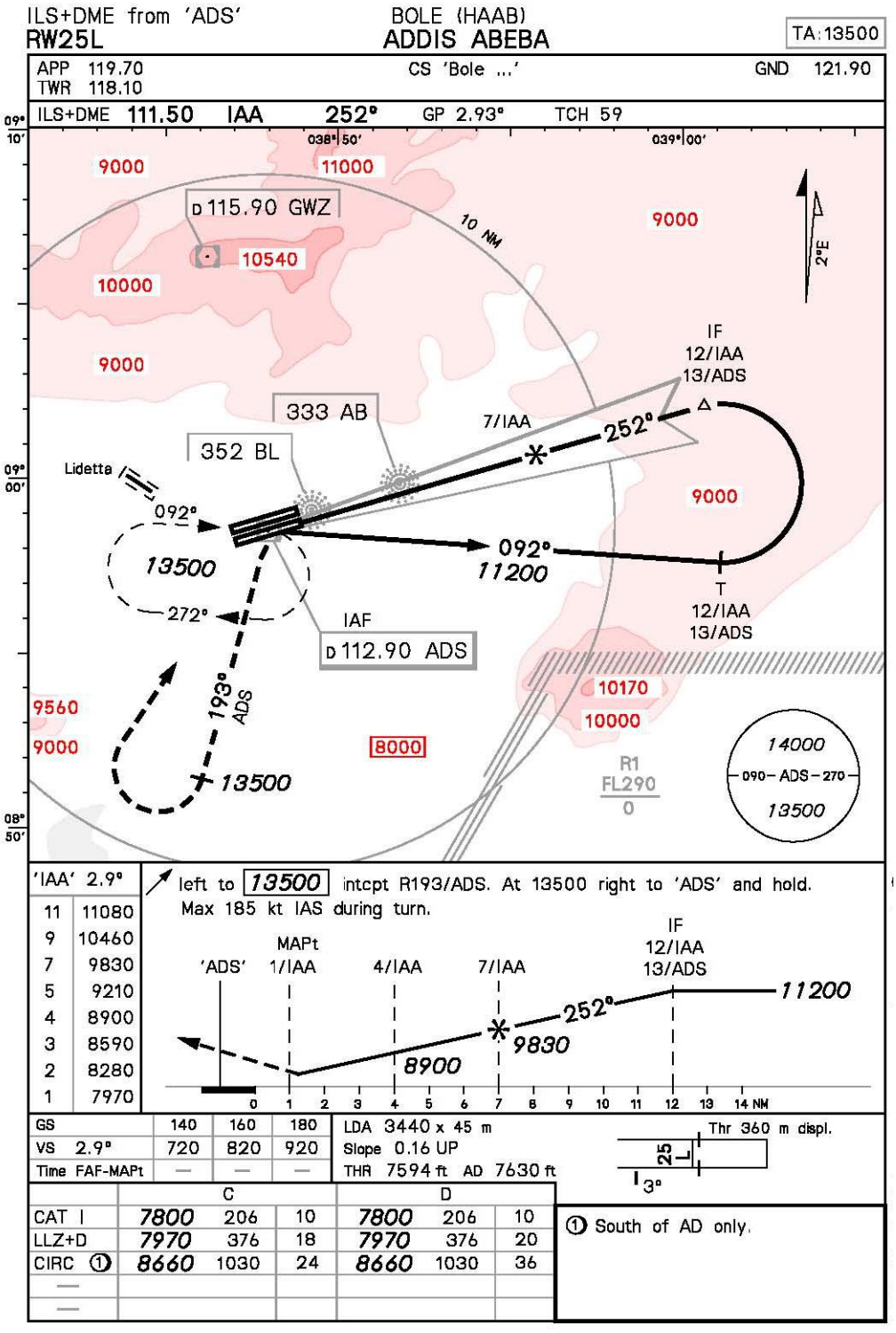
13. No. In view of the distance on downwind to the runway of about 2,4 nm it is very likely that visual contact with the runway will be lost.

14. The circling will remain safe whilst in the circling area and at MDA. However if either of these conditions is no longer fulfilled a Go Around is mandatory when contact with the runway is lost.

15. The final confguration must be slected when intercepting the visual glidepath. Level flight in final configuration is not recommended..

Note:
During circling at ADD the rado altimeter height will increase when starting the turn towards downwind. This is caused by the decreasing terrain height to the south of the airport. The radio altitude may increase by as much as 500 ft. Be aware not to base timings and Point of Descent on this indication !

Attachment 1



Attachment 2