# ICAO APAC FPP

# RNP AR online Workshop

2026

# RNP AR Procedure Design
# Final Approach Segment

ICAO DOC 9905

## Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual

# Learning Objectives

- **Upon completion of this module, you will be able to:**
  - • Explain RNP navigation accuracy requirements for final approach segment
  - • Describe FAP (Final Approach Point) positioning and calculation methods
  - • Apply RF leg design criteria in final approach segment
  - • Calculate Vertical Path Angle (VPA) and temperature limitations
  - • Understand VEB (Vertical Error Budget) and OAS (Obstacle Assessment Surface)

# RNP Navigation Accuracy Requirements

- **Accuracy Range:**
  - • Least Stringent: 0.3 NM
  - • Most Stringent: 0.1 NM
- **Key Principle:**
  - More stringent RNP only if significant operational advantage obtained
- **Multiple Minima:**
  - • When RNP < 0.3 NM published, also publish OCA/H for RNP 0.3 NM
  - • If 0.3 NM not possible, use highest practicable RNP

# Segment Length

- **Length Requirements:**
  - • Maximum Length: Not specified
  - • Minimum Length: Per PANS-OPS Vol.II Part I Sec 4 Chap 5
- **Critical Requirements:**
  - ✓ Must accommodate descent required
  - ✓ Must provide straight stabilized segment prior to OCA/H

# Alignment - Straight-in Approaches

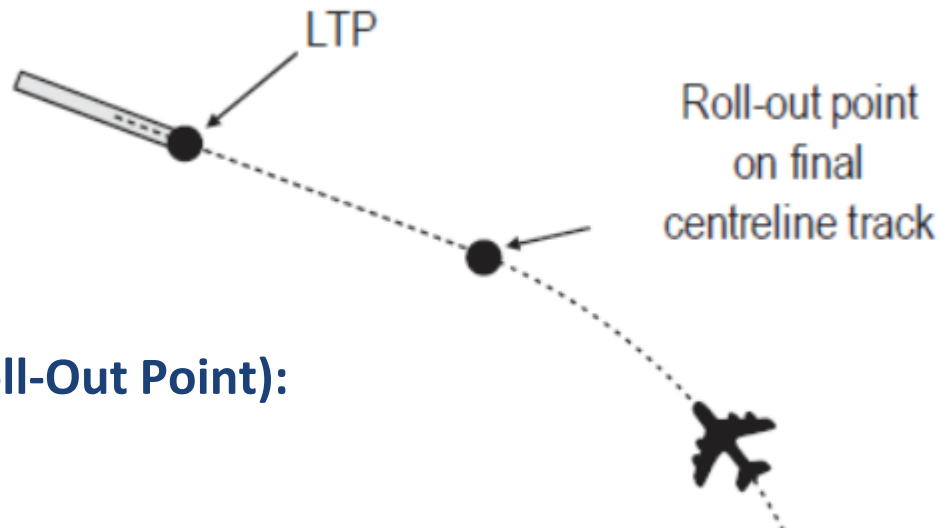
- **Optimum: TF segment straight from FAP to LTP on runway centreline**

- **Permitted Offset (max 5°):**
  - a) Intercept height ≥ 55 m (180 ft) above LTP
  - b) OCA/H ≥ Intercept altitude + 20 m (66 ft)
  - c) Chart annotation: 'Final approach track offset X.X degrees'

- ⚠ NOT permitted as noise abatement measure

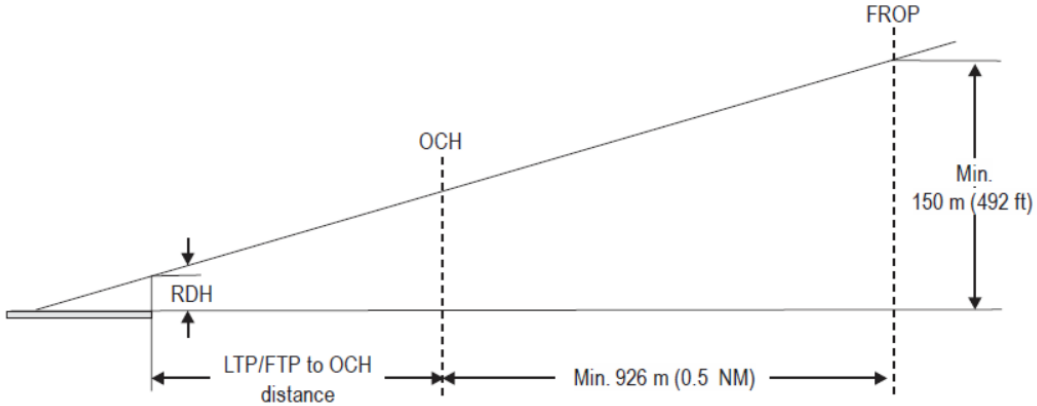
# Turns in Final Approach - RF Legs

| Turn Type | Permitted |
|---|---|
| RF Leg | ✅ Yes |
| Fly-by Turn | ❌ No |



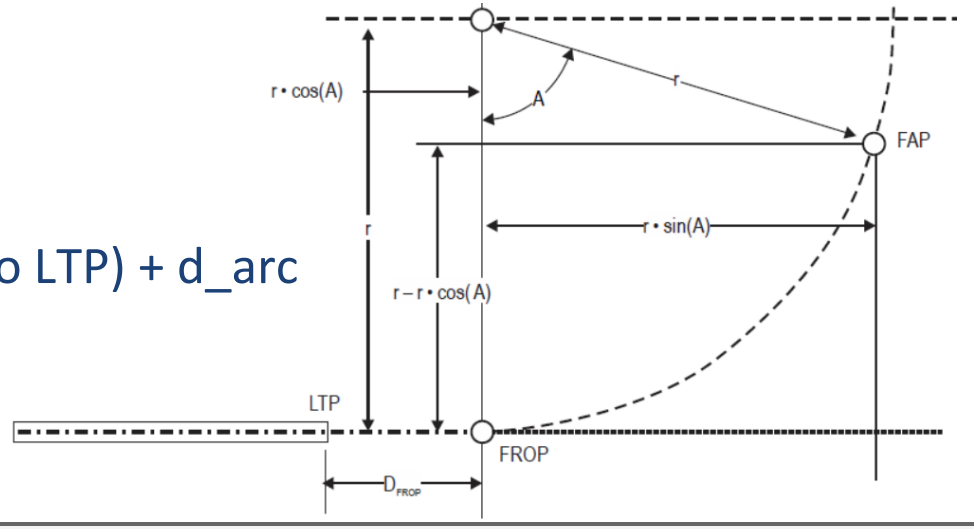

- **Straight Segment Required (FROP - Final approach Roll-Out Point):**

- **<u>Greater of:</u>**
  - a) Altitude: $D_{150}$ = (150-RDH)/tan(VPA) meters
    - or (492-RDH)/tan(VPA) feet
  - b) Distance: 926 m (0.5 NM) before OCA/H



# FAP Location and Calculation

- **FAP Definition:**
  - Point where VPA from RDH above LTP intersects intermediate altitude
- **Straight Segment Coordinates:**
  - • Use reciprocal of final approach true track (true track - 180°)
  - • Calculate geodetically from LTP/FTP
- **With RF Leg:**
  - D_FAP = (a - RDH)/tan(VPA) = d(Distance from FROP to LTP) + d_arc
  - Where: a = FAP altitude - THR elevation



# Vertical Path Angle Requirement

- **VPA Limits:**
  - • Minimum: 2.5°
  - • Optimum: 3.0°
  - • Maximum Effective: 3.5°

- **Conditions:**
  - a) Effective VPA at min temp ≥ 2.5°
  - b) Effective VPA at max temp ≤ 3.5°

- **Chart Publication Required:**
  - • Temp where effective VPA exceeds 3.5°
  - • Minimum authorized temperature limit

# RDH and VASIS Coordination

- **RDH Values:**
  - • Standard: 15 m (50 ft)
  - • Short runways (Code 1&2): min 12 m (40 ft)

- **VASIS(visual approach slope indicator system) Coordination:**
  - • Optimize VPA to equal VASIS GP angle at prevailing temp
  - • Chart note required if difference > 0.2°

# Temperature Effects

- **Principle:**
  - BARO-VNAV vertical guidance affected by ISA deviation
- **ISA Calculation:**

| | |
|---|---|
| SI | $ISA_{airport} = 15 - (0.0065 \times Airport_{elev})$ °C |
| Non-SI | $ISA_{airport} = 15 - (0.00198 \times Airport_{elev})$ °C |

# Temperature Effects

- **Principle:**
  - BARO-VNAV vertical guidance affected by ISA deviation

- **Use 5-year history (or longer) for temperature range**
- **Determine coldest temperature in month with lowest average temperature for each year**
- **Average of 5 values = average coldest temperature**

  - Calculate: $\Delta ISA_{LOW} = -(ISA^{\circ}C - ACT^{\circ}C)$
    - ACT = Average Coldest Temperature

# Minimum VPA Calculation

- **Min VPA = Greater of**
  - 2.5° or:
  - $\text{Min VPA} = \arctan\left[\frac{a - RDH - \Delta h}{D_{FAP}}\right]$
- **Where:**
  - $\Delta h = \left(\frac{\Delta ISA_{LOW}}{L_0}\right) \times \ln\left[1 + \frac{L_0 \times a}{T_0 + L_0 \times h_{THR}}\right]$
- **Published Limit:**
  - NA below = ISA + ΔISA_LOW
  - published low temperature limitation： “NA below”

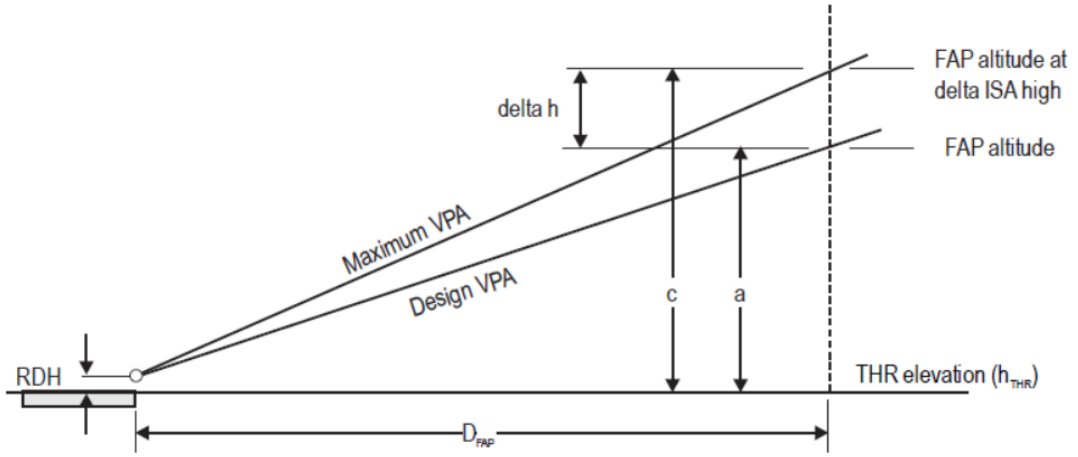
| | |
|---|---|
| $L_0$ | Standard temperature lapse rate (-0.0065°/m or -0.00198°/ft) |
| $T_0$ | Standard temperature at sea level (288.15 K) |
| $h_{THR}$ | THR elevation |

# High Temperature Limit

- **Calculate ΔISA_HIGH for effective VPA = 3.5° :**

$$\Delta ISA_{HIGH} = L_0 \times \frac{\tan(3.5^\circ) \times D_{FAP} + RDH - a}{\ln\left[1 + \frac{L_0 \times a}{T_0 + L_0 \times h_{THR}}\right]}$$

- **Published Limit:**
  - STEEPabove = ISA_airport + ΔISA_HIGH
  - published high temperature： STEEPabove



# OAS VEB

- **Parameters**
  - 
  - 

| Parameter | Source |
|---|---|
| $D_{VEB}$ (OAS origin distance from LTP) | Appendix A (SI) or B (non-SI) |
| OAS Gradient | Appendix A or B |

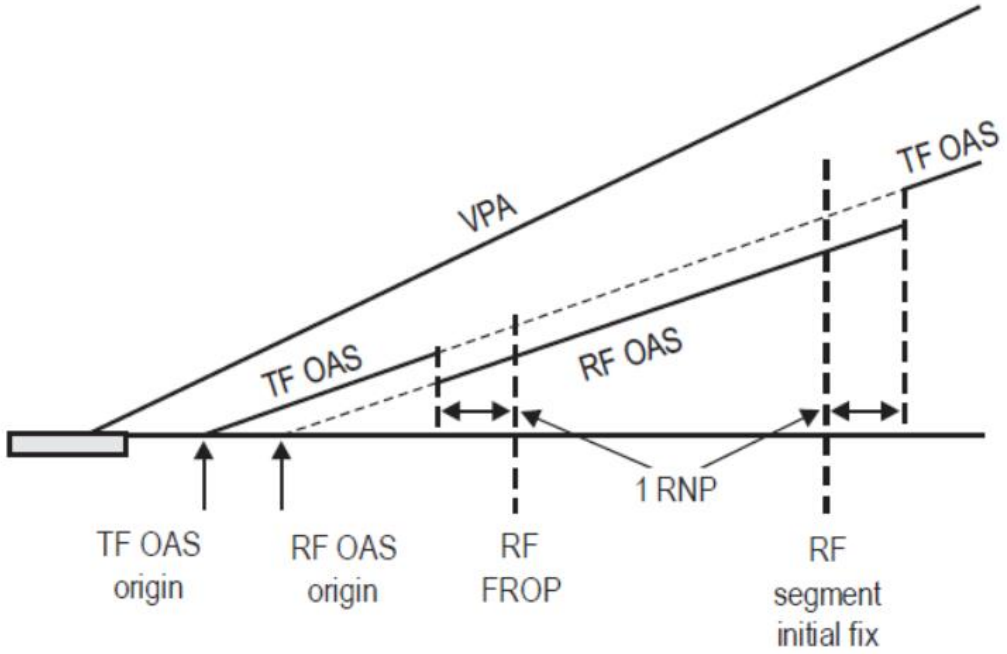
- **OAS Height Calculation:**
  - $$OAS_{HGT} = OAS_{gradient} \times (x - D_{VEB})$$

    Where:

    - $x$ = distance from LTP to obstacle

# Aircraft Body Geometry Adjustment

- Wings Level: 8 m (26 ft) assumed
- **Banked Turn:**
  - bg = 40 × sin(design bank + 5°) meters
  - bg = 132 × sin(design bank + 5°) feet
- Max design bank: 25°
- ⚠ Recalculate VEB if VPA increased to eliminate penetration



# Visual Segment Protection

- Reference: PANS-OPS Vol.II Part I Sec 4 Chap 5, 5.4.6

- **RNP AR Modifications:**

| Parameter | Standard | RNP AR Modification |
|---|---|---|
| VSS lateral limit | - | **2 RNP** |
| VSS OCS lateral limit | - | **1 RNP** each side of nominal approach track |


# Let's Focus/Propose/Plan Together