Missed Approach Segment

TNA Exercise

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# Data

MAPt = VOR

Obstacles (distances based on MAPt and nominal track)

O1

From: 8600m

Right: 6300m

Elevation: 882m

O2

From: 16200m

Left: 2200m

Elevation: 795m

O3

From: 25500m

Left: 3100m

Elevation: 3776m

Aerodrome elevation: 1000ft or 305m

Final Approach OCA: 1300ft or 397m

Cat D aircraft

# Requirement

Design the protection area including turn protection. It must address all obstacles and avoid O3.

# Initial segment – MAPt to SOC

**Semi-width protection area = 1nm or 1852m**

**Secondary area width = 0.5nm or 926m**

Distance from MAPt to SOC is:

IAS used is final approach speed up to SOC

IAS for Cat D aircraft from table I-4-1-1 and -2. Use maximum.

IASmax = 345km/h or 185kts

Using ISA + 15°C, and aerodrome elevation, convert to TAS

TASmax = 359.17km/h

Use 19km/h tailwind

GSmax = 378.17km/h

Navaid used for missed approach is a VOR, tracking tolerance is ±7.8°

MAPt tolerance is 0 because it is based on a navaid

Reaction time c is 3 seconds

Time to SOC is 15s

**Total distance is reaction time + time to SOC = 1890.83m**

Initial missed approach segment area semi-width at SOC = initial semi-width + (distance from MAPt \* tan(tracking tolerance)

**Semi-width at SOC = 2111.01**

**Secondary area width at SOC = 1055.51m**

# Intermediate segment – SOC to TNA

Nominal gradient = 2.5%

MOC in primary area is 30m

Plot obstacles

O1 is outside the protection area so must be cleared during the turn by 50m

Protection area semi-width at O1 = initial semi-width + (distance from MAPt \* tan(tracking tolerance)

**Semi-width at O1 = 3030.06**

**Secondary area width at O1 = 1515.03m**

Calculate distance do

**do = 3239.70m**

TNA at O1 is Obstacle elevation + MOC – (do \* gradient)

**TNA at O1 is 2800ft**

O2 is in secondary area

Applicable MOC for O2 is 27.58m

**TNAO2 = MOCA50 at O2 = 3000ft**

Establish the gradients and altitudes that will clear the obstacle and its corresponding MOCA located within the protection area.

Using the OCA at the MAPt and the MOCA at the obstacle O2 in ft, calculate the missed approach gradient.

**The gradient required to clear MOCAO2 is 3.4%**

The altitude achieved at the obstacle using the 2.5% nominal gradient is 753.97m. This is below MOCAO2.

A 2.5% gradient must be published therefore the only option is to raise the final approach OCA.

Using a 2.5% gradient the new OCAs are:

**OCA2.5% = 1680ft or 509.85m**

The limiting TNA is the highest of the TNA’s for O1 and O2.

**TNAO2 is the limiting value. TNA = 3000ft**

Establish where TNA occurs as a distance from SOC. This gives the point at which the limiting obstacle is cleared by the minimum 50m MOC and is maintained throughout the turn.

Using a 2.5% gradient and the OCA30, distance from SOC is 16093.44m

Using a 3.4% gradient with the original OCA, distance from SOC is 15203.50m

Use 2.5% gradient distance as start of Final Missed Approach Segment

# Final Missed Approach Segment – TNA onwards

Start of turn is based on reaching the TNA using the limiting gradient. The parameters to use for the turn are:

TNA = 3000ft

Temp = ISA + 15°

Angle of Bank = 15°

Reaction time = 3s

Bank establishment time = 3s

Wind speed = 30kts or 56km/h

IAS for Cat D aircraft from table I-4-1-1 and -2. Use maximum.

IAS = 490km/h or 265kts

Calculate TAS at the TNA

TAS = 525.66km/h

Apply a 30kts tailwind

GS = 581.66km/h

Calculate the latest Turning Point (TP)

The latest (TP) is the distance covered in 6s (reaction time + AoB establishment time)

**c = 969.44m**

Calculate bounding circles to establish the outer area boundary for the turn. This will identify whether the obstacle we are trying to avoid is within or outside the protected area.

Bounding circles

Calculate the radius using the TAS

**r = 8113.69m**

Draw a circle with radius r starting at the latest TP

Calculate E90

**E90 = 1357.75m**

Draw this circle at the end of the radius

Calculate radius at 0°, 90° and 180°

**r0 = 8226.51m**

**r90 = 9471.43m**

**r180 = 10829.18m**

Draw these circles and extend the secondary area to outer area of bounding circles

Establish whether obstacle is outside turning area or not.

**Obstacle we are trying to avoid is outside bounding circles. No further changes required.**

# Summary

* Limiting obstacle is O1 giving a TNA of 3000ft.
* To clear obstacle O2, a steeper climb gradient is required.
* 2.5% climb gradient OCA/H is 1680ft.
* 3.4% climb gradient OCA/H is 1300ft
* Obstacle O3 is cleared with a turn at the TNA. Obstacle cleared by bounding circles by approximately 302.01m laterally. A slower speed could be used/mandated to increase clearance. The use of wind spirals would make the protection area smaller whilst complying with design criteria. A combination of these two would also increase clearance.