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SECTION 1

Introduction to PANS-OPS (DOC 8168)

Procedures for Air Navigation Services – Aircraft Operations

■ WHAT IS PANS-OPS?

PANS-OPS stands for **Procedures for Air Navigation Services – Aircraft Operations**. It is ICAO Document 8168 and consists of two volumes:

- **Volume I – Flight Procedures:** Operational procedures recommended for flight operations personnel and flight crew. Outlines the parameters on which Volume II criteria are based.
- **Volume II – Construction of Visual and Instrument Flight Procedures:** For procedures specialists. Describes areas, obstacle clearance requirements, and guidelines for constructing instrument flight charts.

✈ BASELINE ASSUMPTIONS FOR ALL CALCULATIONS

- All engines operating (unless contingency procedures are being developed — that is the operator's responsibility).
- All procedures depict **tracks**. Pilots apply corrections to heading for known wind.
- Calculations are based on an altitude of **600 m (2,000 ft) above MSL** and **ISA +15°C** unless otherwise stated.

General Criteria for Departure Procedures



Obstacle Clearance — Areas

AREA STRUCTURE

Where track guidance is provided, each segment comprises a specified volume of airspace. The vertical cross-section is an **area located symmetrically about the centre line** of each segment.

- Vertical cross-section = divided into **Primary** and **Secondary** areas.
- Full obstacle clearances are applied over the **primary area**.
- Clearance reduces to **zero at the outer edges** of the secondary areas.

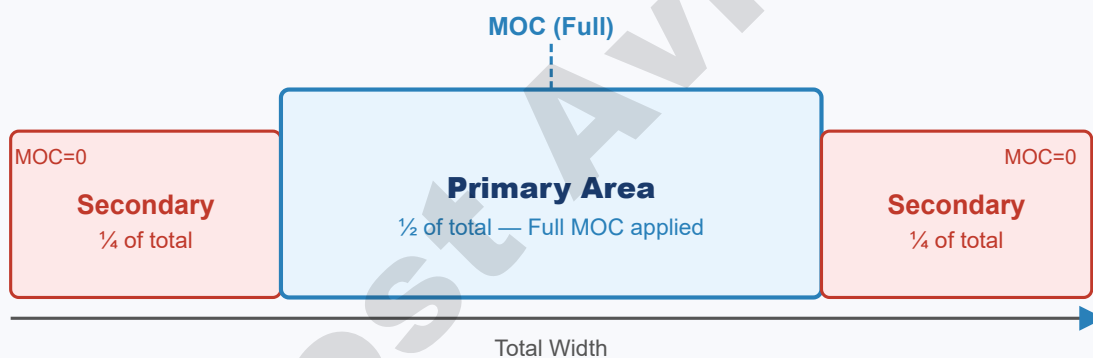


Fig 1 — Cross-section: Primary & Secondary Areas with MOC distribution

KEY AREA RULES

- On **straight segments**: Primary area width = **1/2 of total width**. Each secondary area = **1/4 of total width**.
- Where **no track guidance is provided** during a turn: the entire total width is considered **primary area**.
- MOC is provided at full value across the primary area. In secondary areas, MOC reduces from inner edge to **zero at outer edge**.

Obstacle Clearance (MOC) in Departure

📐 MOC Values — Departure Phase

🚨 CRITICAL MOC VALUES — MEMORISE

At the Departure End of Runway (DER):

MOC = **ZERO**

Increases by:

0.8% of the horizontal distance from DER
(assuming max turn of 15°).

In the Turn Initiation Area and Turn Area:

MOC = **90 m (295 ft)**

Mountainous/precipitous terrain:

Procedures designer may **increase MOC**.

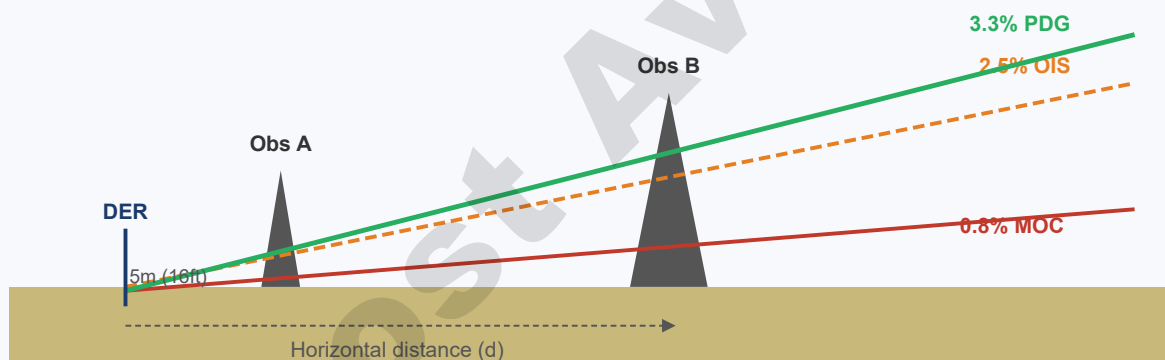


Fig 2 — MOC increases at 0.8% of horizontal distance from DER. PDG = 3.3%. OIS = 2.5%.

Instrument Departure Procedure — Design

DESIGN CONSIDERATIONS

- Design of an IDP is dictated by the **terrain surrounding the aerodrome**.
- May also be required for **ATC requirements** in the case of SID routes.
- These factors influence the type and siting of nav aids and the departure route.
- Airspace restrictions may also affect routing and siting of nav aids.

AERODROME OPERATING MINIMA

Where obstacles cannot be cleared by the appropriate margin when flown on instruments, aerodrome operating minima are established to permit **visual flight clear of obstacles**.

Wherever possible, a **straight departure aligned with the runway centre line** is specified.

TURNING DEPARTURE TRIGGER

When a departure route requires a turn of more than **15°** to avoid an obstacle, a **turning departure** is constructed.

Establishment of a Departure Procedure

A departure procedure is established for each runway where instrument departures are expected. It will include procedures for the **various categories of aircraft**.

WIND EFFECT — KEY RULE

- When **radar vectored**: Pilots will **NOT compensate** for wind effects.
- When flying departure routes expressed as **tracks to be made good**: Pilots **WILL compensate** for known or estimated wind.

Procedure Design Gradient (PDG)

■ DEFINITION OF PDG

The PDG is an aid to the procedures designer, who adjusts the route to **minimise the PDG** consistent with other constraints.

🚨 STANDARD PDG VALUES — CRITICAL

Unless otherwise published:

PDG = **3.3 per cent**

For helicopters (Cat H):

PDG = **5.0 per cent**

Basis of PDG:

OIS gradient = **2.5%**

+ Additional margin = **0.8%**

= PDG = **3.3%**

Gradient Specification — How it Works

📌 PDG SPECIFICATION RULES

- Published gradients are specified to an **altitude/height after which the minimum gradient of 3.3%** is considered to prevail.
- The final PDG continues until obstacle clearance is ensured for the next phase (en-route, holding, or approach).
- At that point, the departure procedure **ends** and is marked by a significant point.

Close-In Obstacles Rule

🚨 CLOSE-IN OBSTACLE RULE

Gradients to a height of **60 m (200 ft) or less**, caused by close-in obstacles, are **NOT specified**. However, a **note will be published** stating that close-in obstacles exist.

Fixes as Aid in Obstacle Avoidance

✓ **DME / RNAV FIXES**

Where a suitably located DME exists, additional specific height/distance information for obstacle avoidance may be published. RNAV waypoints or other suitable fixes may be used to provide a means of **monitoring climb performance**.

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Radar Vectors during Departure

WHEN TO ACCEPT RADAR VECTORS

Pilots should **NOT accept radar vectors during departure UNLESS** one of the following applies:

1. They are **above the minimum altitudes/heights** required to maintain obstacle clearance in the event of engine failure. (This relates to engine failure between V1 and minimum sector altitude, or end of contingency procedure.)
2. The departure route is **non-critical with respect to obstacle clearance**.

Standard Instrument Departures (SIDs)

SID TERMINATION

The SID terminates at the **first fix/facility/waypoint of the en-route phase** following the departure procedure.

Straight Departures

ALIGNMENT RULE

A straight departure is one in which the initial departure track is **within 15° of the alignment of the runway centre line**.

STRAIGHT DEPARTURE — OBSTACLE RULES

- If obstacles exist that affect the departure route, PDGs **greater than 3.3%** may be specified.
- When such a gradient is specified, the altitude/height to which it extends **shall be promulgated**. After this point, PDG of 3.3% (Cat H: 5.0%) resumes.
- Gradients to a height of **60 m (200 ft)** or less due to close-in obstacles are **not specified**; a note will be published instead.

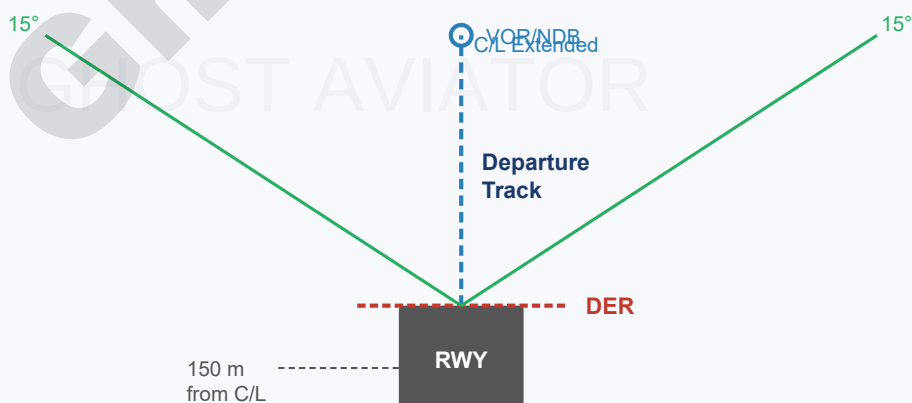


Fig 3 — Straight Departure: Initial track within $\pm 15^\circ$ of runway C/L. Area plays at 7.8° (VOR) or 10.3° (NDB).

Turning Departures

TURNING DEPARTURE — DEFINITION & ALTITUDE RULES

- Turn of **more than 15°** from runway C/L = **Turning Departure**.
- Straight flight is assumed until reaching an altitude/height of at least **120 m (394 ft)** for fixed-wing aircraft.
- For helicopters: **90 m (295 ft)**.

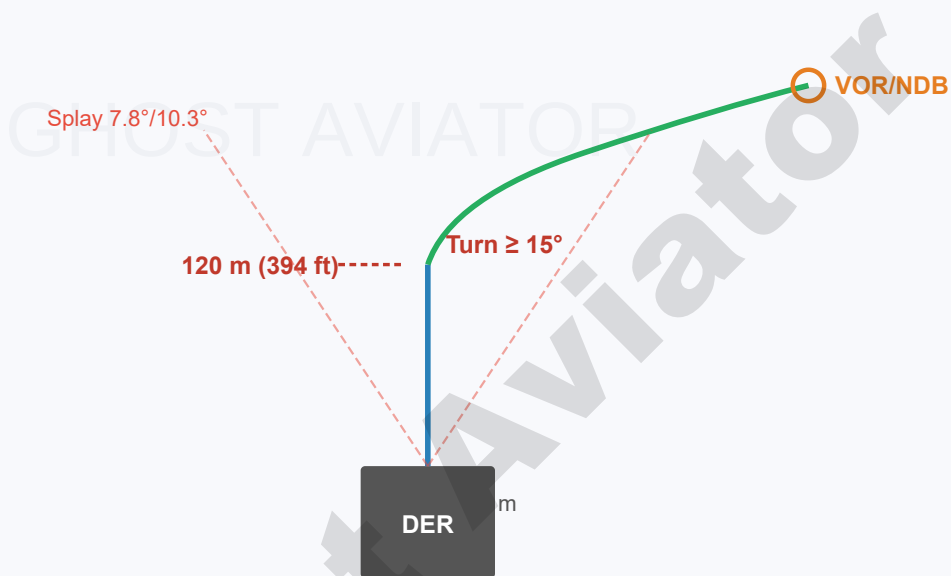


Fig 4 — Turning Departure: Straight climb to 120 m (394 ft) before turn. Turn area splay = 7.8° VOR / 10.3° NDB.

Omnidirectional Departures

■ GENERAL

Where **no track guidance** is provided, departure procedures are designed using the **omnidirectional method**.

Where obstacles do not permit omnidirectional procedures, one of the following is necessary:

- Fly a Standard Instrument Departure (SID) route; or
- Ensure ceiling and visibility permit obstacles to be avoided by visual means.

Beginning of Departure

DER & TURN INITIATION RULES

- Departure procedure begins at the **Departure End of Runway (DER)** = end of area declared suitable for take-off.
- Since point of lift-off varies, a turn at **120 m (394 ft)** above aerodrome elevation is **not initiated sooner than 600 m from the beginning of the runway**.
- Procedures are normally designed/optimised for turns at **600 m** from the beginning of the runway.
- Turns may NOT be initiated before the DER (or specified point); this will be noted on the departure chart.
- For **Category H**: procedure turns can be initiated at **90 m (295 ft)** if the DER and earliest initiation point are at the beginning of the runway/FATO.

PDG for Omnidirectional Departures

PDG RULES

- Default PDG = **3.3%** (helicopters: 5%) + straight climb on extended runway C/L until **120 m (394 ft)** above aerodrome elevation (helicopters: 90 m).
- The basic procedure ensures:
 - (a) Aircraft climbs on extended C/L to **120 m (394 ft)** before turns can be specified.
 - (b) At least **90 m (295 ft)** of obstacle clearance is provided before turns greater than 15° are specified.



Four Design Options for Omnidirectional Procedures

(A) STANDARD CASE

No obstacles penetrate the **2.5% OIS** and 90 m (295 ft) clearance prevails. A 3.3% climb to 120 m satisfies requirements for a **turn in any direction**.

(B) SPECIFIED TURN ALT/HEIGHT

Where obstacles preclude omnidirectional turns at 120 m, the procedure specifies a **3.3% climb to a higher alt/height** where omnidirectional turns can be made.

(C) SPECIFIED PDG

Where obstacles exist, the procedure defines a minimum gradient **more than 3.3%** to a specified altitude/height before turns are permitted.

(D) SECTOR DEPARTURES

The procedure identifies **sectors** for which either a minimum gradient or minimum turn alt/height is specified. E.g., "climb straight ahead to alt X before turning east; climb to alt Y before turning west."

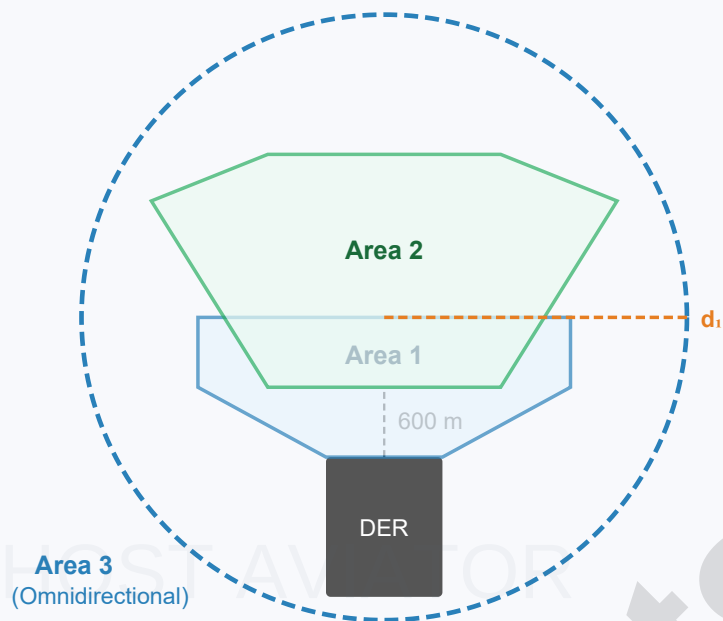


Fig 5 — Areas 1, 2, 3 for omnidirectional departures. Area 3 is the circular omnidirectional zone.

RNAV Systems — GNSS, SBAS, GBAS, PBN

Key Definitions

GNSS

Global Navigation Satellite System. A worldwide position and time determination system including one or more satellite constellations, aircraft receivers, and system integrity monitoring, augmented as necessary.

GBAS

Ground Based Augmented System. User receives augmentation information directly from a **ground-based transmitter**.

SBAS

Satellite Based Augmentation System. User receives augmentation information from a **satellite-based transmitter**. (WAAS, EGNOS, GAGAN, MSAS)

ABAS

Aircraft Based Augmentation System. Augments and/or integrates GNSS information with information available **on board the aircraft**.

GLS

GBAS Landing System. For approach and landing using GNSS augmented by GBAS as the primary navigational reference.

PBN

Performance Based Navigation. Area navigation based on performance requirements for aircraft operating along an ATS route, instrument departure/approach procedure, or in designated airspace.

Four Kinds of Turns in RNAV

RNAV TURN TYPES

1. **Turn at a fly-by waypoint** — Turn anticipation always provided.
2. **Turn at a flyover waypoint** — No turn anticipation.
3. **Turn at an altitude/height** — Some systems cannot code this; must be executed manually.
4. **Fixed radius turn** — Generally associated with RNP procedures.

✦ SBAS KEY VALUES

- From DER to turn initiation point: SBAS receiver provides nominal **full-scale deflection (FSD) of 0.3 NM**.
- Larger FSDs may be acceptable with augmentations (e.g., autopilot).
- SBAS receiver will NOT transition to en-route integrity performance until the **final waypoint** in the departure procedure is sequenced.

◆ GBAS NOTE

No departure criteria specifically designed for GBAS exists. Departure operations based on basic GNSS or SBAS may be flown by aircraft with a GBAS receiver using the optional GBAS positioning service.

General Criteria for Arrival & Approach Procedures

Accuracy of Fixes

FIX TOLERANCE AREA

Because all navigation facilities and waypoints have accuracy limitations, the geographic point identified is not precise but may be **anywhere within an area called the fix tolerance area** which surrounds its plotted point of intersection.

Fix Tolerances for Specific Navigation Systems

Fix Tolerances by Navigation System

Navigation System	Fix Tolerance	Notes
TAR (Terminal Area Radar)	± 1.5 km (0.8 NM)	Within 37 km (20 NM)
RSR (En-route Surveillance Radar)	± 3.1 km (1.7 NM)	Within 74 km (40 NM)
DME	± 0.46 km (0.25 NM) + 1.25% of distance	To the antenna
75 MHz Marker Beacon	Used for ILS & "z" markers	Instrument approach

Types of Approach

✓ STRAIGHT-IN APPROACH

Wherever possible, a straight-in approach aligned with the runway centre line is specified.

For **non-precision approaches**, a straight-in approach is acceptable if the angle between the final approach track and runway C/L is **30° or less**.

📌 CIRCLING APPROACH

Specified when terrain or other constraints cause the final approach track alignment or descent gradient to fall outside the criteria for a straight-in approach.

The final approach track is in most cases aligned to pass over some portion of the **usable landing surface**.

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Categories of Aeroplanes & Speed Table

■ BASIS OF CATEGORISATION

Five categories based on the **indicated airspeed at threshold (V_{at})** which equals the stall speed $V_{SO} \times 1.3$ or stall speed $V_{S1g} \times 1.23$ (whichever is higher) in landing configuration at maximum certificated landing mass.

A $V_{at} < 91 \text{ kt}$ **B**

91 – 120 kt

C

121 – 140 kt

D

141 – 165 kt

E

166 – 210 kt

H

Helicopters

Speeds for Procedure Calculations (kt) — DOC 8168 Table 1-4-1-1

Cat	V _{at} (kt)	Initial Approach (kt)	Final Approach (kt)	Circling Max (kt)	Missed App Intermediate (kt)	Missed App Final (kt)
A	<91	90 / 150 (110*)	70 / 100	100	100	110
B	91– 120	120 / 180 (140*)	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	90	90

* Maximum speed for reversal and racetrack procedures. ** Max speed for racetrack: ≤6000 ft = 100 kt; >6000 ft = 110 kt. *** GNSS point-in-space: 120 KIAS initial/intermediate, 90 KIAS final/MA (or 90/70 KIAS based on operational need).



Descent Gradient (Final Approach)

DESCENT GRADIENT / ANGLE RULES — FINAL APPROACH

Minimum/Optimum (with FAF):

5.2% / 3.0° (52 m/km = 318 ft/NM)

Maximum for Cat A & B:

6.5% / 3.7° (65 m/km = 395 ft/NM)

Maximum for Cat C, D, E:

6.1% / 3.5° (61 m/km = 370 ft/NM)

Maximum for Cat H:

10% / 5.7°

✓ CDFA — CONTINUOUS DESCENT FINAL APPROACH

- Requires a **continuous descent without level-offs**, flown with VNAV guidance or manual calculation.
- Rate of descent adjusted to achieve continuous descent to a point approximately **15 m (50 ft) above the landing runway threshold**.
- Descent shall pass at or above the minimum altitude at any stepdown fix.
- CDFA with advisory VNAV = **3D instrument approach operation**.
- CDFA with manual calculation = **2D instrument approach operation**.

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Approach Segments — IAF to MAPt

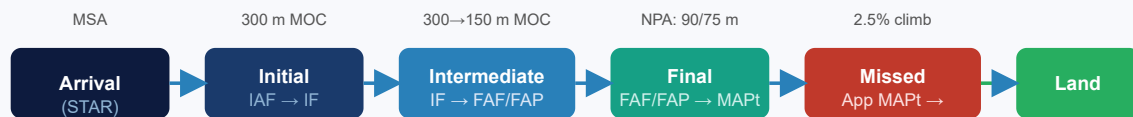


Fig 6 — Instrument Approach Segments: Arrival → Initial → Intermediate → Final → Missed Approach → Land

Arrival Segment (STAR)

STAR — STANDARD TERMINAL ARRIVAL ROUTE

Permits transition from the **en-route phase** to the **approach phase**. Arrival route normally ends at the IAF.

Protection area convergence: Begins at **46 km (25 NM)** before the IAF, with a maximum convergence angle of **30° each side** of the axis.

MSA / TAA — CRITICAL VALUES

- **MSA (Minimum Sector Altitude)** provides at least **300 m (1,000 ft)** obstacle clearance within **46 km (25 NM)** of the navigation aid, IAF, or IF.
- **TAA (Terminal Arrival Altitude):** Associated with PBN procedures based on the "T" or "Y" arrangement with three IAFs around the IF. TAAs replace the 46 km (25 NM) MSA where published.

1 Initial Approach Segment

INITIAL APPROACH — KEY FACTS

- Begins at the **IAF** and ends at the **IF**.
- Aircraft has left the en-route structure and is manoeuvring to enter the intermediate segment.
- Speed and configuration depend on distance from aerodrome and descent required.
- Max angle of interception of initial segment to IF: **90° for Precision** **120° for Non-Precision**
- MOC: **300 m (1,000 ft)** in primary area, reducing to zero at outer edge of secondary area.

Types of Manoeuvres in Initial Approach

REVERSAL PROCEDURES

Used where no suitable IAF or IF is available. Entry is restricted to a specific direction or sector — a **base turn or procedure turn** is prescribed. Directions and timing specified must be strictly followed. A racetrack or holding manoeuvre cannot be conducted unless so specified.

Three manoeuvre types:

1. **45°/225° Procedure Turn** (1 to 3 minutes outbound timing)
2. **80°/260° Procedure Turn** (1 to 3 minutes outbound timing)
3. **Base Turn** (1, 2, or 3 minutes — end of outbound leg by radial or DME distance)

RACETRACK PROCEDURE

- 180° turn overhead facility/fix onto outbound track for 1, 2, or 3 minutes.
- Followed by a 180° turn in the same direction to return to inbound track.
- Outbound leg may alternatively be limited by a **DME distance or intersecting radial/bearing**.

2 Intermediate Approach Segment

INTERMEDIATE APPROACH — KEY FACTS

- Aircraft speed and configuration adjusted to prepare for final approach. **Descent gradient kept as shallow as possible.**
- MOC: Reduces from **300 m (984 ft)** to **150 m (492 ft)** in the primary area, reducing to zero at outer edge of secondary area.
- Begins: On inbound track of procedure turn / base turn / final inbound leg of racetrack.
- Ends: At the FAF or Final Approach Point (FAP).
- *Note: Where no FAF is specified, the inbound track IS the final approach segment.*

3 Final Approach Segment

TYPES OF FINAL APPROACH

1. **NPA with FAF** — Non-precision approach with final approach fix
2. **NPA without FAF** — Non-precision approach; facility is both IAF and MAPt
3. **APV** — Approach with vertical guidance
4. **PA** — Precision approach

NPA WITH FAF

- Begins at **FAF**, ends at **MAPt**.
- FAF is sited on the final approach track.
- **Optimum distance FAF to threshold: 9.3 km (5.0 NM)**
- **Maximum length:** normally not greater than **19 km (10 NM)**
- MOC: **75 m** with FAF
- Stepdown fixes may be incorporated. Two OCA/H values published (higher for primary, lower if stepdown fix is positively identified).

NPA WITHOUT FAF

- Single facility on or near aerodrome = both **IAF** and **MAPt**.
- Indicates: (a) minimum alt/height for reversal/racetrack; and (b) OCA/H for final approach.
- In absence of FAF, descent to MDA/H starts once established inbound on final approach track.
- MOC: **90 m** without FAF
- Final approach track **cannot normally be aligned on runway C/L**.

Precision Approach — FAP

FINAL APPROACH POINT (FAP) — PRECISION

- FAP = point in space on final approach track where **intermediate approach altitude/height intercepts the nominal glide path / MLS elevation angle**.
- Intermediate altitude generally intercepts glidepath at heights of **300 m (1,000 ft) to 900 m (3,000 ft)** above runway elevation.
- For a 3° glide path, interception occurs between **6 km (3 NM) and 19 km (10 NM)** from the threshold.
- **Outer Marker/DME fix**: Permits verification of glidepath/altimeter relationship. Descent below fix crossing altitude should NOT be made prior to crossing the fix.
- *Note: FAF is associated with NPA; FAP is associated with PA.*

OCA/H, MDA/H, DA/H — KEY DEFINITIONS

- **OCA (Obstacle Clearance Altitude)** — Referenced to MSL.
- **OCH (Obstacle Clearance Height)** — Referenced to threshold elevation (or aerodrome elevation if threshold >2 m/7 ft below aerodrome elevation).
- **MDA (Minimum Descent Altitude)** — NPA/circling: altitude below which descent must NOT be made without required visual reference. Referenced to MSL.
- **MDH (Minimum Descent Height)** — Referenced to aerodrome elevation or threshold elevation.
- **DA (Decision Altitude)** — PA/APV: altitude at which a missed approach must be initiated if required visual reference not established. Referenced to MSL.
- **DH (Decision Height)** — Referenced to threshold elevation.

VSS — VISUAL SEGMENT SURFACE

Constructed per ICAO Doc 8168/PANS-OPS Volume II. Identifies obstacles that may affect execution of an IAP (except circling). Refers to the final approach leg between MDA/DA of the procedure and the runway threshold.

Missed Approach Segment

MISSSED APPROACH — GENERAL

- Only **one** missed approach procedure per instrument approach procedure.
- Three phases: **Initial, Intermediate, and Final.**
- Specifies a point where MA begins and a point or alt/height where it ends.
- MA should be initiated not lower than **DA/H** in precision approaches, or at the MAPt not lower than **MDA/H** in non-precision.

MAPt Definition

✚ FOR PA/APV

MAPt = point of intersection of the electronic glide path with the applicable DA/H.

✚ FOR NPA

MAPt = a navigation facility, a fix, or a specified distance from the FAF. Upon reaching the MAPt if required visual reference is not established, missed approach must be initiated at once.

MISSSED APPROACH GRADIENT

Normally based on a minimum missed approach **climb gradient of 2.5 per cent.**

Three Phases of Missed Approach

Missed Approach Phases

Phase	Begins At	Ends At	Key Characteristics
Initial	MAPt	SOC (Start of Climb)	Concentrated attention on establishing climb. Guidance equipment not extensively utilised. No turns specified in this phase.
Intermediate	SOC	First point where 50 m (164 ft) obstacle clearance is obtained	Climb continued straight ahead. Track may be changed by max 15° . Aircraft begins track corrections.
Final	50 m (164 ft) clearance point [Cat H: 40 m (131 ft)]	Point where new approach/holding/en-route flight is initiated	Turns may be prescribed in this phase. Airspace for turns based on <i>final missed approach speeds</i> .

✓ TURNING MISSED APPROACH

Turns in a missed approach procedure are only prescribed where **terrain or other factors make a turn necessary**. The protected airspace for turns is based on speeds for the *final missed approach*.

ICAO Classification of Approaches (NPA / APV / PA)

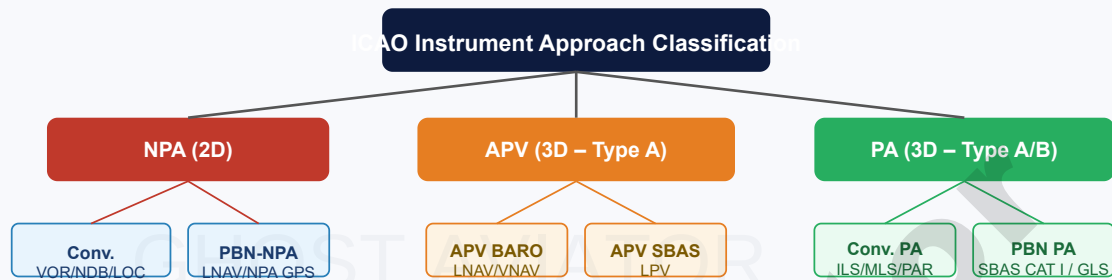


Fig 7 — ICAO Classification of Instrument Approach and Landing Operations



Approach Operation Types

TYPE A VS TYPE B — CRITICAL FOR EXAMS

Type A: Minimum descent height or decision height at or above **75 m (250 ft)**.

Includes: NPA, APV, PA Cat I with DH ≥ 75 m.

Type B: Decision height **below 75 m (250 ft)**.

Categorised as Precision Approach Runway:

- **CAT I:** DH ≥ 60 m (200 ft); RVR ≥ 800 m or visibility ≥ 550 m
- **CAT II:** DH 30–60 m (100–200 ft); RVR ≥ 300 m
- **CAT III:** DH < 30 m (100 ft) OR no DH; RVR < 300 m OR no RVR limitation

CAT II and CAT III operations shall NOT be authorized unless RVR information is provided.

Performance Requirements in Support of Instrument Approach Operations

Type of Approach	Annex 10 System Performance	Annex 6 Approach Operation Category
Non-Precision (NPA)	—	2D – Type A
APV (Vertical Guidance)	—	3D – Type A
Precision Approach (PA)	CAT I, DH $\geq$ 75 m (250 ft)	3D – Type A
	CAT I, DH $\geq$ 60 m (200 ft) and $<$ 75 m (250 ft)	3D – Type B — CAT I
	Category II	3D – Type B — CAT II
	Category III	3D – Type B — CAT III

■ TERMINAL INSTRUMENT FLIGHT PROCEDURE TYPES

- **NPA Conventional:** Ground-based (VOR/DME, NDB, Localiser). Runway visibility $\geq$ 1,000 m.
- **NPA PBN (RNP APCH):** Uses GNSS. Charted as RNAV(GNSS) or RNAV(GPS). Types: RNP App, NPA GPS, LNAV.
- **APV (RNP AR APCH):** 3D guidance but lower performance than PA. Types: APV BaroVNAV, APV SBAS (LPV), LNAV/VNAV.
- **PA Conventional:** ILS, MLS, PAR. 3D approach ops Type A or B.
- **PA PBN:** SBAS Cat I, GLS (GBAS Landing System).

Visual Manoeuvring (Circling)

DEFINITION

Visual manoeuvring (circling) is the phase of flight after an instrument approach has been completed, which brings the aircraft into position for landing on a runway that is **not suitably located for straight-in approach** (i.e., alignment or descent gradient criteria cannot be met).

The Visual Manoeuvring Area

AREA CONSTRUCTION

Arcs centred on each runway threshold, joined by tangent lines. Radius depends on:

- **Aircraft category**
- **Speed** for each category
- **Wind speed: 46 km/h (25 kt)** throughout the turn
- **Bank angle: 20° average or 3° per second**, whichever requires less bank

DESCENT BELOW MDA/H RULES

Descent below MDA/H should NOT be made until ALL three of the following are met:

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

MISSED APPROACH WHILE CIRCLING

If visual reference is lost while circling, the **specified missed approach procedure must be followed**. The pilot will make an initial climbing turn toward the landing runway and overhead the aerodrome, then establish on the missed approach track.

Holding Procedures

General Rules

BANK ANGLE / RATE OF TURN

All turns to be made at a **bank angle of 25°** or at a **rate of 3° per second**, whichever requires the **lesser bank**.

WIND CORRECTION

Pilots should attempt to maintain the track by applying allowance for known wind — both heading and timing corrections. This applies during **entry and while flying in the holding pattern**.

OUTBOUND TIMING

Timing begins **over or abeam the fix**, whichever occurs later. If abeam position cannot be determined, start timing when the turn to outbound is completed.

DME OUTBOUND LEG

If outbound leg is based on a DME distance, it terminates as soon as the limiting DME distance is reached.

Holding Entry — Three Sectors

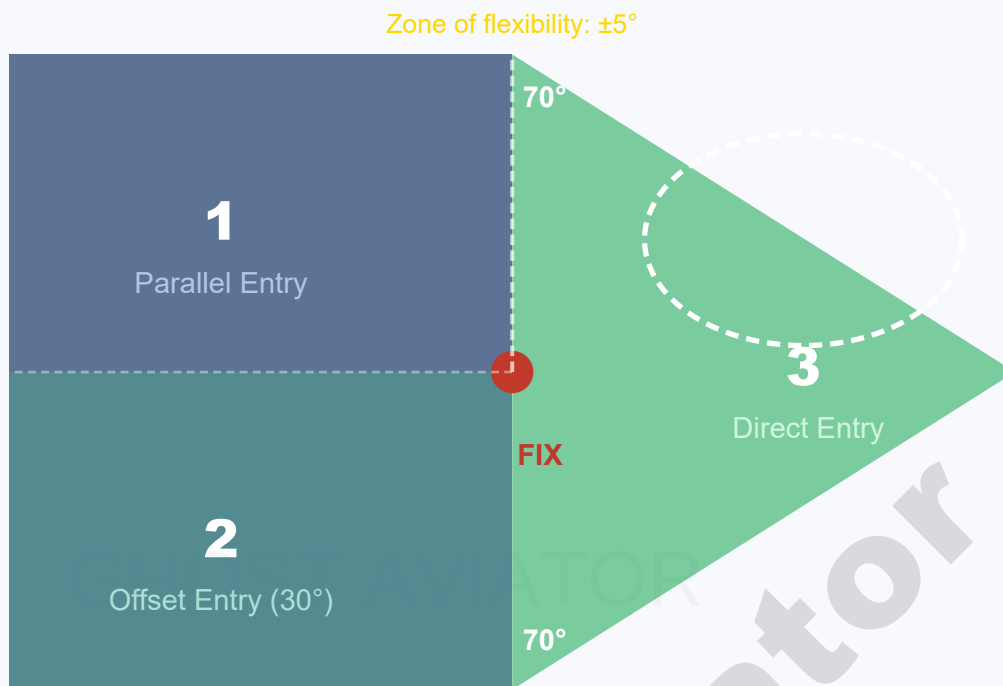


Fig 8 — Holding Pattern Entry Sectors. Sector boundaries have $\pm 5^\circ$ zone of flexibility. Standard holding = turns to the RIGHT.

Holding Entry Procedures

Sector	Entry Type	Procedure
Sector 1	Parallel Entry	At the fix, turn LEFT onto outbound heading for the appropriate period of time; then turn LEFT to intercept inbound track or return to fix; on second arrival, turn RIGHT to follow holding pattern.
Sector 2	Offset Entry (30°)	At the fix, turn to make good a track at 30° from the reciprocal of the inbound track on the holding side; fly outbound for the appropriate time; turn RIGHT to intercept inbound track; on second arrival over fix, turn RIGHT to follow holding pattern.
Sector 3	Direct Entry	Having reached the fix, turn RIGHT to follow the holding pattern.

VOR/DME FIX — ENTRY TRACK LIMITATIONS

- The entry track to a VOR/DME fix is limited to: (a) the VOR radial; (b) the DME arc; or (c) the entry radial to a VOR/DME fix at the end of the outbound leg as published.
- *Note: DME arc entry is specified only when there is a specific operational difficulty making other entry procedures impossible.*



Holding Speeds

Holding Speeds — Categories A through E

Level / Altitude	Normal Conditions	Turbulence Conditions
Up to 4,250 m (14,000 ft)	425 km/h (230 kt) — Cats C,D,E 315 km/h (170 kt) — Cats A,B	520 km/h (280 kt) [or 0.8 Mach] 315 km/h (170 kt) — Cats A,B
4,250 m (14,000 ft) to 6,100 m (20,000 ft) inclusive	445 km/h (240 kt)	520 km/h (280 kt) or 0.8 Mach — lesser
6,100 m (20,000 ft) to 10,350 m (34,000 ft) inclusive	490 km/h (265 kt)	520 km/h (280 kt) or 0.8 Mach — lesser
Above 10,350 m (34,000 ft)	0.83 Mach	0.83 Mach

Notes: Speed of 520 km/h (280 kt) for turbulence requires prior ATC clearance, unless publications indicate the holding area can accommodate it. 315 km/h (170 kt) applies to Cat A and B only.

DME ARC ENTRY — OUTBOUND TIME LIMITS

- At or below **4,250 m (14,000 ft)**: still air time for outbound entry heading must not exceed **1 minute**.
- Above **4,250 m (14,000 ft)**: must not exceed **1.5 minutes**.

MINIMUM HOLDING LEVEL

- Provides clearance of at least **300 m (984 ft)** above obstacles in the holding area.
- Minimum holding altitude published shall be rounded **up** to the nearest 50 m or 100 ft.
- Over high terrain/mountainous areas: additional clearance up to **600 m (1,969 ft)** is provided to accommodate turbulence, down-drafts, and altimeter errors.

Simultaneous ILS Operations on Parallel / Near-Parallel Runways

Modes of Operation for Parallel Instrument Runways

Mode	Name	Description	Runway Separation
Mode 1	Independent Parallel Approaches	Radar separation minima between aircraft using adjacent ILS/MLS are not prescribed .	≥ 1,035 m between C/Ls
Mode 2	Dependent Parallel Approaches	Radar separation minima between aircraft using adjacent ILS/MLS are prescribed .	≥ 915 m between C/Ls
Mode 3	Independent Parallel Departures	Aircraft departing in same direction from parallel runways simultaneously. (Less than specified C/L distance for wake turbulence = single runway.)	≥ 760 m between C/Ls
Mode 4	Segregated Parallel Ops	One runway for approaches, one for departures. Approach runway staggered ≥ 2 NM straight and level minimum. Descent point.	≥ 760 m (reduce by 150m/30% = 300 m min)

RNAV Arrival & Approach — Based on VOR/DME

VOR/DME RNAV APPROACH

Based on one reference facility composed of a **VOR and collocated DME**. The reference facility will be indicated. The VOR/DME RNAV approach is a **non-precision approach procedure**.

RNAV VOR/DME — Key Values by Segment

Segment	FTT Value	Key Rules
STARs (Arrival)	3.7 km (2.0 NM) until 46 km (25 NM) from IAF; 1.9 km (1.0 NM) after	Based on RNP 1 or better; or specific RNAV criteria
Final Approach	MOC = 75 m (246 ft) in primary area	Generally aligned with runway. FAF = fly-by waypoint. Flyover waypoint also provided at runway threshold.
Missed Approach	Area splays at 15° each side from earliest MAPt	MAHF (Missed Approach Holding Fix) defines end of missed approach segment.

Altimeter Setting Procedures

PURPOSE

Provide adequate vertical separation between aircraft and adequate terrain clearance during all phases of flight. Method is based on the following basic principles:

Core Principles

ALTITUDE VS FLIGHT LEVEL

- At or below **transition altitude**: vertical position expressed as **ALTITUDE** (altimeter set to QNH).
- Above **transition altitude**: vertical position expressed as **FLIGHT LEVELS** (altimeter set to 1,013.2 hPa).
- Change from altitude → flight level: at **transition altitude** (on climb).
- Change from flight level → altitude: at **transition level** (on descent).
- Transition layer** = airspace between transition level and transition altitude.

TRANSITION ALTITUDE — CRITICAL VALUES

- Normally specified for each aerodrome by the State.
- Minimum transition altitude in India = 4,000 ft**
- Height above aerodrome: as low as possible but **normally not less than 900 m (3,000 ft)**.
- Calculated height rounded **up** to the next full 300 m (1,000 ft).
- Transition level located **300 m (1,000 ft)** above the transition altitude (to permit concurrent use in cruising flight with vertical separation ensured).
- Flight Level Zero = 1,013.2 hPa**. Consecutive FLs separated by a pressure interval corresponding to at least **500 ft (152.4 m)** in the standard atmosphere.

Pre-Flight Altimeter Test

✓ **QNH / QFE SETTING PRE-FLIGHT OPERATIONAL TEST**

1. With aircraft at a known elevation on the aerodrome, set the altimeter to the current QNH/QFE setting.
2. Vibrate the instrument by tapping unless mechanical vibration is provided.

A serviceable altimeter indicates the elevation/height within a tolerance of:

- Test range 0 to 9,000 m (0 to 30,000 ft): **±20 m or 60 ft**
- Test range 0 to 15,000 m (0 to 50,000 ft): **±25 m or 80 ft**

SET 1013.2

SET QNH

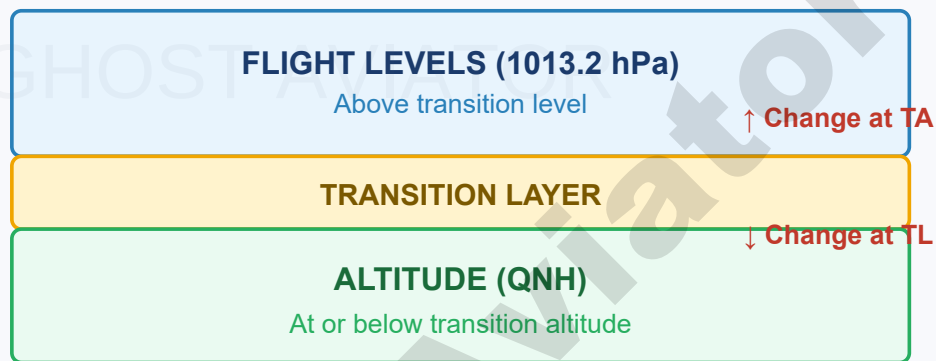


Fig 9 — Altimeter Setting. Change to 1013.2 hPa when CLIMBING through Transition Altitude. Change to QNH when DESCENDING through Transition Level.

Secondary Surveillance Radar (SSR) & Transponder

Key Definitions

SSR

Secondary Surveillance Radar. Uses **transmitters/receivers (interrogators) and transponders**.

ACAS (DEFINITION)

Aircraft system based on SSR transponder signals operating **independently of ground-based equipment** to provide advice to the pilot on potential conflicting aircraft equipped with SSR transponders.

MODE A

To elicit transponder replies for **identity and surveillance**.

MODE C

To elicit transponder replies for **automatic pressure-altitude transmission and surveillance**.



Transponder Operating Procedures

✓ GENERAL OPERATION RULE

When an aircraft carries a serviceable transponder, the pilot shall operate it **at all times during flight**, regardless of whether SSR is used for ATS purposes in that airspace.

Squawk codes are four-digit octal numbers. Dials read 0–7 inclusive. Lowest squawk = **0000**. Highest = **7777**.

📌 CODE SELECTION PRIORITY

1. Operate on Mode A codes **as directed by the ATC unit** with which contact is being made.
2. Operate on Mode A codes as prescribed by **regional air navigation agreements**.
3. In absence of any ATC directions or regional agreements: operate on **Mode A Code 2000**.

CONFIRM SQUAWK PROCEDURE

When ATC requests "CONFIRM SQUAWK (code)", the pilot shall:

1. Verify the Mode A code setting on the transponder.
2. Reselect the assigned code if necessary.
3. Confirm to ATC the setting displayed on the transponder controls.

 **Pilots shall NOT SQUAWK IDENT unless requested by ATC.**



Emergency Squawk Codes

7700

GENERAL EMERGENCY

7600

COMMUNICATION FAILURE

7500

UNLAWFUL
INTERFERENCE (HIJACK)

EMERGENCY TRANSPONDER RULES

- **7700 (Emergency):** Set unless ATC has previously directed to operate on a specified code. However, pilot may select 7700 whenever there is specific reason to believe it is the best course of action.
- **7600 (Comm Failure):** Set when losing two-way communications. Controller will determine extent of failure by instructing pilot to SQUAWK IDENT or change code.
- **7500 (Unlawful Interference):** If circumstances warrant, Code 7700 should be used instead. If ATC requests pilot to confirm 7500, pilot shall — according to circumstances — **either confirm or not reply at all**. Non-reply = confirmation that 7500 is not an inadvertent selection.

TRANSPONDER FAILURE AFTER DEPARTURE

ATC units shall attempt to provide for continuation of the flight to the destination aerodrome in accordance with the flight plan. Pilots may, however, expect to comply with specific restrictions.

ACAS — Airborne Collision Avoidance System

■ PURPOSE OF ACAS

ACAS indications shall be used by pilots in the avoidance of potential collisions, enhancement of situational awareness, and the active search for, and visual acquisition of, conflicting traffic.

Nothing in ACAS procedures prevents pilots-in-command from exercising their best judgment and full authority in the choice of the best course of action.



ACAS Operations — Surveillance

📌 SURVEILLANCE RANGE

- Nominal surveillance range: **26 km (14 NM)**
- Minimum guaranteed range when airborne: **8.5 km (4.5 NM)**
- Range can be reduced in geographic areas with large numbers of ground interrogators and/or ACAS-equipped aircraft.



TA vs RA — Critical Distinction

TRAFFIC ADVISORY (TA)

- Intended to **alert pilots** to the possibility of an RA, to enhance situational awareness, and to assist in visual acquisition of conflicting traffic.
- Pilots shall **NOT manoeuvre** in response to TAs only.
- On receipt of a TA, use all available information to **prepare for appropriate action** if an RA occurs.
- TAs can be issued against any Mode C transponder-equipped aircraft.

RESOLUTION ADVISORY (RA) — MANDATORY ACTIONS

1. **Respond IMMEDIATELY** by following the RA as indicated, unless doing so would jeopardize safety.
2. Follow the RA even if there is a **conflict between RA and ATC instruction** to manoeuvre.
3. **Do NOT manoeuvre in the opposite sense** to the RA.
4. As soon as possible, **notify the appropriate ATC unit** of the RA, including the direction of any deviation.
5. Promptly comply with any **modified RAs**.
6. Limit alterations to the **minimum extent** necessary.
7. Promptly return to ATC clearance when conflict is resolved.
8. Notify ATC when returning to the current clearance.

ACAS COLLISION AVOIDANCE — KEY RULES

- TAs can be issued against any transponder-equipped aircraft responding to Mode C interrogations, even without altitude-reporting capability.
- RAs can be issued **only against aircraft that are reporting altitude** and in the vertical plane only.
- RAs against ACAS-equipped intruders are coordinated to ensure complementary RAs are issued.
- Failure to respond to an RA deprives the aircraft of collision protection AND restricts the other aircraft's ACAS choices.
- Manoeuvring in the opposite direction to an RA is **likely to result in further reduction in separation**.

ACAS ALERT PRIORITY ORDER

The following alerts take precedence over ACAS:

- **Stall Warning**
- **Wind Shear Warning**
- **Ground Proximity Warning System (GPWS) alerts**

GHOST AVIATOR

Ghost Aviator

GHOST AVIATOR

DGCA Question Bank & Answer Key

Selected practice questions — 102 questions total

Key Questions — Departures & PDG

Q1**PANS-OPS means:**

- A) Procedures for Air Navigation Services - Aircraft operations
- B) Pilots Alternate Navigational Systems and Operational Procedures
- C) Procedures for Air Navigation Systems - Airfield operations

Answer: A**Q2****The document that specifies recommendations for instrument procedures is called...**

- A) PANS OPS Doc 8168
- B) The Convention of Chicago
- C) The Air Navigation bulletin

Answer: A**Q3****Which defines transition altitude?**

- A) Altitude above which vertical position determined by local QNH
- B) Altitude below which vertical position is determined by reference to QNH
- C) Altitude at which 1013 hPa is set and vertical position reported as FL

Answer: C**Q4****The Transition Level:**

- A) Published in Section ENR of the AIP
- B) Shall be the lowest FL available for use above the transition altitude
- C) Is calculated and declared for an approach by the Pilot-in-command

Answer: B**Q5****During flight through the transition layer the vertical position should be expressed as:**

- A) Altitude above MSL during climb
- B) Either altitude above MSL or FL during climb
- C) Altitude above MSL during descent

Answer: C**Q6****Transition from altitude to FL, and vice versa, is done:**

- A) At TL during climb and TA during descent
- B) At TA during climb and TL during descent
- C) Only at transition altitude

Answer: B

Q10

The transition altitude of an aerodrome should not be below:

- A) 4000 ft
- B) 1000 ft
- C) 1500 ft

Answer: A

Q11

Pilot of departing aircraft under IFR shall change altimeter from QNH to 1013.25 hPa when passing:

- A) Transition layer
- B) Level specified by ATC
- C) Transition altitude

Answer: C

Q88

What is the obstacle clearance in the intermediate approach segment?

- A) 300 m (984 ft)
- B) 200 m (656 ft)
- C) Reducing from 300 m to 150 m

Answer: C

Q91

In relation to three entry sectors, entry into holding pattern shall be according to:

- A) Course
- B) Track
- C) Heading

Answer: C

Q92

Zone of flexibility on either side of sector boundaries in holding entry:

- A) 5°
- B) 20°
- C) 10°

Answer: A

Q93

What is the outbound timing in a holding pattern above FL 140?

- A) 2 minutes
- B) 1 minute
- C) 1 minute 30 seconds

Answer: C

Q94

In a holding pattern all turns are to be made at:

- A) Rate of 3°/sec or bank angle of 25°, whichever lesser bank
- B) Rate of 3°/sec
- C) Rate of 3°/sec or bank angle of 20°, whichever lesser bank

Answer: A

Q95

In a standard holding pattern turns are made:

- A) To the left
- B) To the right
- C) In a direction depending on wind direction

Answer: B

Complete Answer Key (All 102 Questions)

Question Bank – Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	A	3	C	4	B	5	C	6	B	7	A
8	C	9	B	10	A	11	C	12	B	13	C	14	C
15	C	16	A	17	C	18	A	19	B	20	C	21	B
22	A	23	A	24	B	25	A	26	C	27	A	28	B
29	C	30	A	31	C	32	A	33	B	34	C	35	C
36	B	37	B	38	A	39	C	40	C	41	A	42	C
43	B	44	A	45	B	46	A	47	A	48	A	49	B
50	C	51	C	52	B	53	C	54	C	55	C	56	A
57	C	58	A	59	A	60	A	61	B	62	B	63	C
64	A	65	A	66	A	67	C	68	C	69	A	70	B
71	A	72	A	73	C	74	A	75	B	76	C	77	B
78	B	79	A	80	B	81	A	82	C	83	B	84	A
85	C	86	B	87	C	88	C	89	C	90	B	91	C
92	A	93	C	94	A	95	B	96	B	97	A	98	A
99	C	100	C	101	A	102	B	–	–	–	–	–	–

Critical Numbers — Must Memorise

All the key figures from PANS-OPS Chapter 13 in one place

GHOST AVIATOR

Ghost Aviator

GHOST AVIATOR

PANS-OPS Chapter 13 — Critical Numerical Values

Topic	Value	Unit	Context
Standard PDG (fixed-wing)	3.3%	gradient	Unless otherwise published
Standard PDG (helicopters)	5.0%	gradient	Cat H procedures
OIS gradient (basis of PDG)	2.5%	gradient	Obstacle Identification Surface
MOC increase rate from DER	0.8%	of horizontal dist	Departure, max turn 15°
MOC in turn initiation area	90 m (295 ft)	m / ft	Departure turns
Straight departure track alignment	±15°	degrees	From runway C/L
Min altitude before turn (fixed-wing)	120 m (394 ft)	m / ft	Above aerodrome elevation
Min altitude before turn (Cat H)	90 m (295 ft)	m / ft	Helicopter turns
Turn initiation distance from runway start	600 m	m	Normal design optimisation
Close-in obstacle gradient not published	≤60 m (200 ft)	m / ft	A note published instead
MSA / TAA obstacle clearance	300 m (1,000 ft)	m / ft	Within 46 km (25 NM)
Initial approach MOC	300 m (1,000 ft)	m / ft	Primary area
Intermediate approach MOC (start)	300 m (984 ft)	m / ft	Reduces to 150 m
Intermediate approach MOC (end)	150 m (492 ft)	m / ft	Primary area
NPA MOC with FAF	75 m	m	Final approach
NPA MOC without FAF	90 m	m	Final approach
FAF optimal distance from threshold	9.3 km (5.0 NM)	km / NM	NPA with FAF
FAF maximum length from threshold	19 km (10 NM)	km / NM	NPA with FAF

Topic	Value	Unit	Context
FA interception angle (precision)	90°	degrees	Max angle at IF
FA interception angle (non-precision)	120°	degrees	Max angle at IF
Straight-in approach alignment	≤30°	degrees	NPA acceptable angle to C/L
Missed approach gradient (standard)	2.5%	gradient	Minimum climb
MA intermediate phase turn	Max 15°	degrees	From initial MA track
MA final phase MOC (fixed-wing)	50 m (164 ft)	m / ft	Start of final MA phase
MA final phase MOC (Cat H)	40 m (131 ft)	m / ft	Cat H final MA
CAT I DH minimum	60 m (200 ft)	m / ft	Precision approach
CAT I RVR minimum	800 m	m	Or visibility 550 m
CAT II DH range	30–60 m (100–200 ft)	m / ft	RVR ≥ 300 m
CAT III DH	<30 m (100 ft)	m / ft	Or no DH; RVR < 300 m
Type A minimum DH/MDH	≥75 m (250 ft)	m / ft	2D/3D Type A operations
Holding turn bank / rate	25° or 3°/sec	°/sec	Whichever requires lesser bank
Holding entry zone of flexibility	±5°	degrees	Either side of sector boundaries
Holding speed ≤ 14,000 ft (Cat C,D,E)	230 kt	kt	Normal; 280 kt turbulence
Holding speed ≤ 14,000 ft (Cat A,B)	170 kt	kt	Normal and turbulence
Holding outbound time ≤ 14,000 ft	1 minute	min	Outbound leg timing
Holding outbound time > 14,000 ft	1.5 minutes	min	Above 4,250 m
Min holding clearance (normal)	300 m (984 ft)	m / ft	Above obstacles

Topic	Value	Unit	Context
Min holding clearance (mountainous)	600 m (1,969 ft)	m / ft	High terrain areas
India minimum transition altitude	4,000 ft	ft	INDIA specific
Altimeter test tolerance (0–30,000 ft)	±20 m / 60 ft	m / ft	Pre-flight test
Altimeter test tolerance (0–50,000 ft)	±25 m / 80 ft	m / ft	Pre-flight test
ACAS nominal surveillance range	26 km (14 NM)	km / NM	Nominal
ACAS minimum guaranteed range	8.5 km (4.5 NM)	km / NM	When airborne
Circling wind speed assumption	46 km/h (25 kt)	kt	Throughout the turn
Circling bank angle assumption	20° or 3°/sec	° / °/sec	Whichever requires less bank
SBAS straight departure FSD	0.3 NM	NM	From DER to turn initiation
Mode 1 parallel runway C/L separation	≥1,035 m	m	Independent parallel approaches
Mode 2 parallel runway C/L separation	≥915 m	m	Dependent parallel approaches