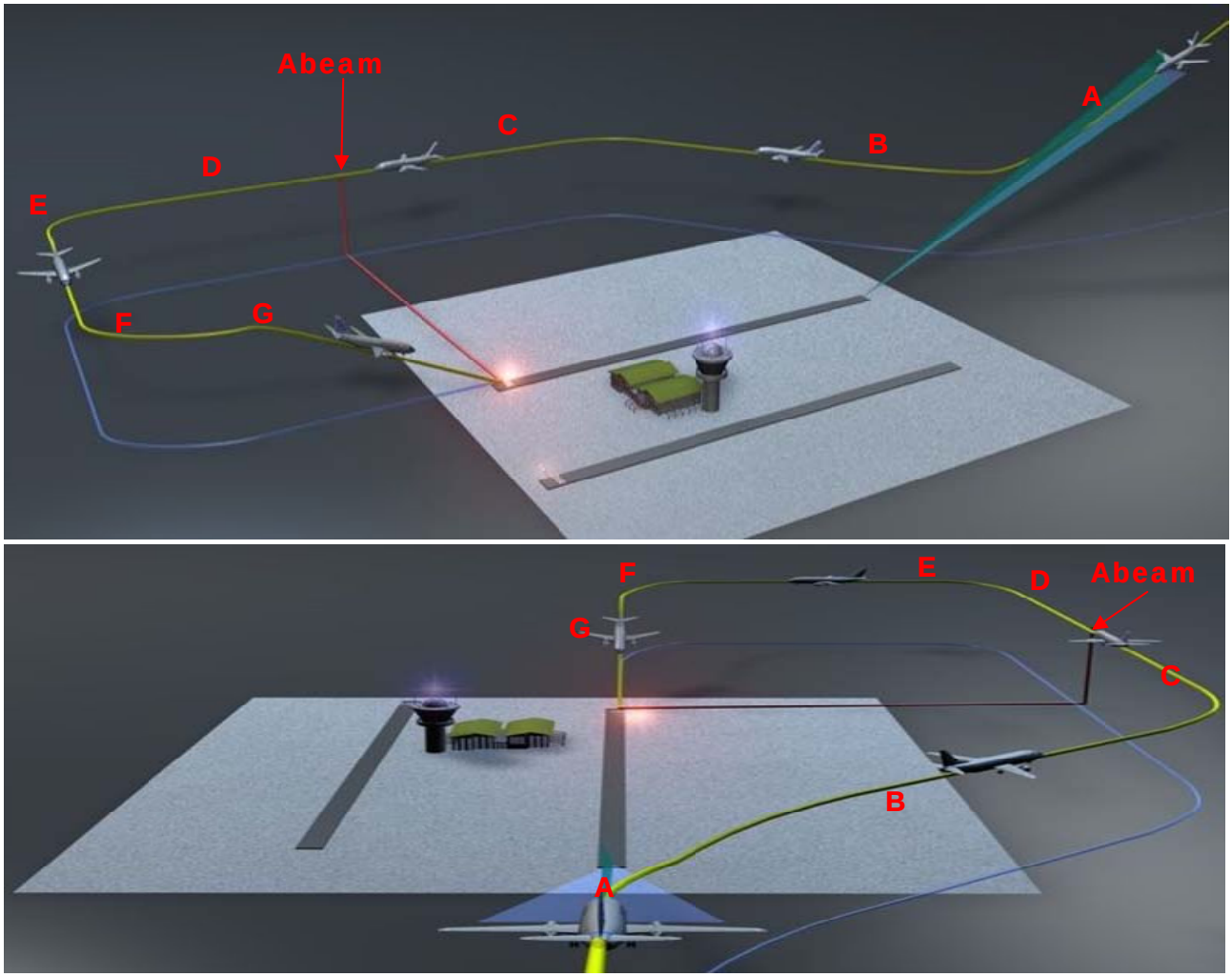
APPROACH : CIRCLE TO LAND

Circle to land is a difficult approach maneuver for which you need a good understanding of how to read charts and flying skills.

In essence its a procedure where a straight in landing is not possible or allowed at the moment so before we get into the details lets explain the basics as depicted below. In the picture we see that we are pretending to land at a certain runway. We follow the rules for that normal approach whether its an ILS approach or an VOR or NDB approach. When we have reached a certain minimum altitude we break out (circling), fly parallel to the runway, turn back and land on the other side of the runway.



A: We are on the approach. When reaching the MDA (Minimum descent altitude) we break out (circling) with a heading + 45°.

B: we fly the new heading for approx 30 sec.

C: We turn back to the heading now parallel of the runway

D: When we pass the threshold (Abeam point) we continue for approx 20-40 seconds before we will turn to base. Be careful not to wonder off too far because there are rules for the maximum distance to the threshold (more about that later)

E: We turn base constantly keeping an eye on the runway.

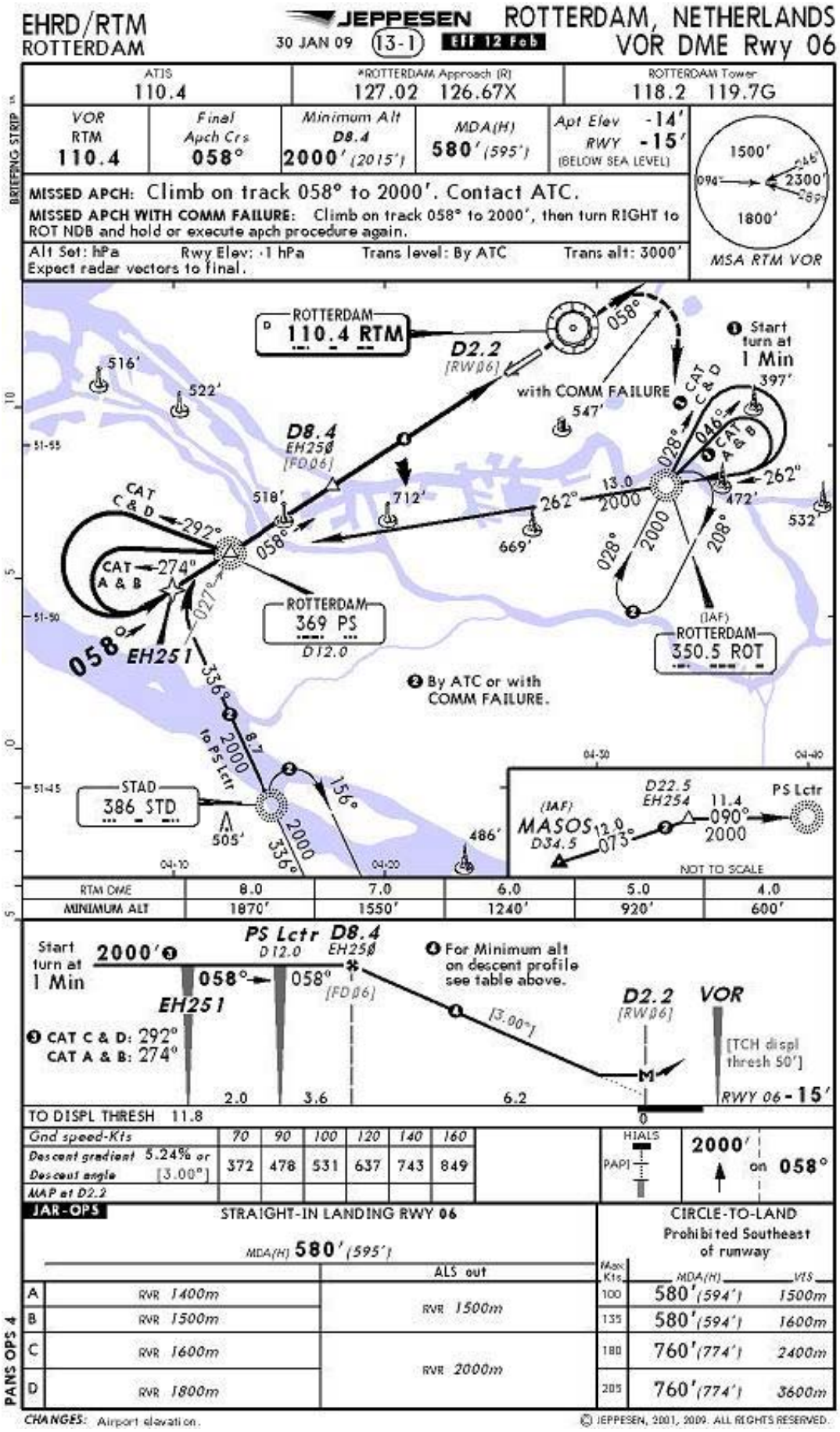
F: We turn final

G: once stabilized on our turn to final we start our descent and land (if clearance received of course)

This is just one of the many circling procedures but its the most common.

Now you understand the basics behind it ....lets quickly look into the exact details and learn to fly it like a professional.

We use a VOR DME approach at Rotterdam airport (EHRD) to runway 06, and we use a procedural Circle To Land for runway 24 where we eventually land.
Because we are going to land on runway 24, you should use the Circle To Land procedure for that runway and not the Circle To Land for runway 06. The Circle To Land procedures are at the bottom right side of each Jeppesen Charts.


EHRD/RTM
ROTTERDAM
JEPPESEN
30 JAN 09
13-1
Eff 12 Feb
ROTTERDAM, NETHERLANDS
VOR DME Rwy 06
ATIS 110.4
*ROTTERDAM Approach (R) 127.02 126.67X
ROTTERDAM Tower 118.2 119.7G
VOR RTM 110.4
Final Apch Crs 058°
Minimum Alt D8.4 2000' (2015')
MDA(H) 580' (595')
Apt Elev -14'
RWY -15'
(BELOW SEA LEVEL)
MISSED APCH: Climb on track 058° to 2000'. Contact ATC.
MISSED APCH WITH COMM FAILURE: Climb on track 058° to 2000', then turn RIGHT to ROT NDB and hold or execute apch procedure again.
Alt Set: hPa Rwy Elev: -1 hPa Trans level: By ATC Trans alt: 3000'
Expect radar vectors to final.
1500'
2300'
1800'
MSA RTM VOR
ROTTERDAM
110.4 RTM
D2.2
[RW06]
with COMM FAILURE
Start turn at 1 Min
D8.4
EH250
[FD06]
CAT C & D
CAT A & B
058°
292°
274°
027°
336°
156°
262°
028°
046°
208°
ROTTERDAM
369 PS
D12.0
ROTTERDAM
350.5 ROT
(IAF)
By ATC or with COMM FAILURE.
EH251
2000
to PS Lctr
8.7
13.0
STAD
386 STD
505'
516'
522'
518'
712'
669'
547'
397'
472'
532'
486'
51-55
51-50
51-45
04-10
04-20
04-30
04-40
D22.5
EH254
11.4
PS Lctr
(IAF)
MASOS
D34.5
12.0
090°
073°
NOT TO SCALE
RTM DME 8.0 7.0 6.0 5.0 4.0
MINIMUM ALT 1870' 1550' 1240' 920' 600'
Start turn at 1 Min
2000'
PS Lctr D12.0
D8.4 EH250
058°
058° [FD06]
EH251
CAT C & D: 292°
CAT A & B: 274°
For Minimum alt on descent profile see table above.
[3.00°]
D2.2 [RW06]
VOR
[TCH displ thresh 50']
RWY 06 -15'
2.0
3.6
6.2
TO DISPL THRESH 11.8
Gnd speed-Kts 70 90 100 120 140 160
Descent gradient 5.24% or
Descent angle [3.00°]
MAP at D2.2
372 478 531 637 743 849
HIALS
PAPI
2000' on 058°
JAR-OPS
STRAIGHT-IN LANDING RWY 06
MDA(H) 580' (595')
ALS out
CIRCLE-TO-LAND
Prohibited Southeast of runway
Max Kts
MDA(H)
VIS
A RVR 1400m RVR 1500m 100 580' (594') 1500m
B RVR 1500m 135 580' (594') 1600m
C RVR 1600m RVR 2000m 180 760' (774') 2400m
D RVR 1800m 205 760' (774') 3600m
PANS OPS 4
CHANGES: Airport elevation.
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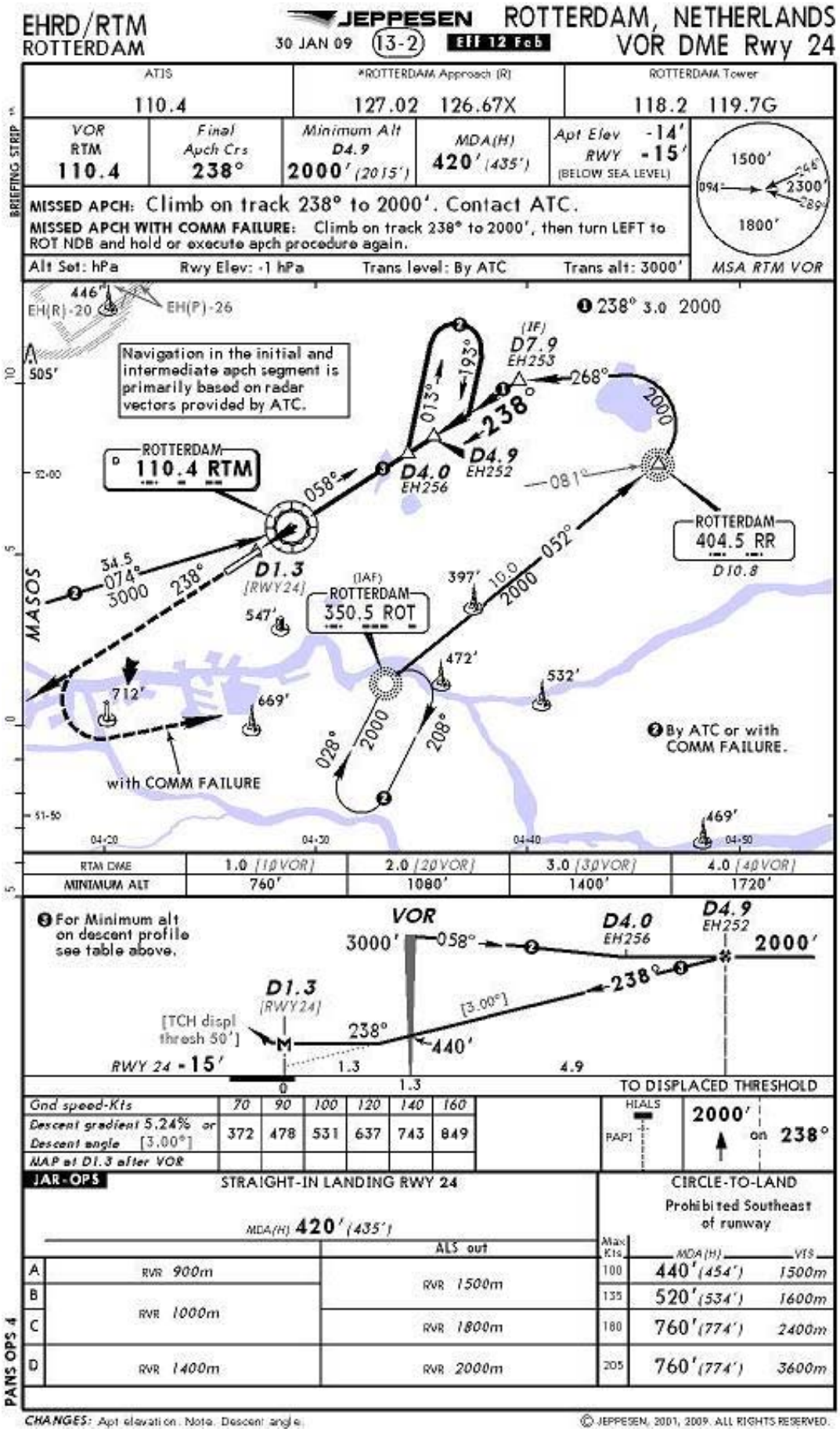
EHRD/RTM
ROTTERDAM
JEPPESEN
30 JAN 09
13-2
Eff 12 Feb
ROTTERDAM, NETHERLANDS
VOR DME Rwy 24
ATIS
110.4
ROTTERDAM Approach (R)
127.02 126.67X
ROTTERDAM Tower
118.2 119.7G
VOR RTM 110.4
Final Apch Crs 238°
Minimum Alt D4.9 2000' (2015')
MDA(H) 420' (435')
Apt Elev -14'
RWY -15'
(BELOW SEA LEVEL)
MISSED APCH: Climb on track 238° to 2000'. Contact ATC.
MISSED APCH WITH COMM FAILURE: Climb on track 238° to 2000', then turn LEFT to ROT NDB and hold or execute apch procedure again.
Alt Set: hPa
Rwy Elev: -1 hPa
Trans level: By ATC
Trans alt: 3000'
MSA RTM VOR
1500'
2300'
1800'
094
BRIEFING STRIP
Navigation in the initial and intermediate apch segment is primarily based on radar vectors provided by ATC.
ROTTERDAM 110.4 RTM
ROTTERDAM 404.5 RR
D10.8
ROTTERDAM 350.5 ROT
(IF)
(IAF)
D7.9 EH253
D4.0 EH256
D4.9 EH252
D1.3 (RWY24)
MASOS
238° 3.0 2000
By ATC or with COMM FAILURE.
with COMM FAILURE
RTM DME
1.0 (10 VOR)
2.0 (20 VOR)
3.0 (30 VOR)
4.0 (40 VOR)
MINIMUM ALT
760'
1080'
1400'
1720'
For Minimum alt on descent profile see table above.
VOR
3000'
D4.0 EH256
D4.9 EH252
2000'
D1.3 (RWY24)
[TCH displ thresh 50']
RWY 24 -15'
[3.00°]
238°
440'
TO DISPLACED THRESHOLD
Gnd speed-Kts 70 90 100 120 140 160
Descent gradient 5.24% or Descent angle [3.00°] 372 478 531 637 743 849
MAP at D1.3 after VOR
HIALS
PAPI
2000' on 238°
JAR-OPS
STRAIGHT-IN LANDING RWY 24
MDA(H) 420' (435')
ALS out
CIRCLE-TO-LAND
Prohibited Southeast of runway
Max Kts
MDA(H)
VIS
A RVR 900m RVR 1500m 100 440' (454') 1500m
B RVR 1000m 135 520' (534') 1600m
C RVR 1800m 180 760' (774') 2400m
D RVR 1400m RVR 2000m 205 760' (774') 3600m
PANS OPS 4
CHANGES: Apt elevation. Note. Descent angle.
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In our example we will fly a classic circling to land procedure while flying a Boeing 737.

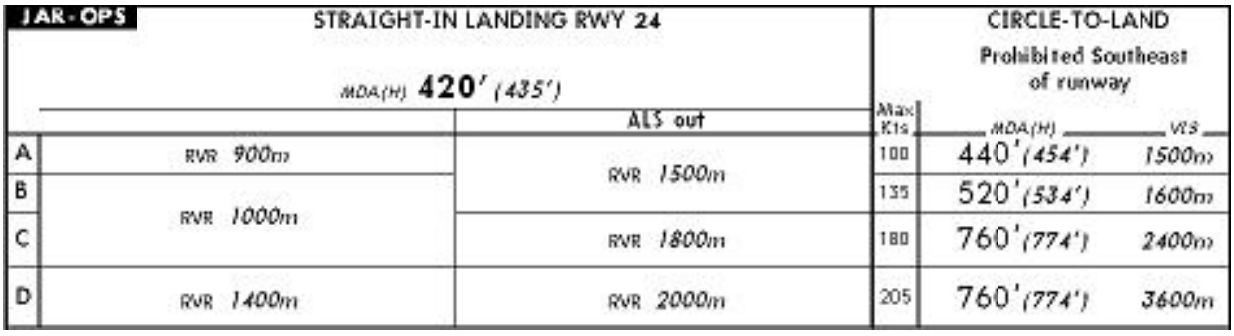
THE INSTRUCTION

Approach	" KLM965, you are cleared for the VOR-DME approach 06, circle to land runway 24, report field in sight"
Pilot	Cleared VOR-DME approach 06, circle to land runway 24,Wilco report field in sight, KLM965"

With the above ATC transmission it is clear that we have to implement a VOR DME approach for EHRD (runway 06), and that we have to carry out a CIRCLE TO LAND procedure for runway 24 where we can land later.

RULES AND PREPARATIONS

Now lets have a look what the charts say at the bottom right of chart 24 !!!!



JAR-OPS	STRAIGHT-IN LANDING RWY 24 MDA(H) 420' (435')		CIRCLE-TO-LAND Prohibited Southeast of runway		
		ALS out	Max Kts	MDA(H)	VIS
A	RVR 900m	RVR 1500m	100	440' (454')	1500m
B	RVR 1000m		135	520' (534')	1600m
C		RVR 1800m	180	760' (774')	2400m
D	RVR 1400m	RVR 2000m	205	760' (774')	3600m

- We are looking for the Minimum descent altitude (MDA). This altitude is subject to the category of aircraft you are flying. With our Boeing 737 (category C aircraft) DO NOT descent below 760 feet and maintain this altitude during the circling procedure until we turn final.

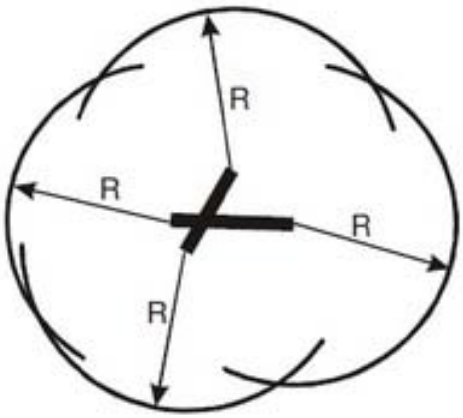
  Pilots should remain at or above the circling altitude until the aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal manoeuvres.

- The speed during the circling for our Cat.C aircraft is MAXIMUM 180 kts.
- The runway Visual Range (RVR) must be at least 2400m ... so don't forget to check the METAR! If its foggy, low visibility, clouds at 600 ft...forget it! Hence, the circling to land procedure is a NON-precision approach
- Circle to land is prohibited Southeast of the runway. So this means we must brake out 45 degrees to the LEFT when approaching rwy 06.

Circling Approach AREA RADII

As we said before, during the circling procedure you need to stay within a certain limit of distance from the threshold of the runway where you are going to land. The maximum distance from the threshold (RADIUS) is based on the aircraft category.

In our case with the B737 ...category C aircraft....we need to stay within a radius distance of 4.2 nm from the threshold. And this means INCLUDING the turn back to the runway...so don't overshoot...stay within the circle!



Radius of the arcs (R) varies with the aircraft category

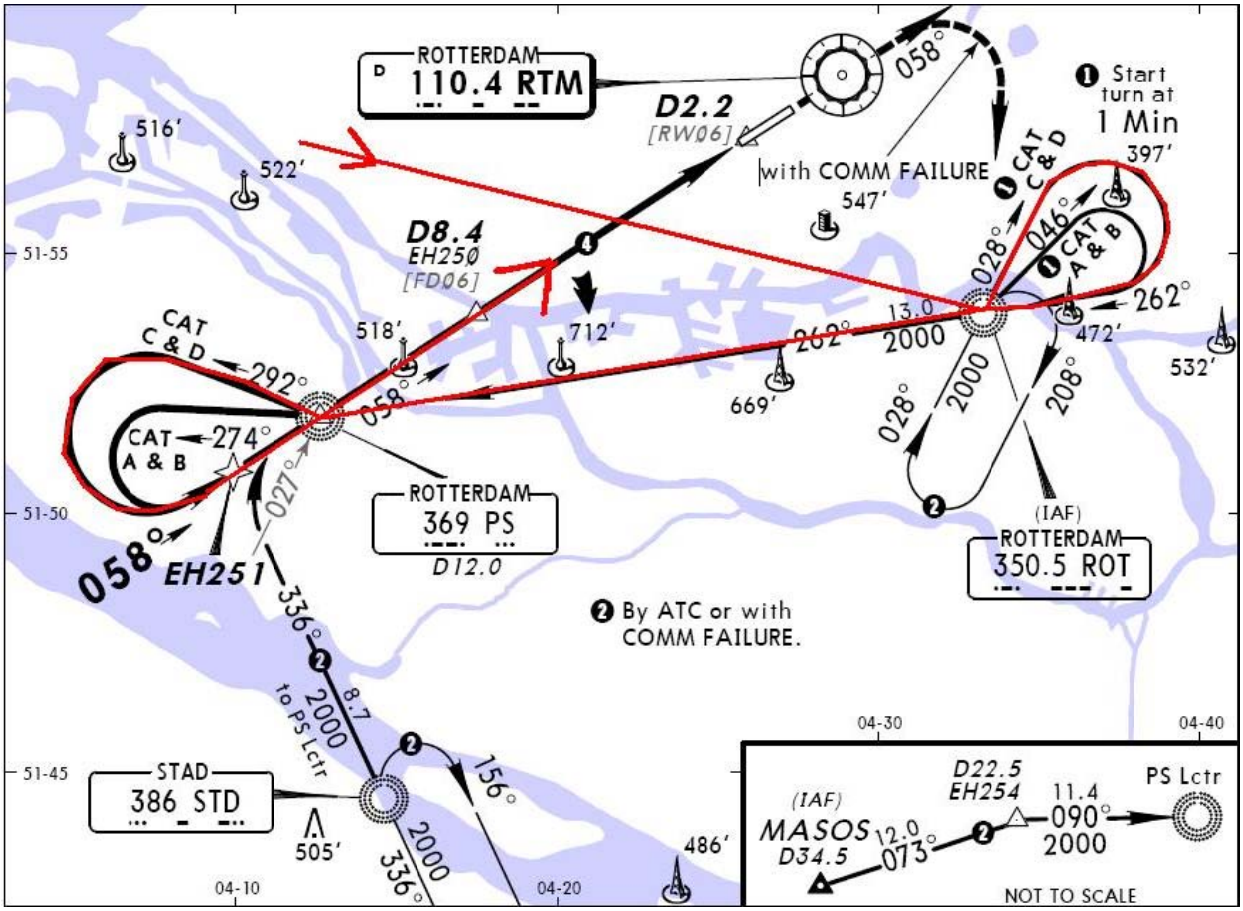
ARC RADIUS		
Aircraft category	**IAS at threshold**	**RADIUS**
Category A	< 91 kts	1,65 Nm
Category B	91 – 120 kts	2,66 Nm
Category C	121 – 140 kts	4,20 Nm
Category D	141 – 165 kts	5,28 Nm
Category E	166 – 210 kts	6,94 Nm

Before we start flying the procedure, lets summarize our circling to land procedure at Rotterdam:

- A circle to land is a NON-Precision approach.
- You should never descent lower than is permitted by the MDA (AGL height).
- You must be 2 NM from the runway when diverting to the left .
- To turn from the opposite approach runway (in our case runway 06), you must make a 45-degree turn to the left and then make a cross wind leg (fly in line with the runway)
- You cannot go beyond 4.2NM from the threshold of the runway 24 including the turn to the final base leg.

Lets FLY:

We now have a look at the map for the VOR DME approach 06, the runway that we have to use for the approach:



In our example we approach from the West towards the ROT NDB where the IAF begins. On the charts we see a HOLD at ROT NDB.

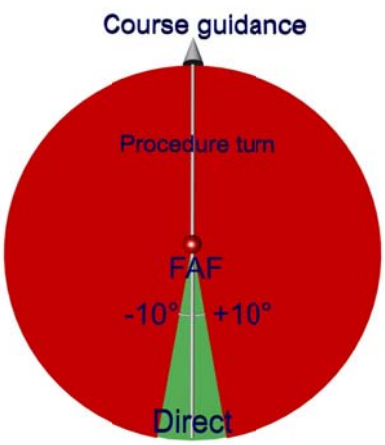
The base heading we fly towards ROT NDB is very important for our descision whether or not to perform a procedure turn.

<u>What where the rules again for the procedure turn???</u>

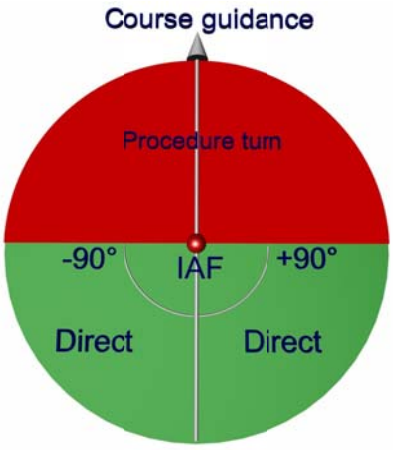
The angle between you current heading and the course guidance

Max 10° on a FAF
Max 90° on a IAF precision approach
Max 120° on a IAF non-precision approach

The approach segment starts with the IAF (Initial apporach fix) and ends at the IF (Intermediate Approach fix).....Within this segment course guidance is given. The angle, in which the predescribed ground course must be intercepted is maximum 90° for a precision approach (ILS / MLS) and 120° for a non-precision approach.

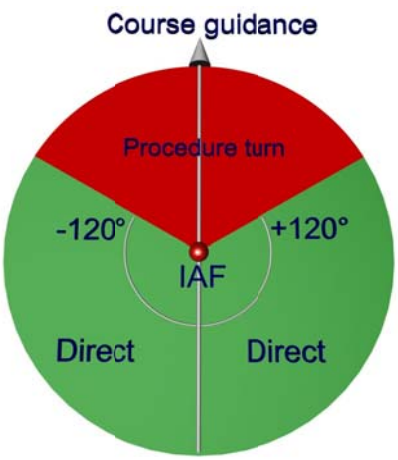


FAF



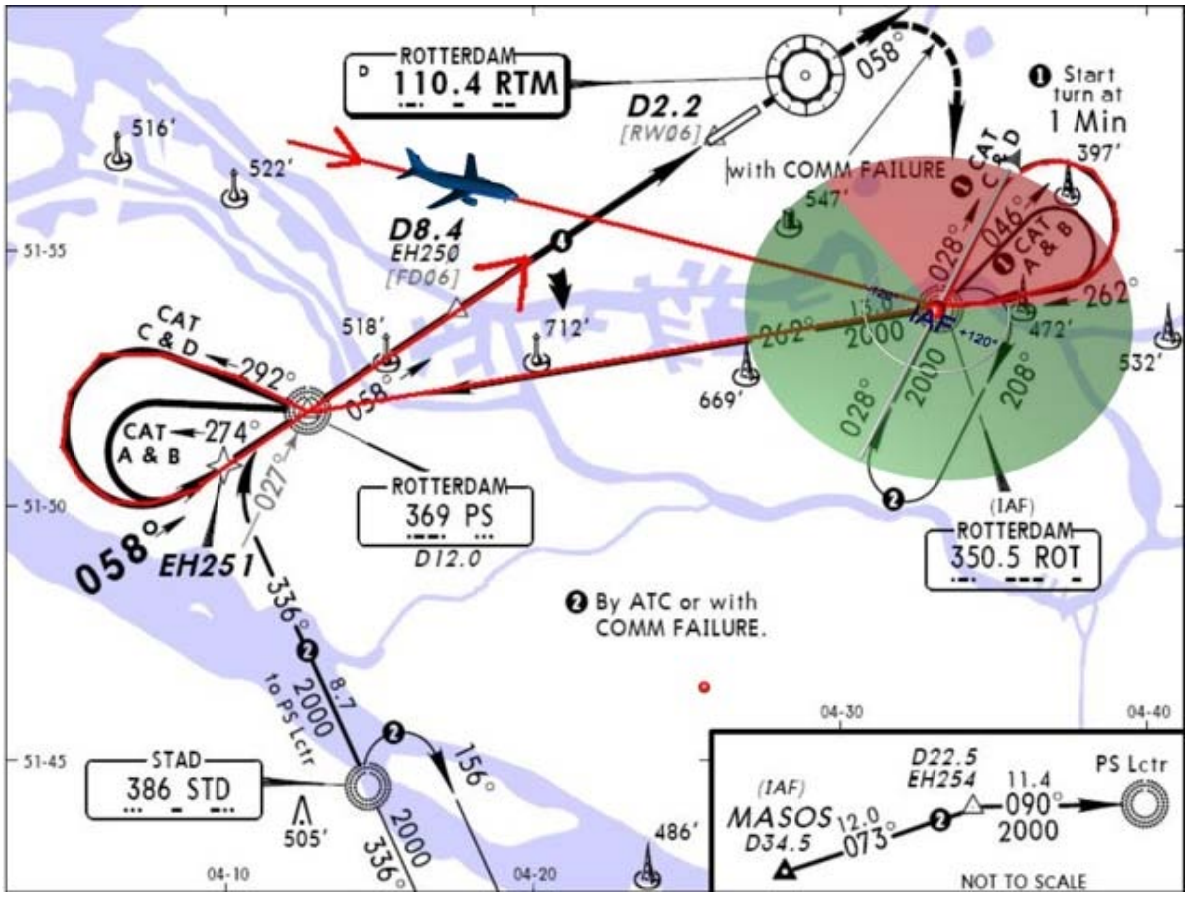
IAF

Precision Approach



IAF

Non-Precision Approach



In case of our Rotterdam approach: ROT is the IAF for the VOR DME approach runway 06 (Non precision) . Course guidance is given, so the IAF complies to the requirements mentioned . You are allowed, **arriving** from an INBOUND track between 028+180 -120 = 88° and 028+180 +120 = 328° continue directly on track 028°. We are comming in from the West with a heading of approx. 110°. We can continue with the procedure without the procedure turn.

Only when your heading is **MORE** than 328° but **LESS** than 88°, you must use the racetrack for a procedure turn before you continue your flight on a heading of 028° for the CAT C&D (or CAT A&B) for 1 minute.

REMEMBER: continue only when you already have received your clearance for the VOR DME approach , otherwise enter the HOLD and wait for further instructions from ATC !

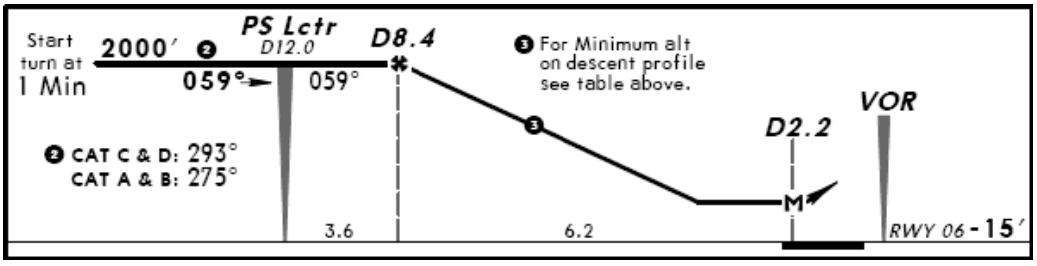
After passing ROT NDB we continue flying heading 028 for 1 minute after which we can make the turn back to the station ROT

After ROT NDB we maintain our heading of 262° and direct PS NDB. Remember that you must always make wind related adjustments

Arriving at PS NDB we fly heading 292 (CAT C, where our aircraft belongs).
If you have a CAT A aircraft the heading will be 274.
The time to fly the 292 degrees is not on the charts but you can always assume that you must hold your heading for 1 minute.

After that minute of heading 292, we turn to the left to return to PS.
PS NDB is aligned with RTM through a VOR radial of 058 degrees.
We may therefore, to prevent misunderstandings, be better off flying a 238 degrees Inbound radial from PS so you are lined up to RTM VOR
(to fly a radial ,we refer you to the appropriate course).

Once we have intercepted the radial we must keep in mind when to start our descent. Lets have a look at the profile veiw of the VOR DME chart rwy 06



We read that at 8.4 NM from the RTM VOR station we may start our descent. Every aircraft has a certain response time so in Practice start a little bit earlier like 0.2 nm before otherwise you can not maintain the correct descent profile!

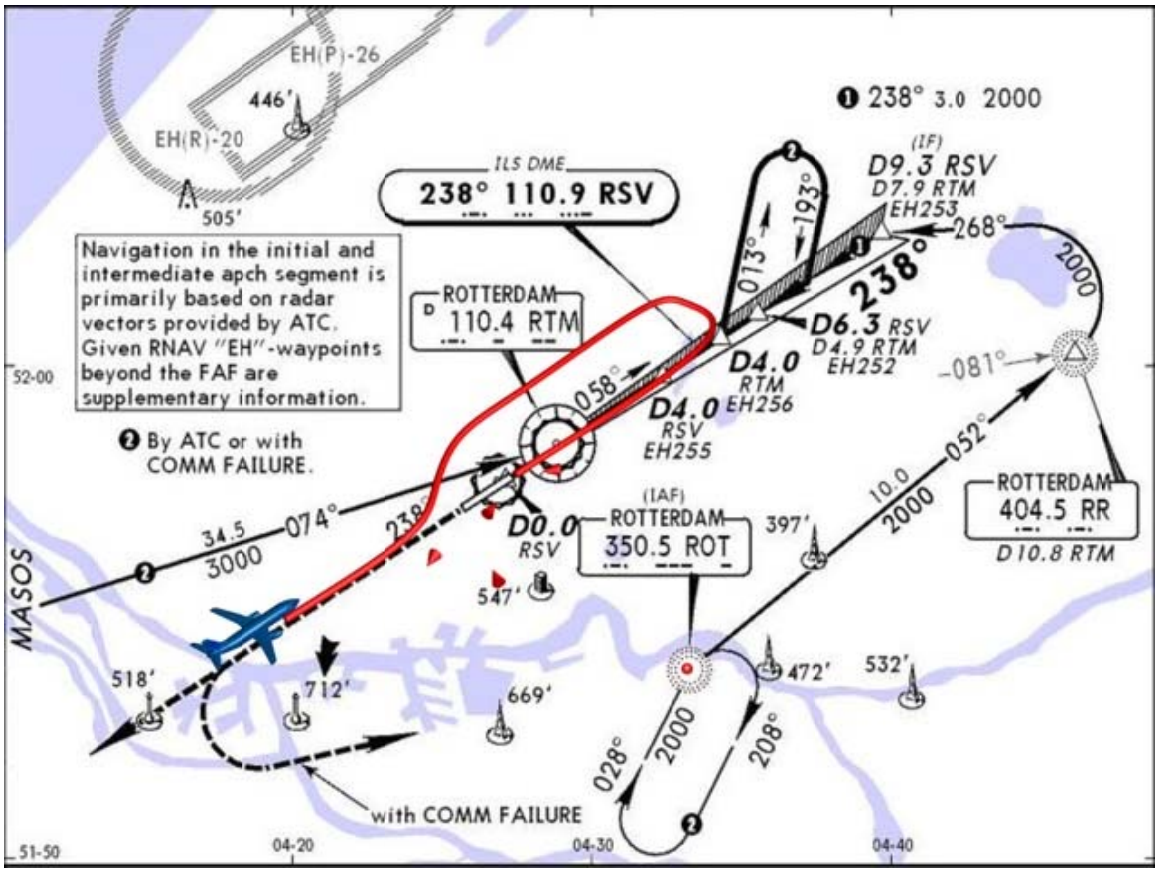
Gnd speed-Kts	70	90	100	120	140	160
Descent Gradient 5.2%	369	474	527	632	737	843
MAP at D2.2						

The descent itself with our 160kts groundspeed equals 843 feet per minute (800 feet per minute rounded off).

We are in the descent and arrive at the previously discussed MDA.
This is the point where we would start the Circle To Land procedure.
We must therefore at our speed not descent lower than 760 feet and just before we reach that height we have to make a turn to the left (right was not allowed at EHRD) with an angle of 45 degrees. Dont forget to compensate for wind corrections.

Bear in mind that you must start that turn of 45 degrees before and not when you reach 760 feet. We had a heading of 058. The correct heading is 58 minus 45 = 013 degrees heading.

Throughout the whole procedure until establish on final, you must stick to the MDA of 760 feet.



You see on the map that we have to fly a type of Traffic Pattern for this Circle To Land. Try not to deviate too far from your runway as you fly heading 013. It is a sense of feeling at this point.
Don't fly to close to runway when flying downwind, this will only create problems when turning in to the final leg. (Your angle will be to tight)

After flying heading 013 turn back to heading 058 to fly parallel to the runway.

Constantly keep in mind that you should not go beyond 4.2NM calculated from the touchdown.

Well I think that we have no problems so far. We are halfway through the Circle To Land procedure and we are going to make ourselves ready for landing on runway 24.

We will use RTM VOR as reference to the threshold. The station is 1,3 nm away from the threshold of the runway according to the charts of rwy 24 (see page 4)

We have set our NAV radio on the VOR RTM and we monitor the DME.

Now closely watch the DME to decide when to make your turn to baseleg. It should be somewhere around: 4.2 – 1.3 =2.9 plus a bit extra as you remembered that the maximum distance from the threshold was INCLUDING the turn. So start at latest 1.9 nm. Not too soon or you will end up too close to final....and not too late for you will overshoot the maximum Radius.

After the base turn we can see on our right side the runway and we report ATC: “Field in sight” (remember...ist a non-precision approach) . We receive the “cleared to land” instruction and we can continue our final turn and land on rwy 24.

DIFFERENT VARIANTS

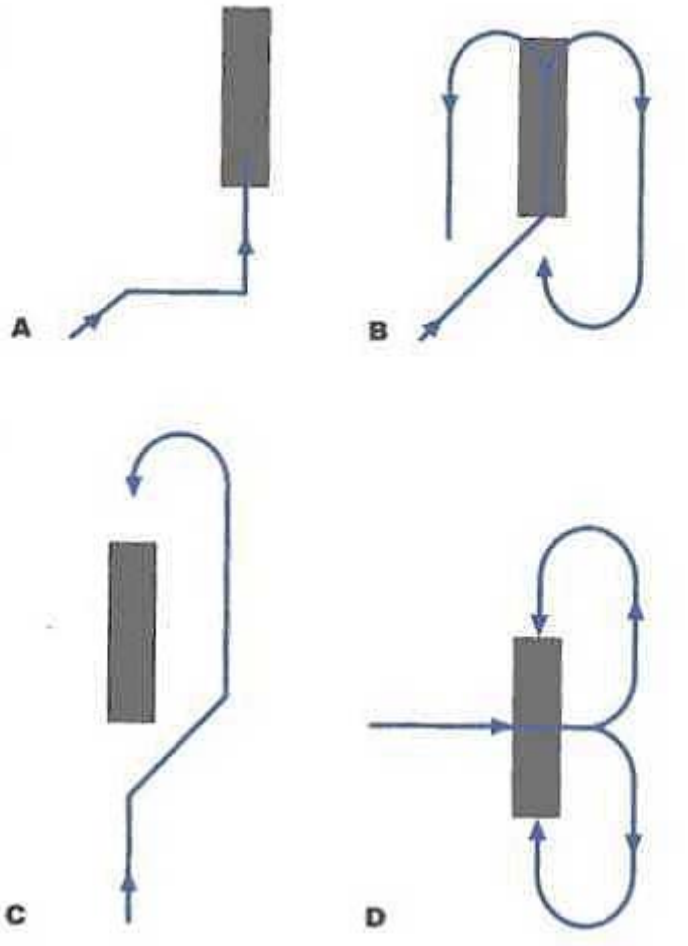
In a Circle To Land you approach from one side of the runway and land on the opposite.

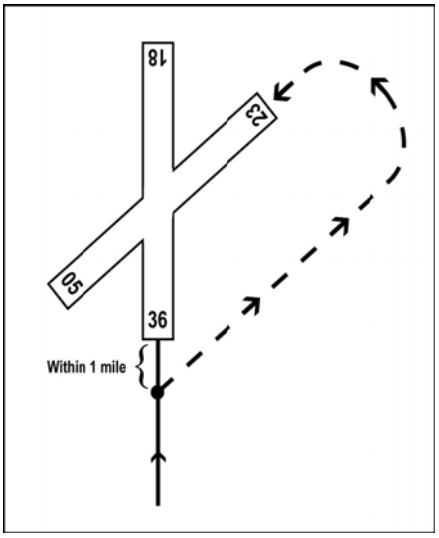
There are a numerous of ways to perform a Circle To Land.
You could (provided the Charts permit) fly to the middle of the runway at an angle of 90 degrees to the runway and then fly 90 degrees to the left or right so that you end up on the downwind leg.
You can also fly at an angle of 45 degrees to the landing runway (do not land) and then fly to the left or right to eventually fly the downwind leg , thereby entering a normal Traffic Pattern to the runway that you have just flown over.

There are countless methods to executing a Circle to Land but the basic procedure is always the same.

Always look at the charts to see if the desired procedure is permitted.
Prepare yourself well for this difficult operation.

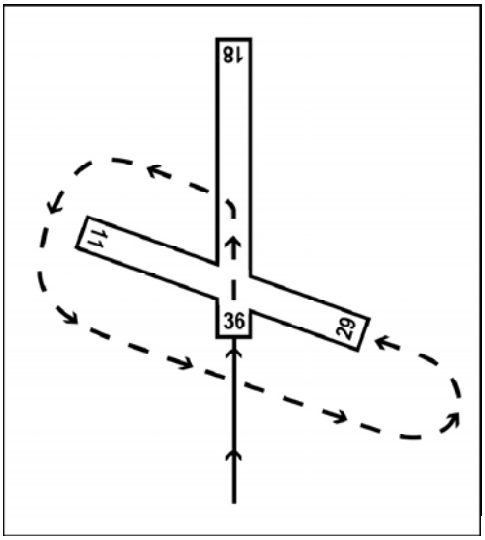
Below a few possible procedures depicted how to execute a Circle To Land.





E

Figure E: *Because the intersection of Runway 23 with the IAP runway is sufficiently down-field, you can break off the electronic final in a manner similar to the "classic" circle-to-land in Figure C.*



F

Figure F: *You want to land on Runway 29, but it's too close to break-off and enter left circling. In this situation, fly down the runway until crossing Runway 11/29 and circle to the left in order to keep the runway visible at all times.*