IFR ARRIVAL AND APPROACH PROCEDURES

1. Introduction

An instrument approach procedure is a series of predetermined manoeuvres by reference to flight instruments.

The design of an approach procedure is, in general, dictated by the terrain surrounding the airfield, the type of operation contemplated and the aircraft to be accommodated.

2. Definition

An Instrument approach procedure (IAP) is a series of predetermined manoeuvres by reference to flight instruments with specified protection from obstacles from the initial approach fix, or where applicable, from the beginning of a defined arrival route to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route obstacle clearance criteria apply.

Instrument approach procedures are classified as follows:

- Non-precision approach (NPA) procedure: An instrument approach procedure designed for 2D instrument approach operations Type A.
- Approach procedure with vertical guidance (APV): A performance-based navigation (PBN) instrument approach procedure designed for 3D instrument approach operations Type A.
- Precision approach (PA) procedure: An instrument approach procedure based on navigation systems (ILS, MLS, GLS and SBAS CAT I) designed for 3D instrument approach operations Type A or B.

There are two methods for executing instrument approach operations:

- a two-dimensional (2D) instrument approach operation, using lateral navigation guidance only;
- a three-dimensional (3D) instrument approach operation, using both lateral and vertical navigation guidance.

Instrument approach operations include an instrument phase and a visual phase:

- The instrument phase ends at the published MDA/H or DA/H unless a missed approach is initiated.
- The continued approach to landing from MDA/H or DA/H will be conducted using visual references.

Lateral and vertical navigation guidance refers to the guidance provided either by:

- a ground-based radio navigation aid
- computer-generated navigation data from ground-based, space-based, self-contained navigation aids or a combination of these.

Instrument approach operations shall be classified based on the designed lowest operating minima below which an approach operation shall only be continued with the required visual reference as follows:

- Type A: a minimum descent height or decision height at or above 75 m (250 ft)
- Type B: a decision height below 75 m (250 ft)

Type B instrument approach operations are categorized as:

- Category I (CAT I): a decision height not lower than 60 m (200 ft) and with either a visibility not less than 800 m or a runway visual range not less than 550 m
- Category II (CAT II): a decision height lower than 60 m (200 ft) but not lower than 30 m (100 ft) and a runway visual range not less than 300 m
- Category IIIA (CAT IIIA): a decision height lower than 30 m (100 ft) or no decision height and a runway visual range not less than 175 m
- Category IIIB (CAT IIIB): a decision height lower than 15 m (50 ft) or no decision height and a runway visual range less than 175 m but not less than 50 m
- Category IIIC (CAT IIIC): no decision height and no runway visual range limitations

Where decision height (DH) and runway visual range (RVR) fall into different categories of operation, the instrument approach operation would be conducted in accordance with the requirements of the most demanding category. (e.g. an operation with a DH in the range of CAT IIIA but with an RVR in the range of CAT IIIB would be considered a CAT IIIB operation or an operation with a DH in the range of CAT II but with an RVR in the range of CAT I would be considered a CAT II operation).

Category II and Category III instrument approach operations shall not be authorized unless RVR information is provided.

The operating minima for 2D instrument approach operations using instrument approach procedures shall be determined by establishing a minimum descent altitude (MDA) or minimum descent height (MDH), minimum visibility and, if necessary, cloud conditions.
The operating minima for 3D instrument approach operations using instrument approach procedures shall be determined by establishing a decision altitude (DA) or decision height (DH) and the minimum visibility or RVR.

The operator shall establish operational procedures designed to ensure that an aeroplane being used to conduct 3D instrument approach operations crosses the threshold by a safe margin, with the aeroplane in the landing configuration and attitude.

3. Categories of aircraft for approach procedures

Aircraft performance has a direct effect on the airspace and visibility required for the various manoeuvres associated with the conduct of instrument approach procedures.
The most significant performance factor is aircraft speed.

Accordingly, categories of aircraft have been established. These categories provide a standardized basis for relating aircraft manoeuvrability to specific instrument approach procedures.

The criteria chosen for establishing this classification of aircraft categories is the indicated airspeed at threshold V_{at} in the landing configuration (flaps, gear) at the maximum certificated mass.

The table below is the category list in function of V_{at}:

Category	$V_{at\ (km/h)}$	$V_{at\ (knot)}$
Category A	IAS < 169 km/h	IAS < 91 kt
Category B	169 km/h ≤ IAS < 224 km/h	91 kt ≤ IAS < 121 kt
Category C	224 km/h ≤ IAS < 261 km/h	121 kt ≤ IAS < 141 kt
Category D	261 km/h ≤ IAS < 307 km/h	141 kt ≤ IAS < 166 kt
Category E	307 km/h ≤ IAS < 391 km/h	166 kt ≤ IAS < 211 kt

Category H is only for helicopters.

$V_{at} = V_{SO} \times 1.3$ or, $V_{at} = V_{S1G} \times 1.23$ (V_{SO} or V_{S1G} are reference stall speeds)

4. Obstacle clearance

The obstacle clearance is a primary safety consideration in the development of instrument approach procedures. The obstacle clearance applied in each instrument approach procedure is considered to be the minimum required for an acceptable level of safety in operation.

For each individual approach procedure, an obstacle clearance altitude/height OCA/H is published on the instrument approach chart for each applicable category of aircraft.

The OCA/H is:

- In a precision approach procedure, the lowest altitude (OCA) above the elevation of the relevant runway threshold at which a missed approach must be initiated.
- In a non-precision approach procedure, the lowest altitude (OCA) above the aerodrome elevation or the elevation of the relevant runway threshold, if the threshold elevation is more than 2m (7ft) below the aerodrome elevation (OCH) below which an aircraft cannot descend without infringing the appropriate obstacle clearance criteria
- In a visual (circling) procedure, the altitude (OCA) above the aerodrome elevation below which an aircraft cannot descend without infringing the appropriate obstacle clearance criteria

In general, minima are developed by adding the effect of a number of operational factors to OCA/H to produce:

- Decision altitude (DA) or decision height (DH) for precision approach
- Minimum descent altitude (MDA) or minimum descent height (MDH) for non-precision approach

5. Speed range for procedure calculation

The procedures and the tracks protection are constructed using a predefined speed range depending on the localization inside the approach tracks.

Aircraft Category	V_{at} (kt)	Speeds for initial approach (kt)	Speeds for final approach (kt)	Maximum speeds for visual manoeuvring (kt)	Maximum speeds for missed approach	
					Intermediate (kt)	Final (kt)
A	<91	90/150	70/100	100	100	110
B	91/120	120/180	85/130	135	130	150
C	121/140	160/240	115/160	180	160	240
D	141/165	185/250	130/185	205	185	265
E	166/210	185/250	155/230	240	230	275
H	N/A	70/120	60/90	N/A	70/90	70/90

N/A = Not applicable

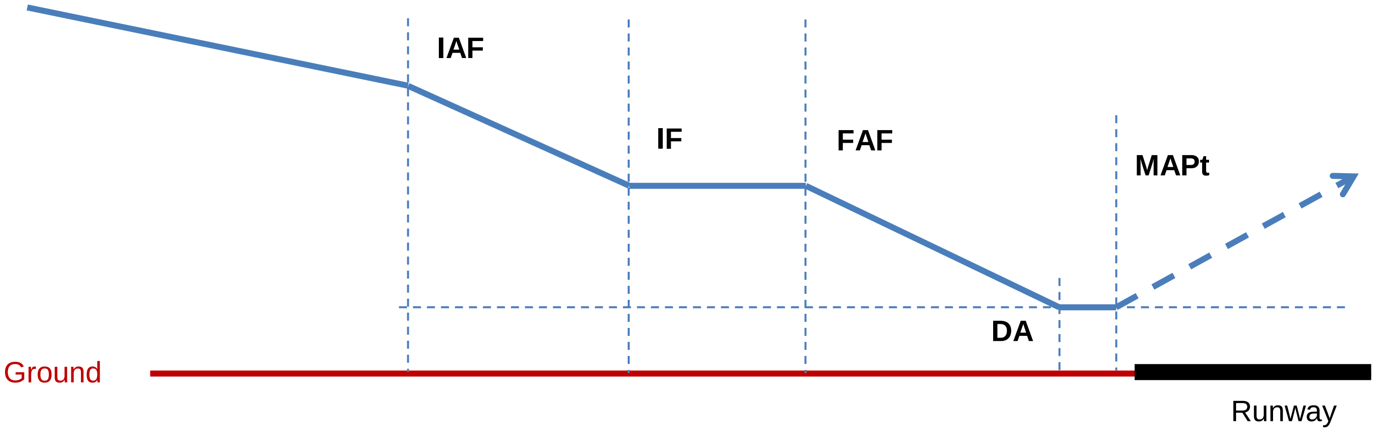
6. Segments of approach procedure

An approach procedure may have up to 5 separate segments:

1. Arrival segment
2. Initial approach segment
3. Intermediate approach segment
4. Final approach segment
5. Missed approach segment

In addition an area for circling the aerodrome under visual conditions is also considered.
Be aware that in some procedures we can have less than 5 separate segments.

These approach segments begin and end at designated fixes or specified points where no fixes are available.



Definition:

IAF = initial approach fix is a fix that marks the beginning of the initial segment and the end of the arrival segment, if applicable. In RNAV application, this fix is normally defined by a fly-by waypoint.
IF = intermediate fix is a fix that marks the end of an initial segment and the beginning of the intermediate segment. In RNAV application, this fix is normally defined by a fly-by waypoint.
FAF = final approach fix is a fix that marks the end of an intermediate segment and the beginning of the final approach segment for non-precision approach.
FAP = final approach point is a fix that marks the end of an intermediate segment and the beginning of the final approach segment for precision approach
MAPt = Missed approach point is a point in an instrument approach procedure at or before which the prescribed missed approach procedure must be initiated in order to ensure that the minimum obstacle clearance is not infringed.
DA = A specified altitude or height in a 3D instrument approach operation at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.
MDA = A specified altitude or height in a 2D instrument approach operation or circling approach operation below which descent must not be made without the required visual reference.
MAHF = Missed approach holding fix is a fix used in RNAV application that marks the end of the missed approach segment and the centre point for the missed approach holding.
MSA =Minimum sector altitude is the lowest altitude which may be used which will provide a minimum clearance of 300m (1000ft) above all objects located in an area contained within a sector of a circle of 46km (25NM) radius centred on a radio aid to navigation.

6.1. Arrival segment

An arrival segment permits transition from the en-route phase to the approach phase.
The arrival segment starts at the latest en-route point and ends at the initial approach fix (IAF).

The arrival segment can be a:

- standard instrument arrival (STAR) route published on charts
- omnidirectional or sector arrival to an initial approach fix (IAF)

6.1.1. Standard Arrival procedure - STAR

A standard instrument arrival (STAR) is a designated instrument flight rule (IFR) arrival route linking a significant point, normally on an ATS route, with a point from which a published instrument approach procedure can be commenced.

Standard arrival clearances for arriving aircraft shall contain the following items:

- Aircraft identification
- Designator of the assigned STAR
- Runway-in-use (except when part of the STAR description)
- Initial level (except when this element is included in the STAR description)
- Any other necessary instructions or information not contained in the STAR description (frequency change)

The clearance to follow the appropriate STAR will normally be issued by ACC without prior coordination with the approach unit.

When an arriving aircraft on a STAR is cleared to descend to a level lower than the level(s) specified in the STAR, the aircraft shall follow the published vertical profile of a STAR, unless such restrictions are explicitly cancelled by ATC. Published minimums levels based on terrain clearance shall always be applied.

6.1.2. Omnidirectional arrival

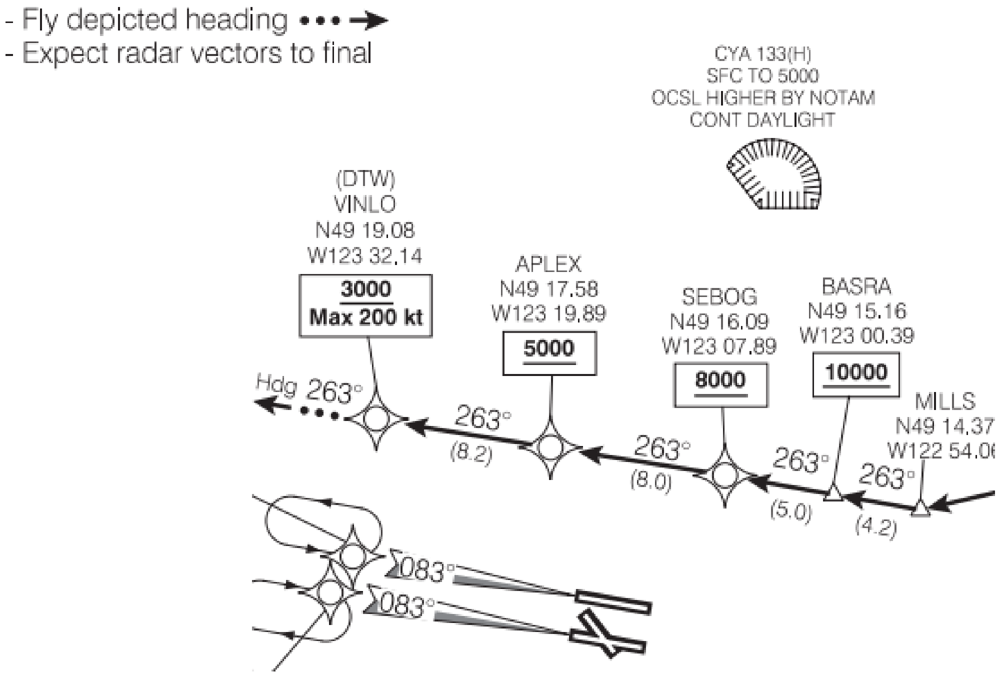
An omnidirectional instrument arrival is an instrument flight rule (IFR) arrival route linking a significant point, normally on an ATS route, direct to a point generally the initial approach fix - IAF - from which a published instrument approach procedure can be commenced.

Omnidirectional or sector arrivals can be provided taking into account the minimum sector altitude (MSA). Pilot shall maintain his aircraft above MSA until reaching the initial approach fix.

Minimum sector altitude (MSA) or terminal arrival altitude (TAA) are established for each aerodrome and provide at least 300m (1000ft) obstacle clearance within 46 km (25 NM) of the navigation aid, initial approach fix or intermediate fix associated with the approach procedure for that aerodrome.

6.1.3. Specific STAR

Some arrival procedures are published without any defined track after a specific fix. In these procedures, you may find ‘vector’ or ‘radar’ words in the diagram or in the description text. These approach procedures are mainly linked with air traffic controllers who give radar vectors during the approach in busiest areas.



Example: CANUCK 2 Arrival at CYVR

When terminal area radar is employed, the aircraft is vectored to a fix, or onto the final approach track, at <u>a point where the approach may be continued by the pilot by referring to the instrument approach chart</u>.

6.2. Initial approach segment

The initial approach segment is the segment of an instrument approach procedure between the initial approach fix (IAF) and the intermediate fix (IF).
The initial approach segment begins at the initial approach fix (IAF) and ends at the intermediate fix (IF).

In the initial approach segment, the aircraft has left the en-route structure and it is entering the Instrument approach procedure.

Aircraft speed and configuration will depend on the distance from the aerodrome and the descent required.

The initial approach segment provides at least 300m (1000ft) of obstacle clearance in the primary area.

Normally track guidance is provided along the initial approach segment to the IF with a maximum angle of interception of 90° for a precision approach and 120° for a non-precision approach.

Sometimes there is no suitable IAF or IF in the procedure in order to have an initial approach segment respecting all construction restrictions. Sometimes IF does not exist and the initial approach segment ends with FAF or FAP.

In some cases, a specific pattern or manoeuvre can be prescribed on this segment like:

- Shuttle
- Dead reckoning segment
- Racetrack
- Reversal procedure
- Radar vectoring segment

6.2.1. Bank angle and speed restrictions

This procedure is based on an average achieved bank angle of 25°, or the bank angle giving a rate of turn of 3° per second whichever is less.

The speeds must not be exceeded to ensure that the aircraft remains within the limits of the protected areas.

6.2.2. Descent

The aircraft shall cross the fix or facility and fly outbound on the specified track descending as necessary to the procedure altitude but no lower as the minimum crossing altitude associated with that segment.

If the descent is specified after the inbound turn, this descent shall not be started until the aircraft is established on the inbound track (racetrack or reversal procedure).

6.2.3. Wind effect

To achieve a stabilized approach, the aircraft shall compensate both heading and timing parameters for the effects of wind in order to regain the inbound track as accurately and expeditiously as possible.

The wind value can be estimated, calculated or given by meteorological reports.

6.2.4. Shuttle

A shuttle is a decent or climb conducted in a holding pattern.

A shuttle is normally prescribed where the descent required between the end of the initial approach and the beginning of the final approach exceeds the values shown in the table below.

The table shows minimum descent rates specified on a shuttle, reversal or race track procedure.

Outbound track	Maximum	Minimum
Category A and B	245 m/min (804 ft/min)	Not applicable
Category C, D and E	365 m/min (1197 ft/min)	Not applicable
Category H	365 m/min (1197 ft/min)	Not applicable
Inbound track	Maximum	Minimum
Category A and B	200 m/min (655 ft/min)	120 m/min (394ft/min)
Category C, D and E	305 m/min (1000 ft/min)	Not applicable
Category H	230 m/min (755 ft/min)	180 m/min (590 ft/min)

6.2.5. Reversal procedure

The reversal procedure may be in the form of a procedure or a base turn. The direction and timing specified should be strictly followed in order to remain within the airspace provided.

There are 3 recognized manoeuvres related to the reversal procedure:

- 45° / 180° procedure turn
- 80° / 260° procedure turn
- Base turn

An aircraft is considered established in the outbound track when it is:

- Within half full scale deflection for the ILS or VOR
- Within ±5° of the required bearing for the NDB

When a DME distance or radial/bearing is specified, it shall not be exceeded when flying on the outbound track.

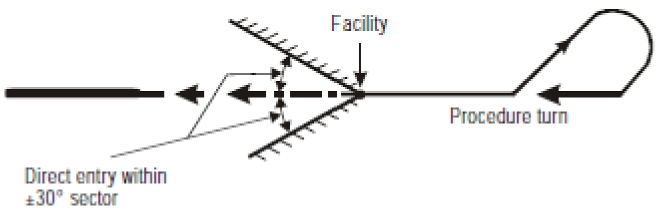
6.2.5.1. 45° / 180° procedure turn

This procedure turn starts at a facility and consists of:

- Straight leg with track guidance (timed leg, limited by radial, DME distance or fix)
- 45° turn (by the right or by the left)
- Straight leg without track guidance. This leg is timed 1min from the start of the turn for aircraft category A and B, 1min 15s for aircraft category C, D and E.
- 180° turn in the opposite direction to intercept the inbound track

A. 45°/180° procedure turn

The entry shall be a direct entry from a track within ±30° of the outbound track of the reversal procedure.



6.2.5.2. 80° / 260° procedure turn

This procedure turn starts at a facility and consists of:

- Straight leg with track guidance (timed leg, limited by radial, DME distance or fix)
- 80° turn (by the right or by the left)
- 260° turn in the opposite direction to intercept the inbound track

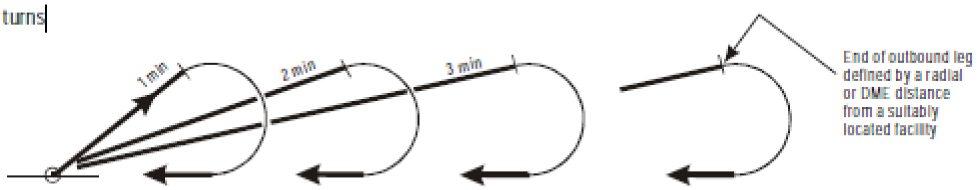
B. 80°/260° procedure turn

The 80°/260° procedure turn is an alternative to the 45°/180°. The entry, speed and bank conditions are the same.

6.2.5.3. Base turn

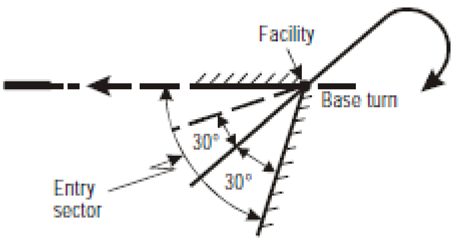
This procedure consists of:

- Specified outbound track (timed leg, limited by radial or DME distance)
- A turn to intercept the inbound track



The outbound track and/or the timing or distance may be different for the various categories of aircraft. If so, separate procedures are published.

The entry shall be a direct entry from a track within ±30° of the outbound track of the reversal procedure.

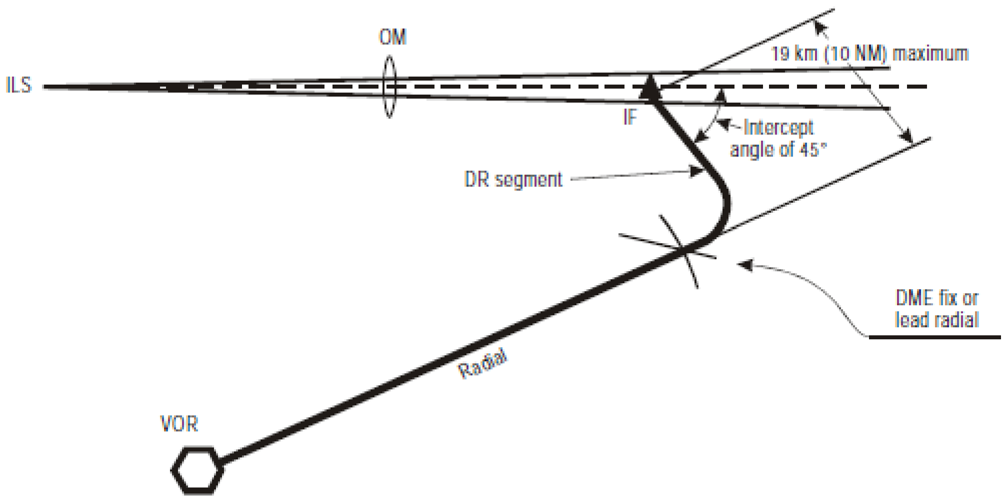


This procedure is based on an average achieved bank angle of 25°, or the bank angle giving a rate of turn of 3° per second whichever is less.

6.2.6. Dead reckoning (DR) segment

Where an operational advantage can be obtained, an ILS may include a dead reckoning (DR) segment from a fix to the localizer. The DR track will intercept the localizer at 45° and will not be more than 19 km (10NM) in length. The point of localizer interception is the beginning of the intermediate segment.

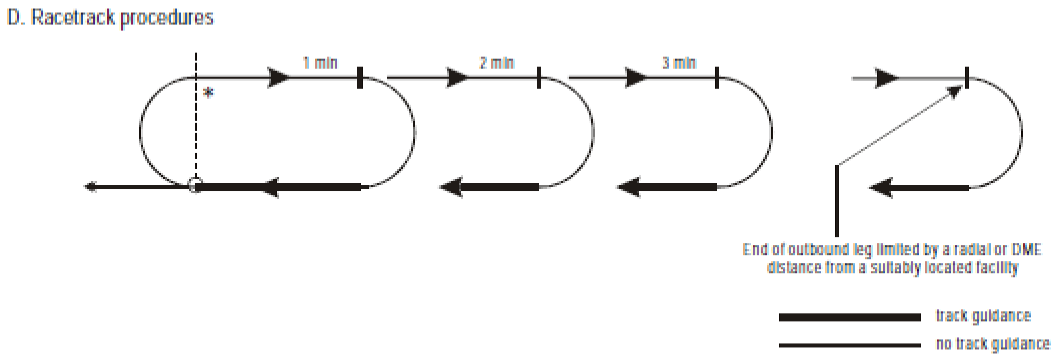
The DR segment allows a proper ILS interception:



6.2.7. Racetrack procedure

This procedure consists of:

- A 180° turn from the inbound track and from overhead the facility, navigation aid or fix, to the outbound straight track for 1, 2 or 3 minutes.
- A 180° turn in the same direction to return to the outbound track

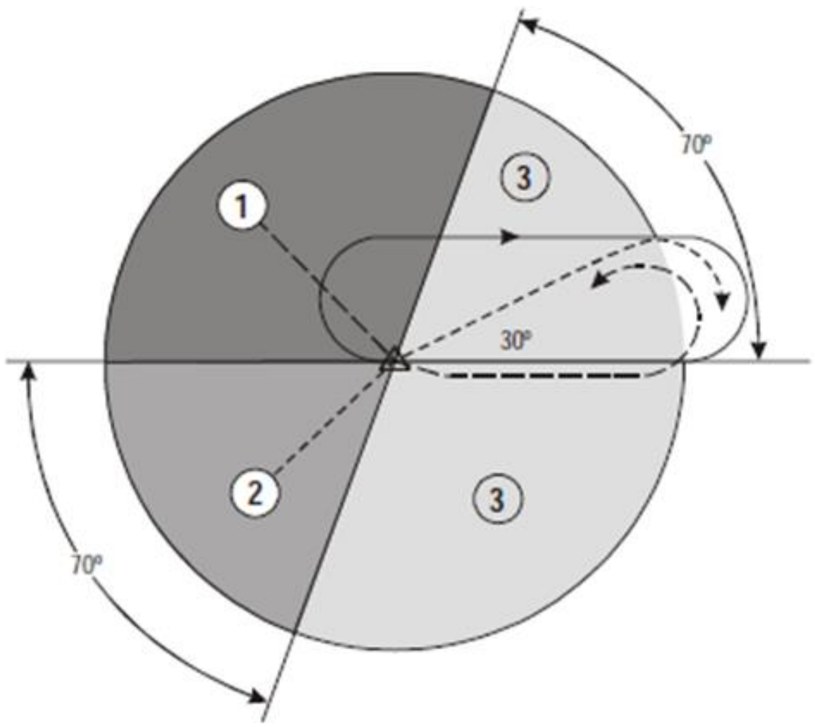


As an alternative of timing, the outbound leg may be limited by a DME distance or intersecting radial/bearing.

Racetrack procedures are used where sufficient distance is not available in a straight segment to accommodate the required loss of altitude and when entry into a reversal procedure is not practical.

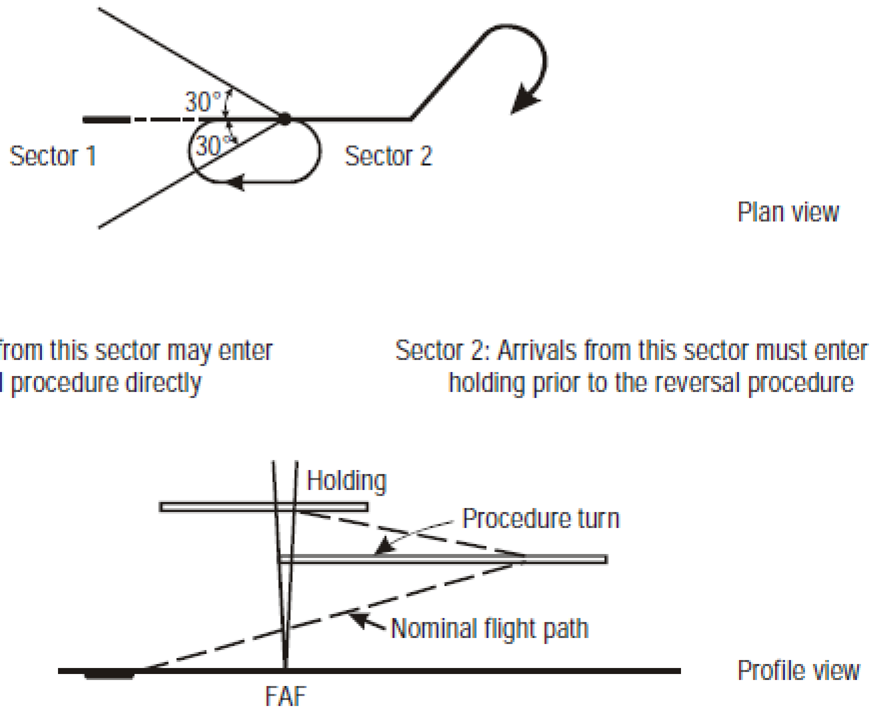
The <u>entry inside a racetrack procedure is like the holding procedure entry method</u>:

- direct entry – sector 3
- offset entry – sector 2
- parallel entry – sector 1



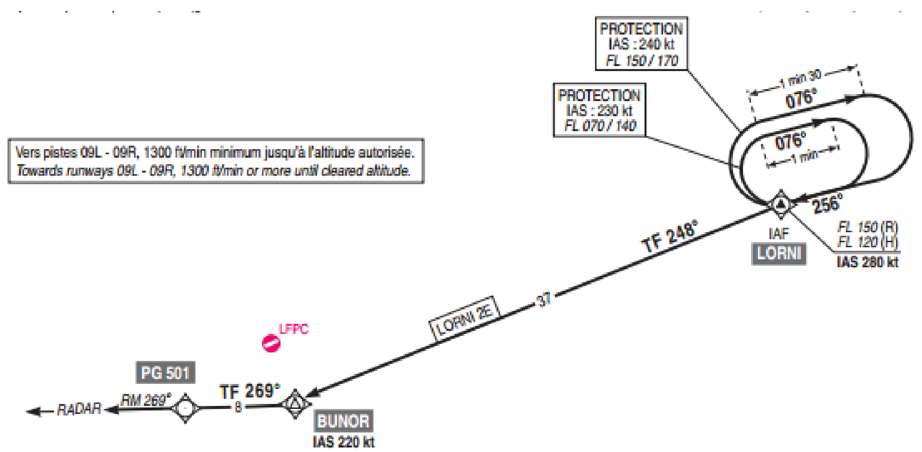
6.2.8. Reversal procedure combined with a holding procedure

Sometimes in a reversal procedure, the aircraft will arrive from sector 2 instead of sector 1. With presence of a holding procedure at the same point, the aircraft shall enter into the holding pattern with adequate manoeuvres in order to be positioned in sector 1 to continue the procedure turn.



6.2.9. Radar guidance during initial approach

Some initial approach procedures are published without any defined track after a specific fix. In these procedures, you may find ‘vector’ or ‘radar’ words in the diagram or in the description text. These procedures are mainly linked with air traffic controllers who give radar vectors during the approach in busiest areas.



Example: LFPG LORNI 2E initial approach for runway 08R/L or 09R/L

The air traffic controller has the responsibility to vector the aircraft to the final approach track at the published altitude after starting to use radar for issuing clearances and instructions.

6.3. Intermediate approach segment

That segment of an instrument approach procedure between the intermediate fix and the final approach fix, or between the end of reversal, racetrack or dead reckoning track procedure and the final approach fix or point as appropriate.

This is the segment during which the aircraft speed and configuration should be adjusted to prepare the aircraft for final approach. For this reason the descent gradient is kept as shallow as possible.

Where a final approach fix (FAF) or a final approach point (FAP) is specified, the intermediate approach segment begins when the aircraft is on the inbound track of the procedure turn, base turn, or final inbound leg of the racetrack procedure.
It ends at the FAF or FAP. Where no FAF is specified, the inbound track is the final approach segment.

During the intermediate approach, the obstacle clearance requirement reduces from 300m (984ft) to 150m (492ft) in the primary area.

If there is no intermediate fix, the intermediate approach segment does not exist.

6.4. Final approach segment

This is the segment in which alignment and descent for landing are made.
Normally, final approach may be made to a runway for a straight-in landing, or to an aerodrome for a visual manoeuvre (circling).

6.4.1. Straight in and circling approach

There are 2 categories of approach:

- Straight-in
- Circling

A straight-in approach is aligned with the runway centre line.

In case of non-precision approach, a straight-in approach is considered acceptable if the angle between the final approach track and the runway centre line is 30° or less.

In case of precision approach, the straight-in approach aligned with the runway centre line is mandatory.

A circling approach is an extension of an instrument approach procedure which provides for visual circling of the aerodrome prior to landing.

A circling approach is specified in those cases where a straight-in approach is not possible.
The criteria can be:

- Terrain or other constraints cause the final approach track alignment is not possible with the runway centre line inside the 30° tolerance.
- Descent gradient is not compatible with landing using straight-in approach

6.4.2. Types of final approach

The criteria for final approach vary according to the type. These types are:

- Non precision approach (NPA) with final approach fix (FAF)
- Non precision approach (NPA) without final approach fix (FAF)
- Approach with vertical guidance (APV)
- Precision approach (PA)

6.4.3. Categories of precision approaches

Category of Operation	Decision Height (DH)	Runway Visual Range (RVR)
CAT I	DH ≥ 200 ft (60m)	RVR ≥ 550 m or VIS ≥ 800m RVR ≥ 1750 ft or VIS ≥ 2400 ft
CAT II	100 ft ≤ DH < 200 ft	RVR ≥ 300 m
CAT III A	No DH or DH < 100 ft	RVR ≥ 175 m
CAT III B	No DH or DH < 50ft	50 m ≤ RVR < 175 m
CAT III C	No DH	No RVR limitation

6.4.4. Non precision approach with FAF

A Non-precision approach (NPA) procedure is an instrument approach procedure designed for 2D instrument approach operations Type A.

The FAF is sited on the final approach altitude to the appropriate MDA/H either for a straight-in approach or for a visual circling.
The distance for locating the FAF relative to the runway threshold is:

- 9.3km (5NM) as optimum distance
- 5.6km (3NM) as minimum distance
- 19km (10NM) as maximum recommended distance

The optimum final descent gradient for a non-precision approach shall be 5.2% (3°), providing a rate of descent of 52m per kilometre (318ft per NM). This value is published on charts.

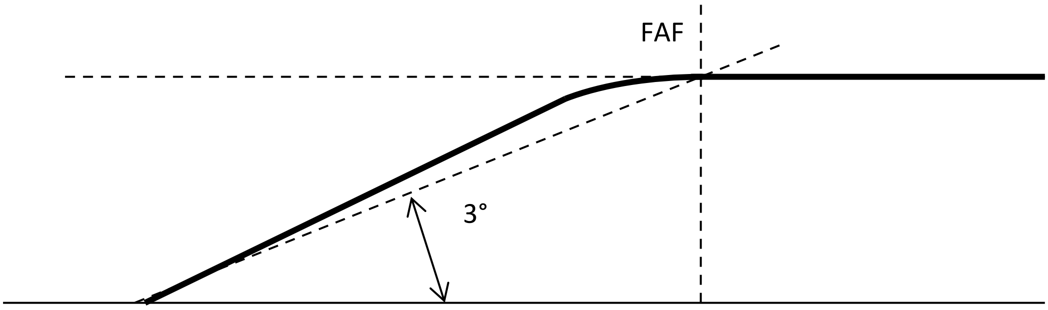
The maximum standard descent gradient for non-precision procedures with FAF is:

- 6.5% for category A and B aircraft
- 6.1% for category C, D and E aircraft
- 10% for category H, helicopter

Non-standard procedures published with a final approach descent gradient greater than these values can exist and it requires a special approval by the national competent authority.

The FAF is crossed at the procedure altitude in descent but no lower than the minimum crossing altitude associated with the FAF. The descent is normally initiated prior to the FAF in order to achieve the prescribed descent gradient/angle.

Delaying the descent until reaching the FAF at the procedure altitude will cause a descent angle to be greater than 3° (see image below).



A step-down fix may be incorporated in some non-precision approach procedures. In this case two obstacle clearance altitude/heights (OCA/H) are published (look at the image on the next page):

- A higher value is applicable to the primary procedure until the step-down fix.
- A lower value is applicable only if the step-down is positively identified during the approach.

Where a step-down procedure using a suitably located DME is published, the pilot shall not begin descent until established on the specified track. Once established on track, the pilot shall begin descent while maintaining the aeroplane at or above the published DME distance/height requirement.

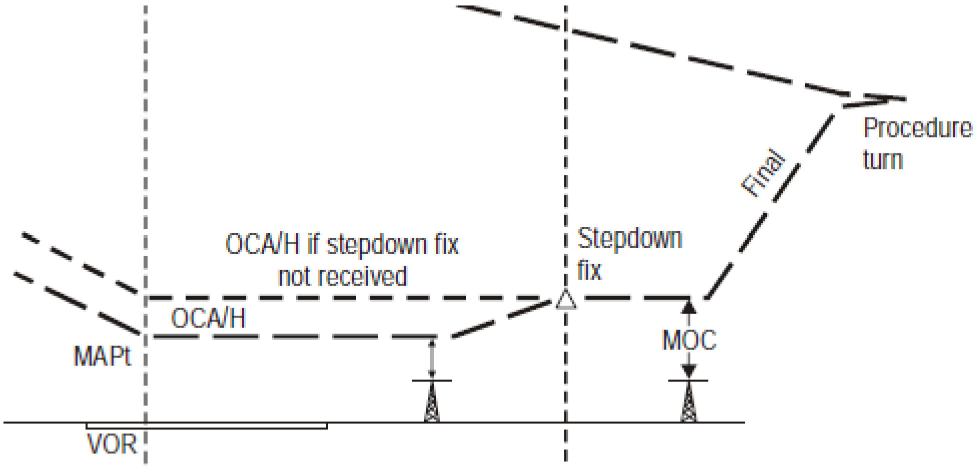


Figure: step-down fix incorporated in non-precision approach procedure

6.4.5. Non precision approach without FAF

Sometimes an aerodrome is served by a single facility (like NDB) located on or near the airfield and no other facility is suitably situated to form a final approach fix (FAF). This is the case to have a non-precision approach without FAF.

A procedure may be designed where the facility is both IAF and the MAPt.

These procedures indicate:

- A minimum altitude/height for a reversal procedure or racetrack
- An OCA/H for final approach

In the absence of a FAF, descent to MDA/H is made once the aircraft is established inbound on the final approach track.

Procedure altitude/heights will not be developed for non-precision approaches without a FAF.
In the non-precision approach without FAF procedures, the final approach track cannot normally be aligned on the runway centre line.

6.4.6. Vertical path control on non-precision approach procedures

Aircraft pilots should reduce the controlled flight into terrain (CFIT) by using standardization in vertical path control on non-precision approach procedures.

They typically employ one of 3 techniques for vertical path control on non-precision approaches:

- Continuous descent final approach (CDFA)
- Constant angle descent
- Step-down descent

Continuous descent final approach (CDFA) is a continuous descent, flown either with VNAV guidance calculated by on-board equipment or based on manual calculation of the required rate of descent without level-offs.

The rate of descent is selected and adjusted to achieve a continuous descent to a point approximately 15m (50ft) above the landing runway threshold or the point where the flare manoeuvre should begin.

CDFA technique simplifies the final segment of the non-precision approach by incorporating techniques similar to those used when flying a precision approach procedure or an approach procedure with vertical guidance.
The CDFA technique is preferred and used whenever possible as it adds to the safety of the approach operation by reducing pilot workload and lessening the possibility of error in flying the approach.

The constant angle descent is a unbroken angle of descent from the final approach fix (FAF) or optimum point on procedures without a FAF to a reference datum above the runway threshold (e.g. 15m (50ft)).

The step-down descent involves an expeditious descent and is described as descent immediately to not below the minimum step-down fix altitude or MDA/H. This technique is acceptable as long as the descent gradient remains less than 15% and the missed approach is initiated at or before the MAPt.

Careful attention to altitude control is required due to the high rates of descent before reaching MDA/H and because of the increased time of exposure to obstacles at the MDA.

6.4.7. Precision approach

A precision approach (PA) procedure is an instrument approach procedure based on navigation systems (ILS, MLS, GLS and SBAS CAT I) designed for 3D instrument approach operations Type A or B.

Lateral and vertical guidance refers to the guidance provided either by:

- Ground based navigation aid
- Computer-generated navigation data

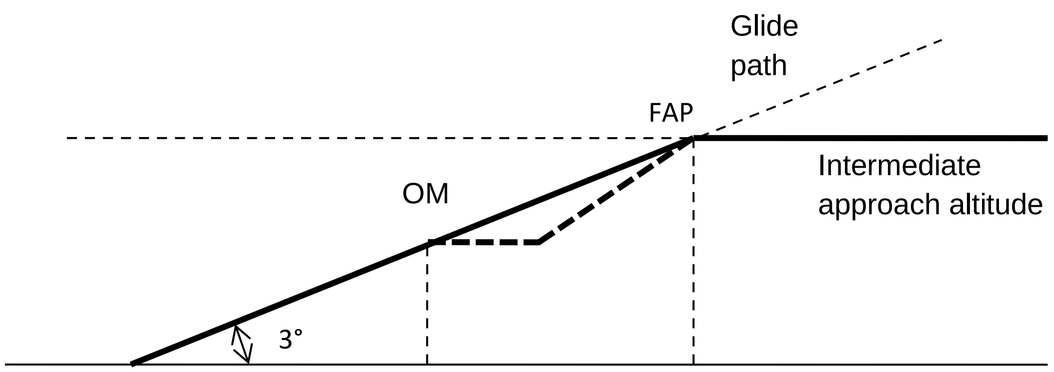
In our public simulator, only the instrument landing system is simulated as a precision approach using radio navigation aids. Modern and advanced aircraft in our public simulator can simulate the new procedure localizer performance with vertical guidance (LPV).

The final approach segment begins at the final approach point (FAP). This is a point on the final approach track where the intermediate approach altitude intercepts the nominal glide path.

The intermediate approach altitude generally intercepts the glide path at heights from 300m (1000ft) to 900m (3000ft) above runway elevation.

For a 3° glide path, interception occurs between 6km (3NM) and 19km (10NM) from the threshold.

The intermediate approach track or radar vector is designed to place the aircraft on the localizer for the final approach track at an altitude that is below the nominal glide path.



The final approach area contains a fix or a facility that permits verification of the glide path versus altimeter relationship. The outer marker or equivalent DME fix is normally used for this purpose. After the final approach point, descent may be made on the glide path to the altitude of the published fix crossing.

Descent below the fix crossing altitude should not be made prior to crossing the fix.

In the event of loss of glide path elevation angle guidance during the approach, the procedure becomes a non-precision approach. The OCA/H published for the glide path inoperative will then apply.

Minimum requirement to make a standard precision approach with an ILS:

- ILS Category I must be flown with pressure altimeter
- ILS Category II must be flown with pressure altimeter, radio altimeter and flight director
- Missed approach climb gradient is 2.5%
- Glide path angle is
  - Optimum = 3°
  - Minimum = 2.5°
  - Maximum = 3.5°

Non standard procedures are those involving a glide path greater than 3.5° or any angle when the nominal rate of descent exceeds 5m/s (1000ft/min).

Non-standard procedures are normally restricted to specifically approved operators and aircraft.

The protection area of a precision ILS approach assume that the pilot does not normally deviate from the centre line more than half-scale deflection after being established on track.

6.4.8. Approach procedure with vertical guidance (APV)

An approach procedure with vertical guidance (APV) is a performance-based navigation (PBN) instrument approach procedure designed for 3D instrument approach operations Type A.

Lateral and vertical guidance refers to the guidance provided either by:

- Ground based navigation aid
- Computer-generated navigation data

RNAV (LNAV/VNAV) approach procedure based on GPS is an APV approach.
In this case, the use of a VNAV system such as baro-VNAV is required.
When baro-VNAV is used, the lateral navigation guidance is based on the RNP APCH and RNP AR APCH navigation specifications.

This APV approach benefits over advisory VNAV guidance being overlaid on a non-precision approach, as they are based on specific procedure design criteria:

- Height loss after initiating a missed approach allowing the use of a DA instead of an MDA, thereby standardizing flight techniques for vertically guided approach operations
- Obstacle clearance throughout the approach and landing phase taking into account temperature constraints down to the DA, therefore resulting in better obstacle protection compared to a non-precision approach procedure.

6.5. Missed approach segment

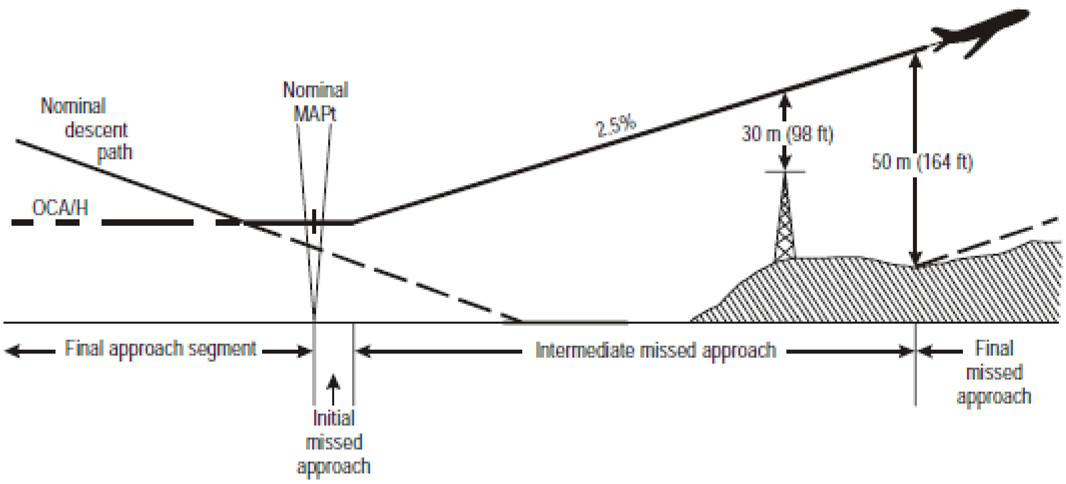
A missed approach segment must be followed if the approach cannot be continued. In this segment, the pilot is faced with the demanding task of changing the aircraft configuration, attitude and altitude.

The missed approach should be initiated not lower than the decision altitude/height (DA/H) in precision approach procedures, or at a specified point in non-precision approach procedures not lower than the minimum descent altitude/height (MDA/H).

It is expected that the pilot will fly the missed approach procedure as published.

The design of the missed approach consists of the three phases:

- Initial
- Intermediate
- Final



6.5.1. Missed approach point (MAPt)

Only 1 missed approach procedure is established for each instrument approach procedure. It is designed to provide protection from obstacles throughout the missed approach manoeuvre. It specifies a point where the missed approach begins and a point or an altitude/height where is ends.

The MAPt in a procedure may be defined by:

- The point of intersection of an electronic glide path with the applicable DA/H in APV or precision approaches
- A navigation facility, a fix or a specified distance from the final approach fix in non-precision approach

The missed approach shall be initiated when reaching the MAPt.

If a missed approach is initiated before arriving at the missed approach point (MAPt), the pilot will normally proceed to:

- The MAPt (any turns on the missed approach shall not begin until the aircraft reaches the MAPt).
- The middle marker fix or a specified DME distance for precision approach procedures.

When approaching the DA/H or MDA/H, only one of the 2 options exists for the crew:

- Continue the descent below DA/H or MDA/H to land with the required visual reference in sight
- Execute a missed approach.

If the visual references required to land have not been acquired when the aircraft is approaching the MDA/H, the vertical (climbing) portion of the missed approach is initiated at an altitude above the MDA/H sufficient to prevent the aircraft from descending through the MDA/H.

If the visual conditions are adequate, the aircraft continues the descent to the runway.

6.5.2. Missed approach gradient

The nominal missed approach climb gradient is 2.5%. Gradients of 3%, 4% or 5% may be used for aircraft of which the climb performance permits an operational advantage to be thus obtained and this is indicated on the instrument approach chart. A gradient of 2% may be used if necessary survey and safeguarding have been provided.

Special conditions: The operation of aircraft, when operating at or near maximum certificated gross mass and with engine-out conditions, needs special consideration at aerodromes which are critical due to obstacles on the missed approach area. This may result in a special procedure being established with a possible increase in the DA/H or MDA/H.

6.5.3. Initial phase

The initial phase of a missed approach begins at the MAPt and ends at the start of climb.
This phase is critical for a pilot and needs attention on establishing the changes in aircraft configuration and starting the climb. No turns are specified in this phase.

6.5.4. Intermediate phase

The intermediate phase of a missed approach begins at the start of climb. The climb is continued normally straight ahead. It extends to the first point where 50m (164ft) obstacle clearance is obtained and can be maintained.
The intermediate missed approach track may be changed by a maximum of 15°. During this phase, it is assumed that the aircraft begins track corrections.

6.5.5. Final phase

The final phase begins at the point where 50m (164ft) obstacle clearance is first obtained and can be maintained (40m (131ft) for category H). It extends to the point where a new approach, holding or a return to en-route is initiated.

6.5.6. Restrictions

Where an obstacle is located early in the missed approach procedure, the instrument approach chart is annotated:

- "Missed approach turn limited to '*value*' KT IAS maximum"
- "Missed approach turn as soon as practicable to '*value*' heading"

The following parameters are specific to turning missed approach:

- Bank angle = 15°
- Wind = 95% of probability on an omnidirectional basis (or 30KT where no data is available)
- Speed = missed approach range speed in the table chapter 4.
- Pilot reaction time = up to 3 seconds.
- Bank establishment time = up to 3 seconds.