PANS-OPS Flight Procedure Design Training for CAAs

23 August – 03 September 2021

15 – Departure procedures

(Doc. 8168, Vol. 2, Part I, Section 3, Chap. 1 to 6)

Outlines

1. Introduction
2. General concept
3. Departure routes
4. Straight departure
5. Turning departure
6. Average path
7. Omnidirectional departures

Introduction

- Criteria apply to:
  - Conventional navigation;
  - Same design principles but specific criteria:
    - Helicopters (not part of this course);
    - PBN departures (PANS-OPS, part II)
- Departure procedures:
  - Specific routes (departure routes);
  - Omnidirectional departure).
- Design assume normal operation and all engines operational:
  - Provision of contingency procedures for abnormal and emergency operation by the air operator.

Introduction

- Input data for designing departure segments:
  - Location of facility to provide guidance;
  - ATC constraints;
  - Environmental constraints;
  - Obstacles.
- Goal:
  - **Identify** obstacles associated with promulgated segments protection area;
  - **Compute required MOC** for each obstacle regulation
  - **Compute minimum slope** for departure trajectory.

General concept

- Aircraft parameters:
  - IAS:
    - Mostly used to protect turns;
    - From 1.1 time Final Missed Approach IAS;
    - Down to 1.1 time Intermediate missed approach IAS.
  - Bank angle : 15°;
  - Flight technical Tolerances;
    - Bank establishment time 3 s;
    - Reaction time : 3 s.

Missed approach maximum speed				
Cat.	Initial & intermediate		Final	
	M. A	X1.1	M.A	X1.1
A	100	110	100	110
B	130	165	150	143
C	160	264	240	176
D	185	291.5	265	203.3

Beginning and end or departure segment

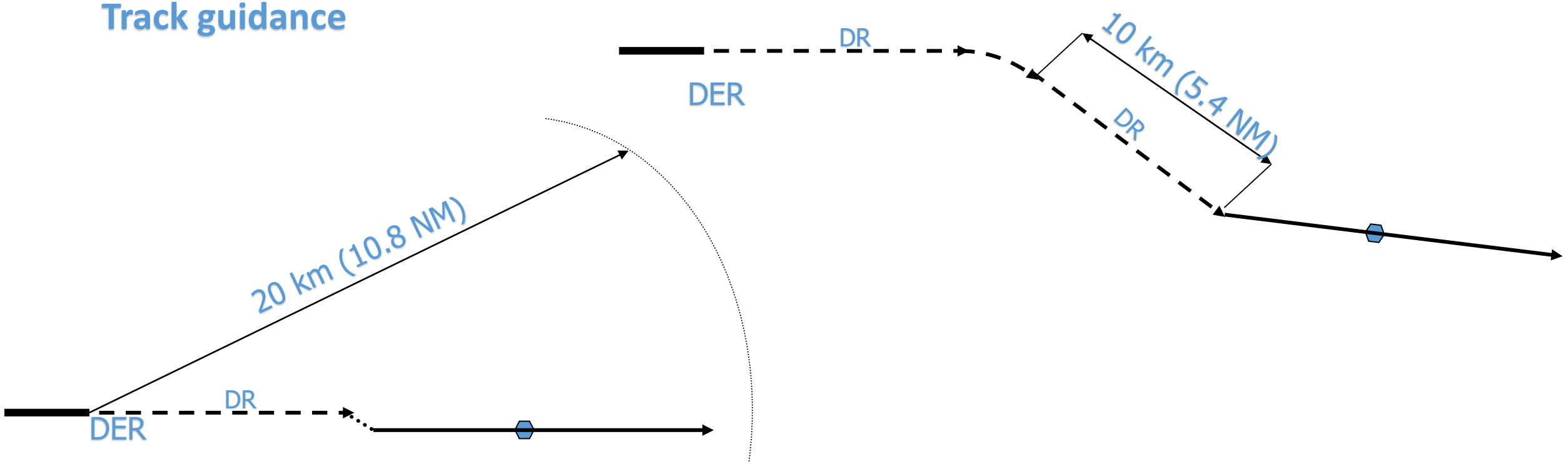
- Beginning:
  - ☞DER (Departure End of Runway)
    - Location : End of runway or clearway if any
    - Elevation: Highest point (end of RWY or clearway)
- End:
  - ☞minimum altitude for the next phase of flight .

Type of departures

- Straight departure:
  - With guidance (facility in front, behind, offset).
  - Without guidance :
    - along RWY centerline
    - Not along RWY centerline.
- Turning departure:
  - No turn below 120 m (400 m) above DER.

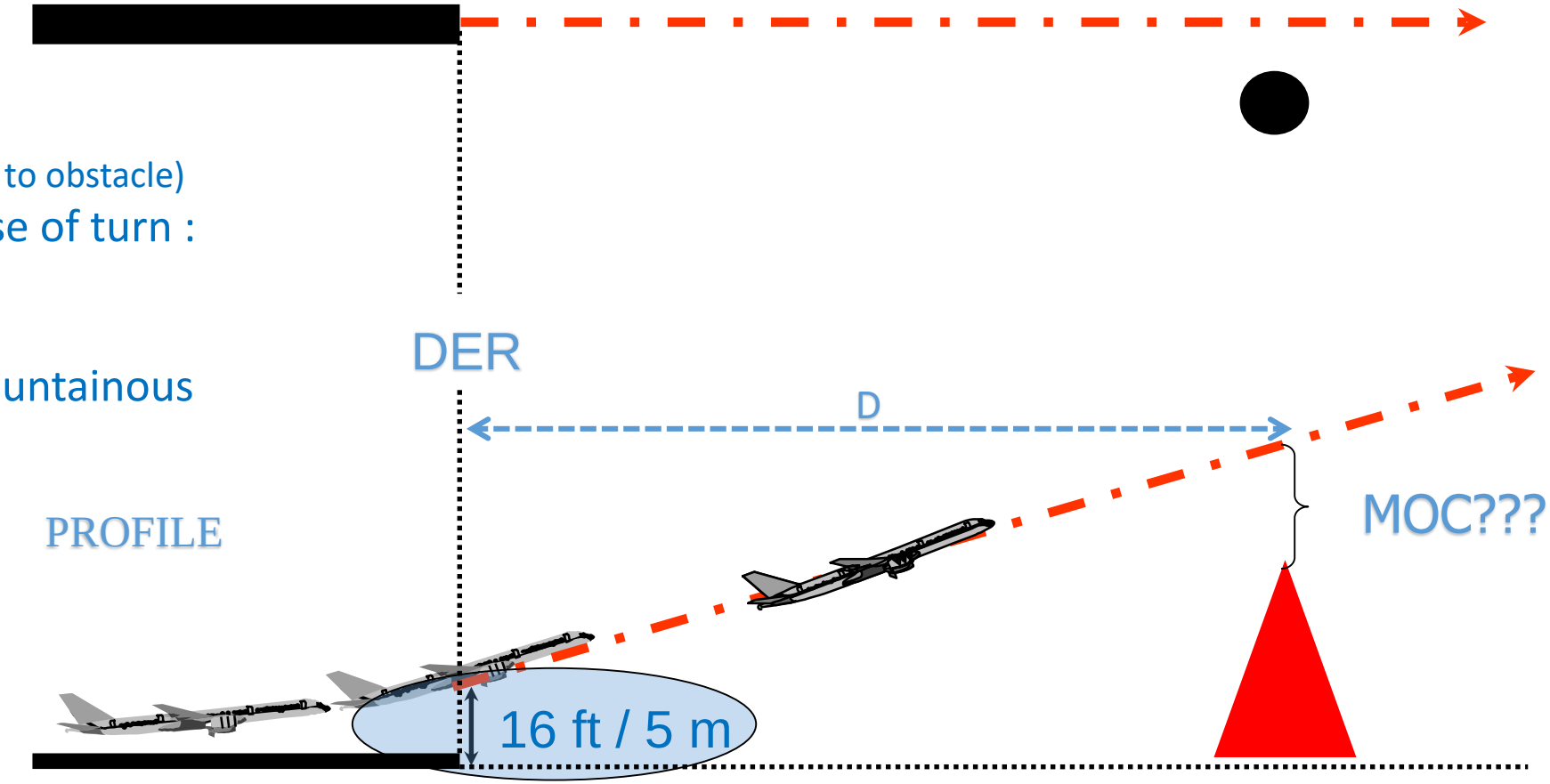
General concept

Track guidance

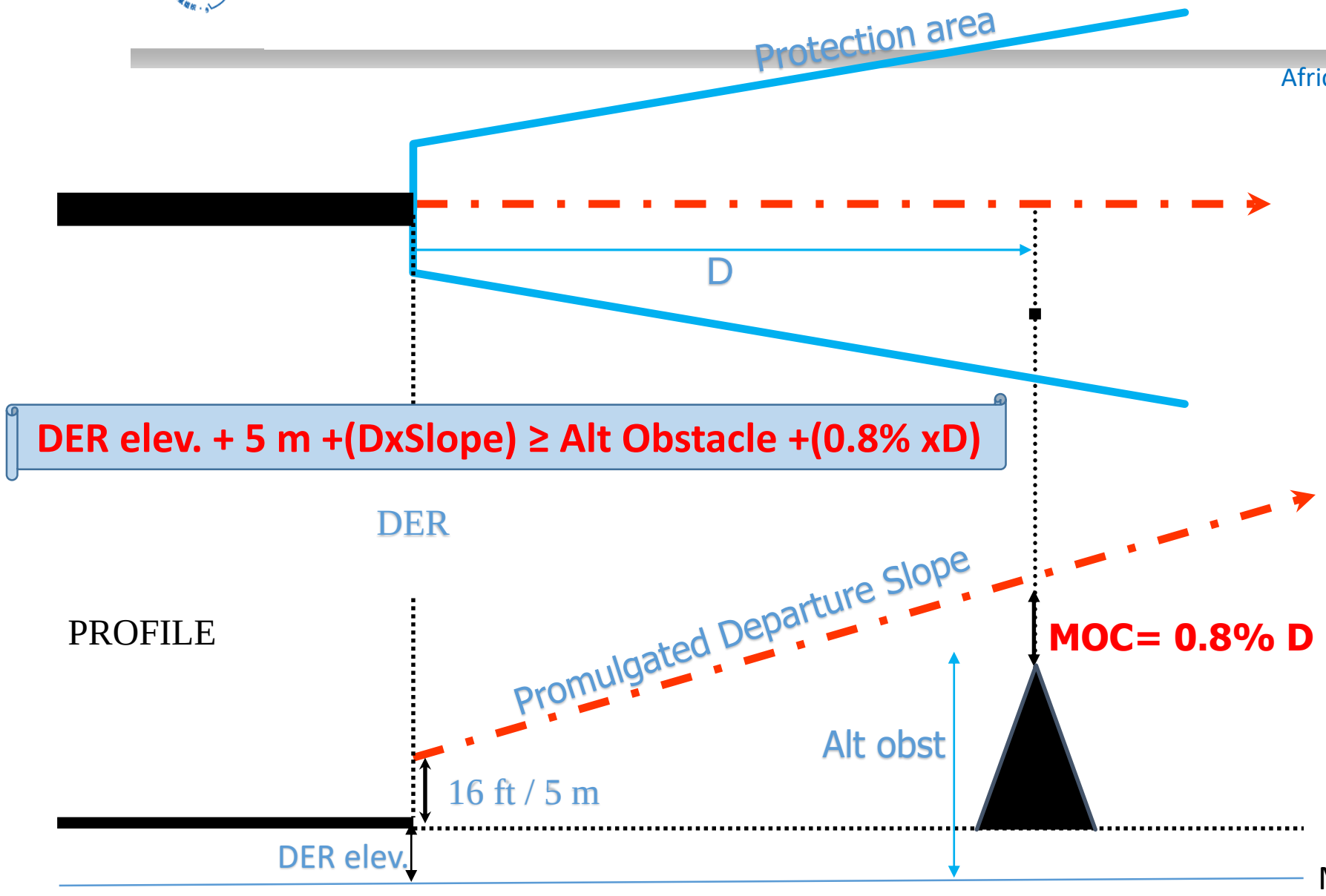


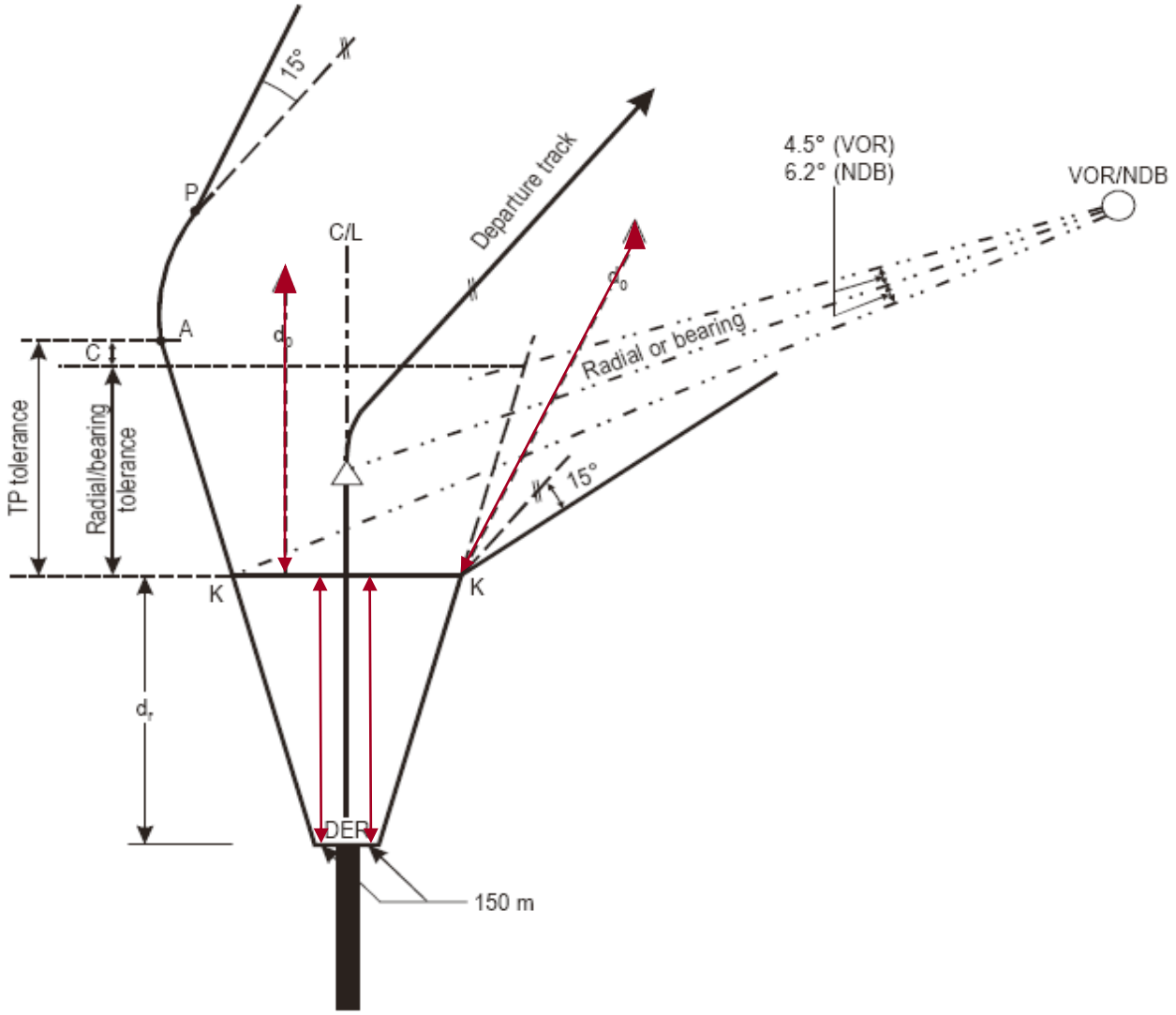
Minimum Obstacle Clearance

- **Varies** with D:
  - Full MOC :
    - 0.8% of **measured** distance (DER to obstacle)
- Specific **minimum** value in case of turn :
  - 75 m / 295ft
  - turn over 15°
- To be increased in case of mountainous terrain.



Protection criteria

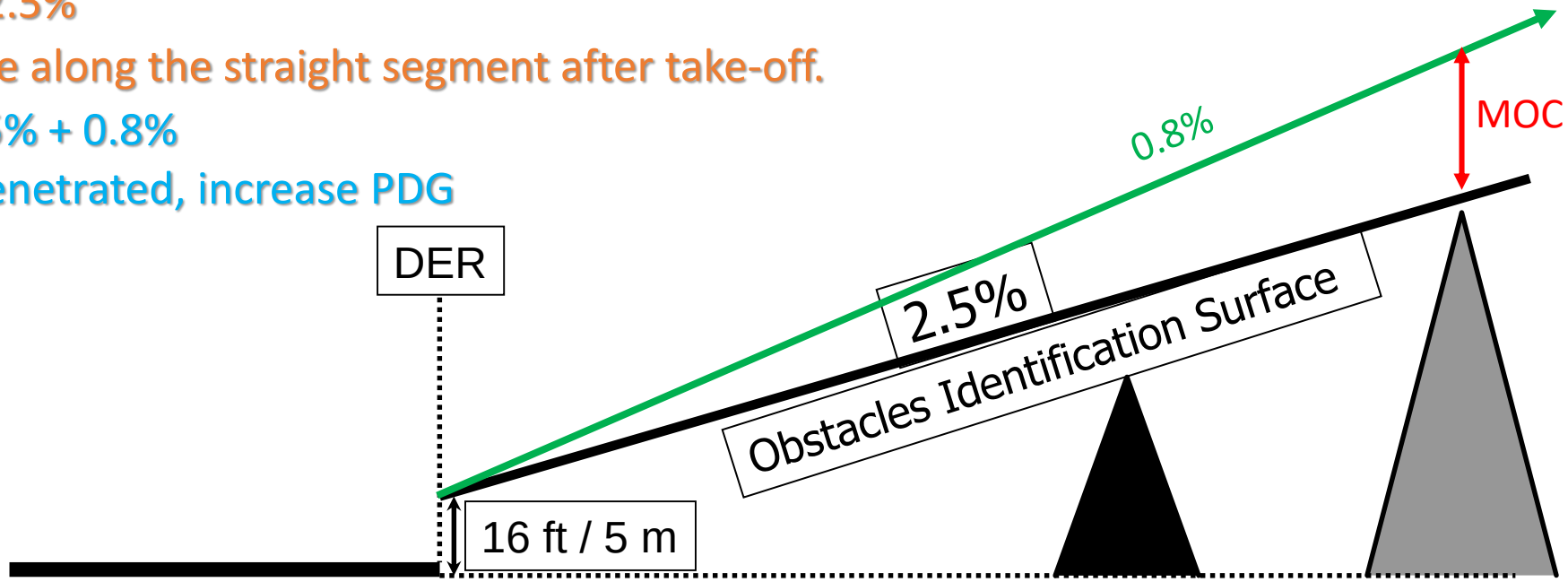




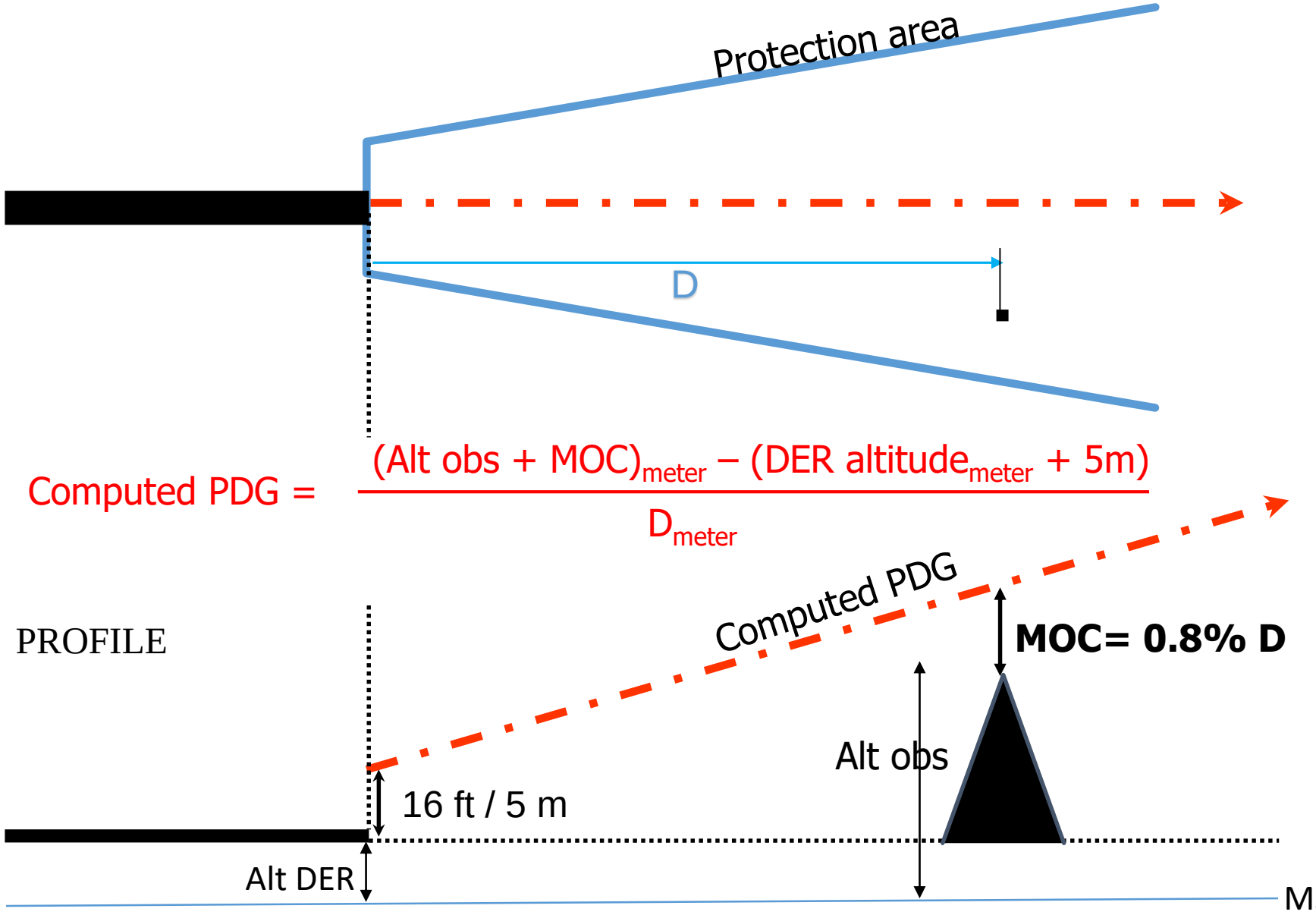
- Big issue for measuring D?
  - For any obstacle?
  - Shortest distance?
  - Longest distance?
  - What if a turn??
- No real rule BUT examples

Obstacle Identification Surface (OIS)

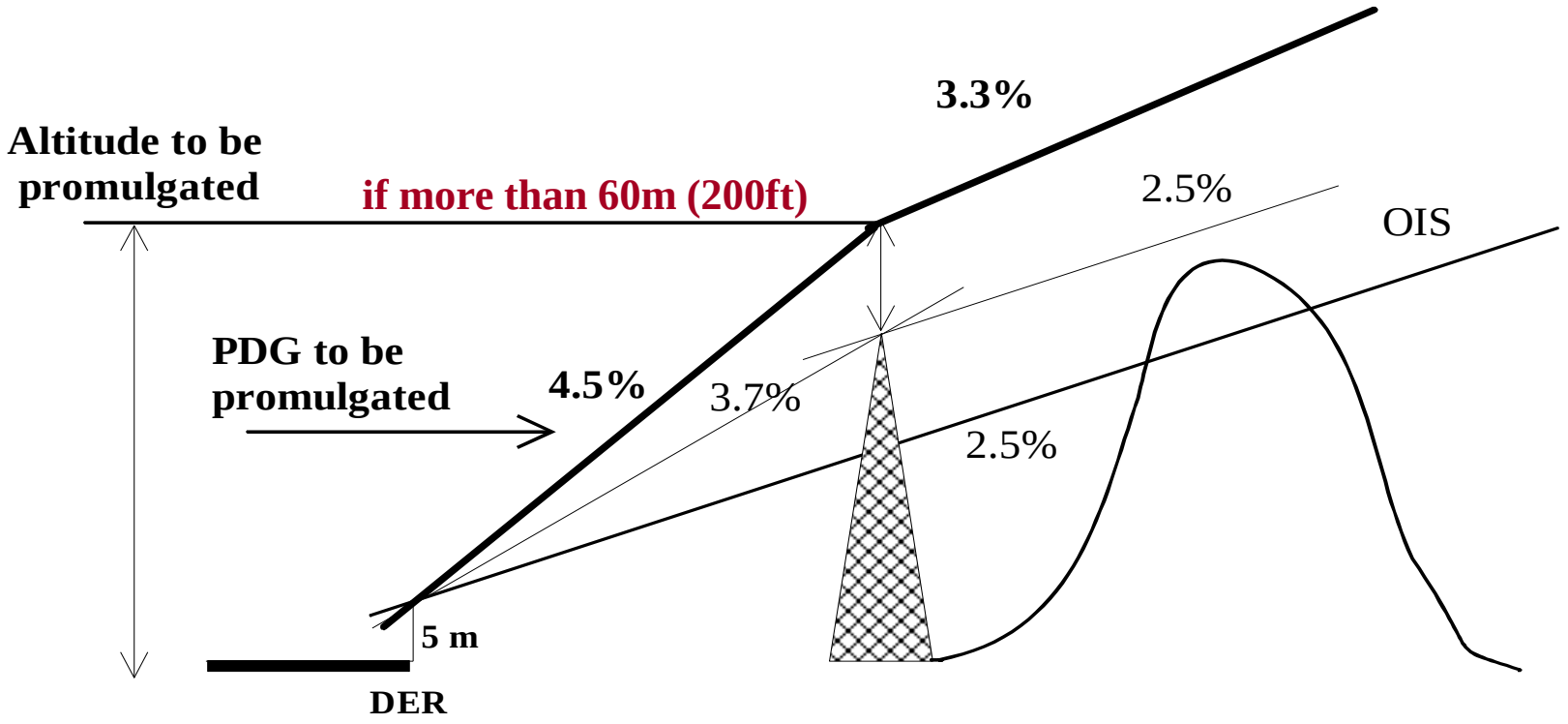
- Established to assist designers: parameters:
  - Origin: 5 m (16 ft) above DER;
  - Slope: 2.5%
  - Obstacle along the straight segment after take-off.
- 3.3% = 2.5% + 0.8%
- If OIS is penetrated, increase PDG



Procedure Design Gradient (PDG)



PDG greater than 3.3%

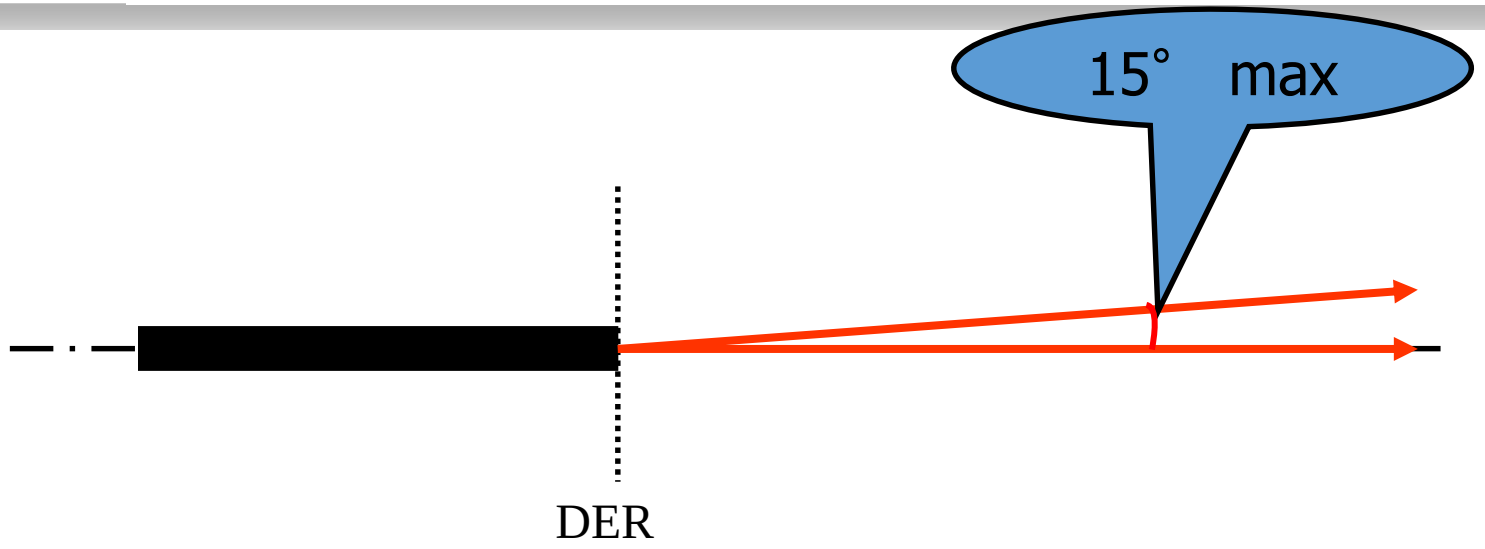


PROCEDURE DESIGN GRADIENT

Departure routes

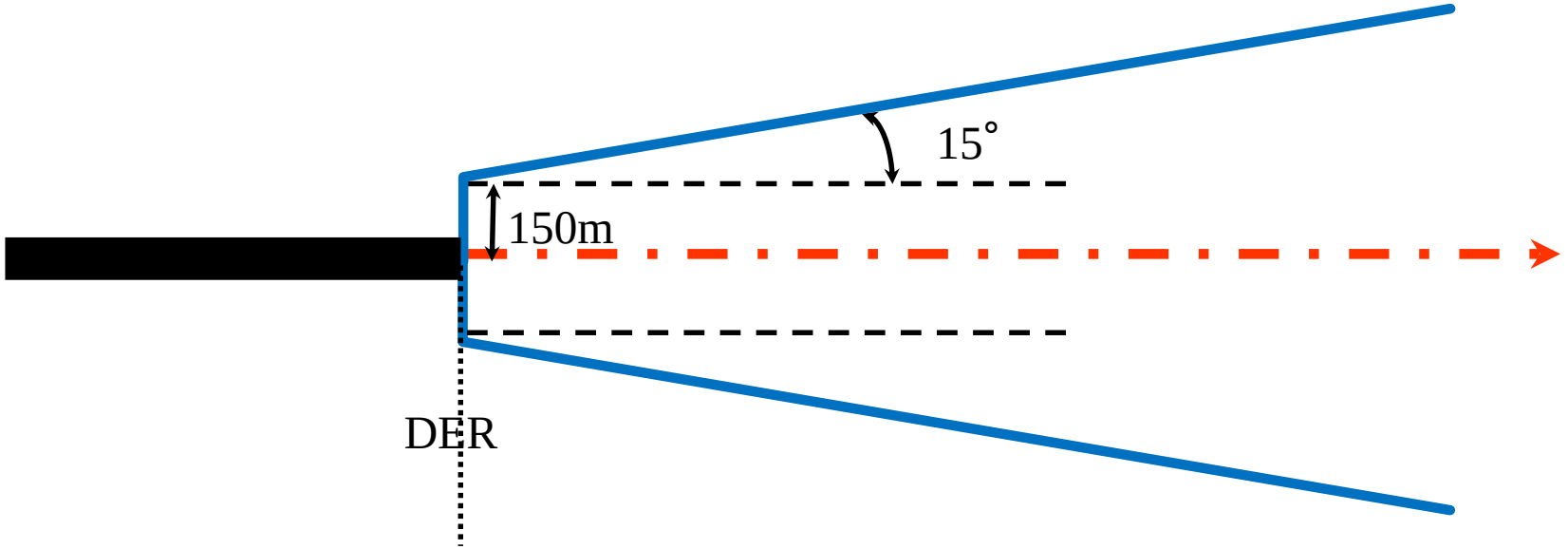
- Two types of departures:
  - Straight departure:
    - Includes turn up to 15°.
  - Turning departure (Turn >15°).
- Track guidance:
  - Guided;
  - Dead reckoning.
- Protection area:
  - Primary and secondary.

Straight departure



- The initial trajectory can have a track adjustment point and be:
  - Dead reckoning or
  - Based on track guidance

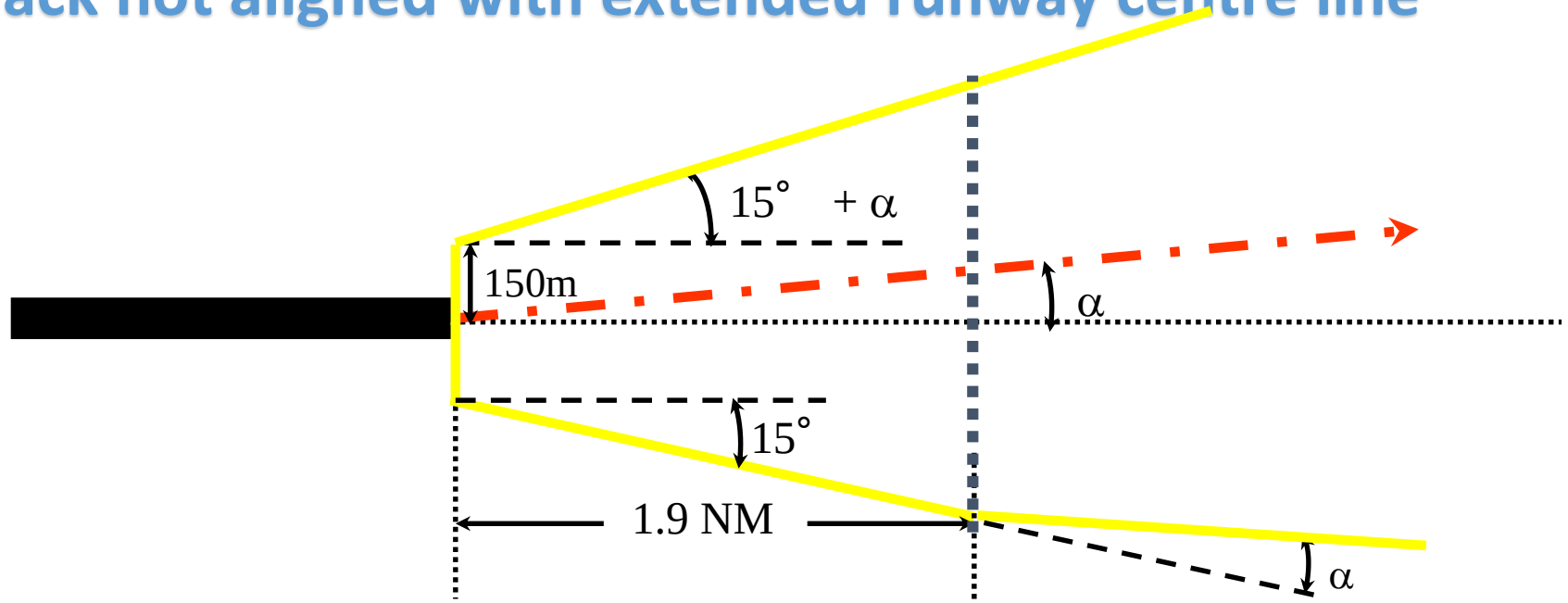
Protection area of the initial segment



Navaid	Total width (NM(km))	Splay angle (°)
NDB	2.5(4.6)	10.3
VOR	2.0(3.7)	7.8

Protection area of the initial segment

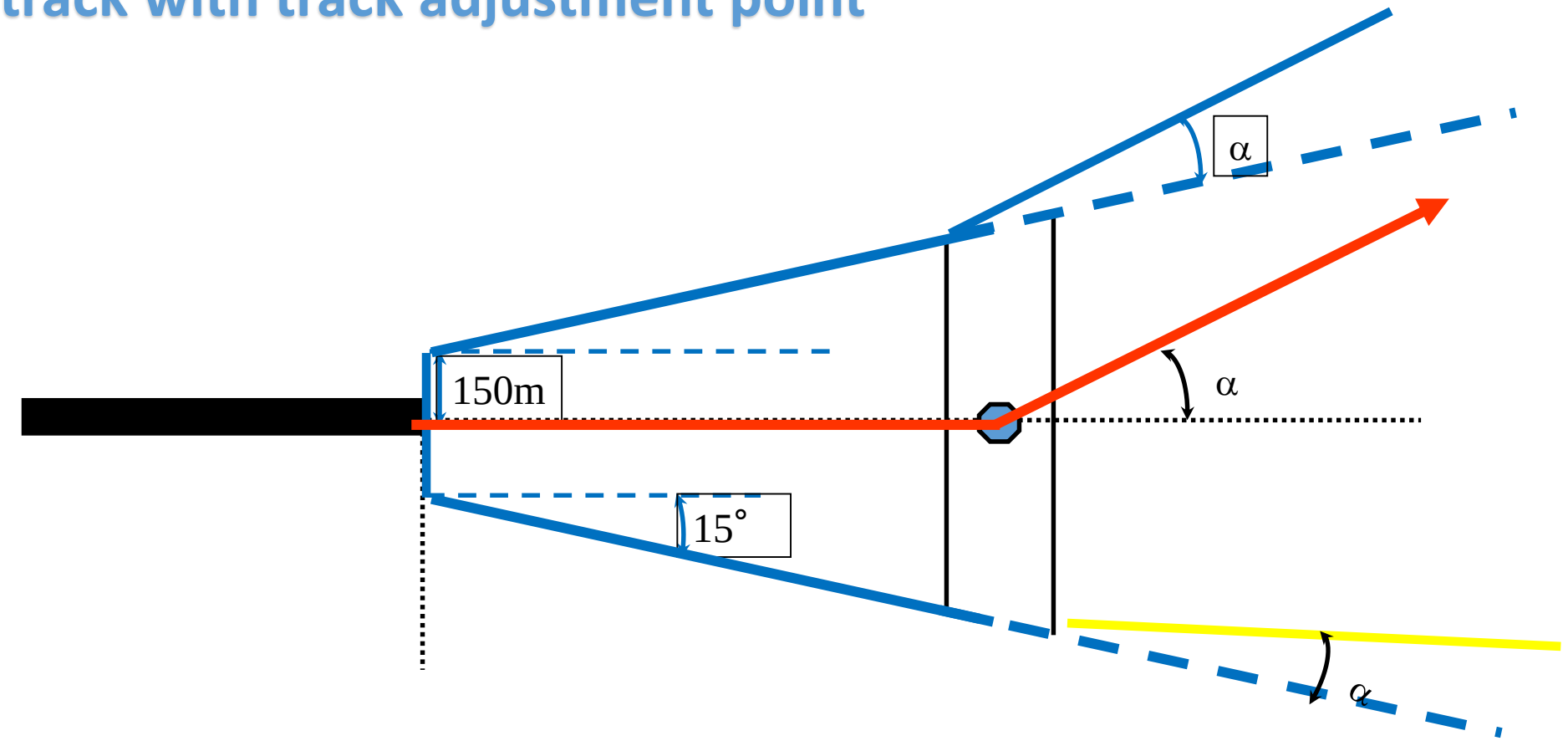
Nominal track not aligned with extended runway centre line



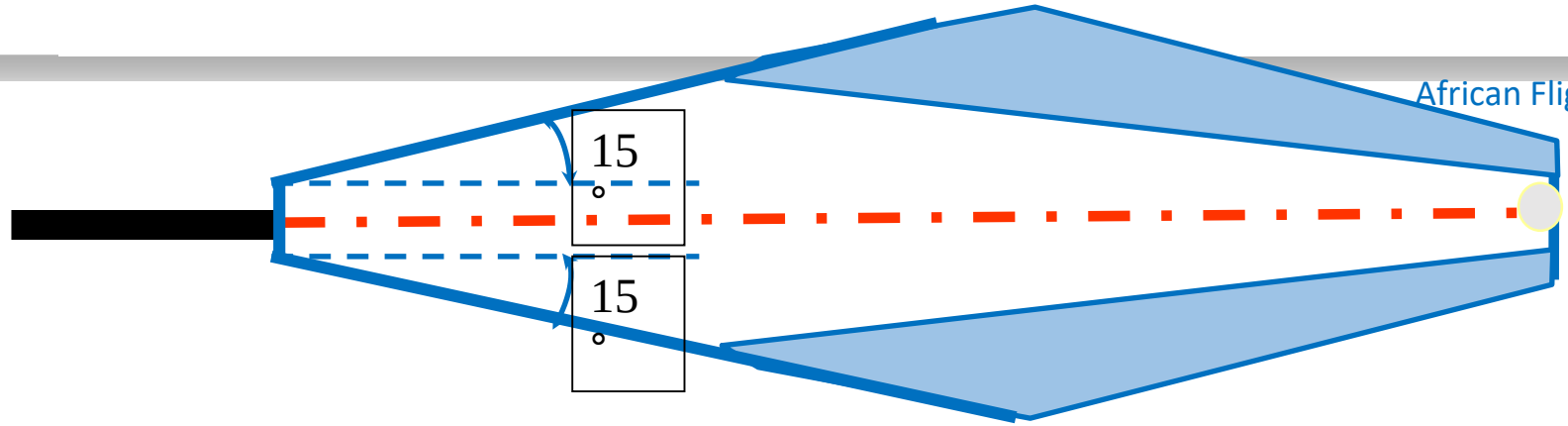
Any track adjustements will take place no further than a point corresponding to 120m (394ft) above the DER

Protection area of the initial segment

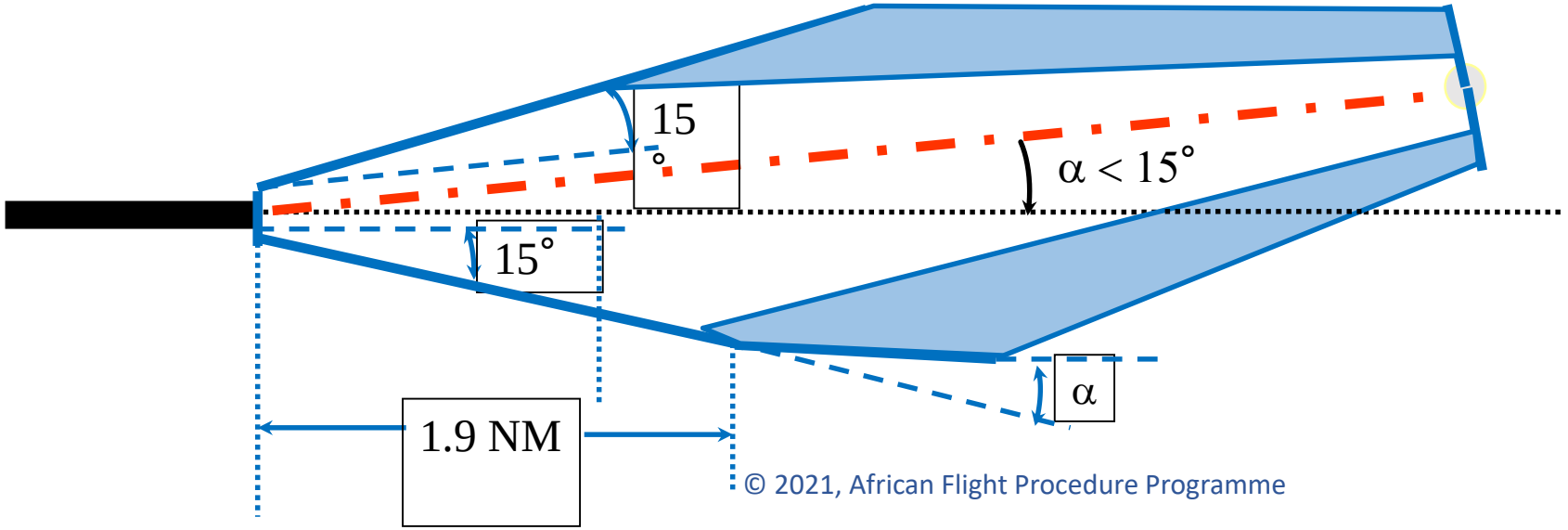
Nominal track with track adjustment point



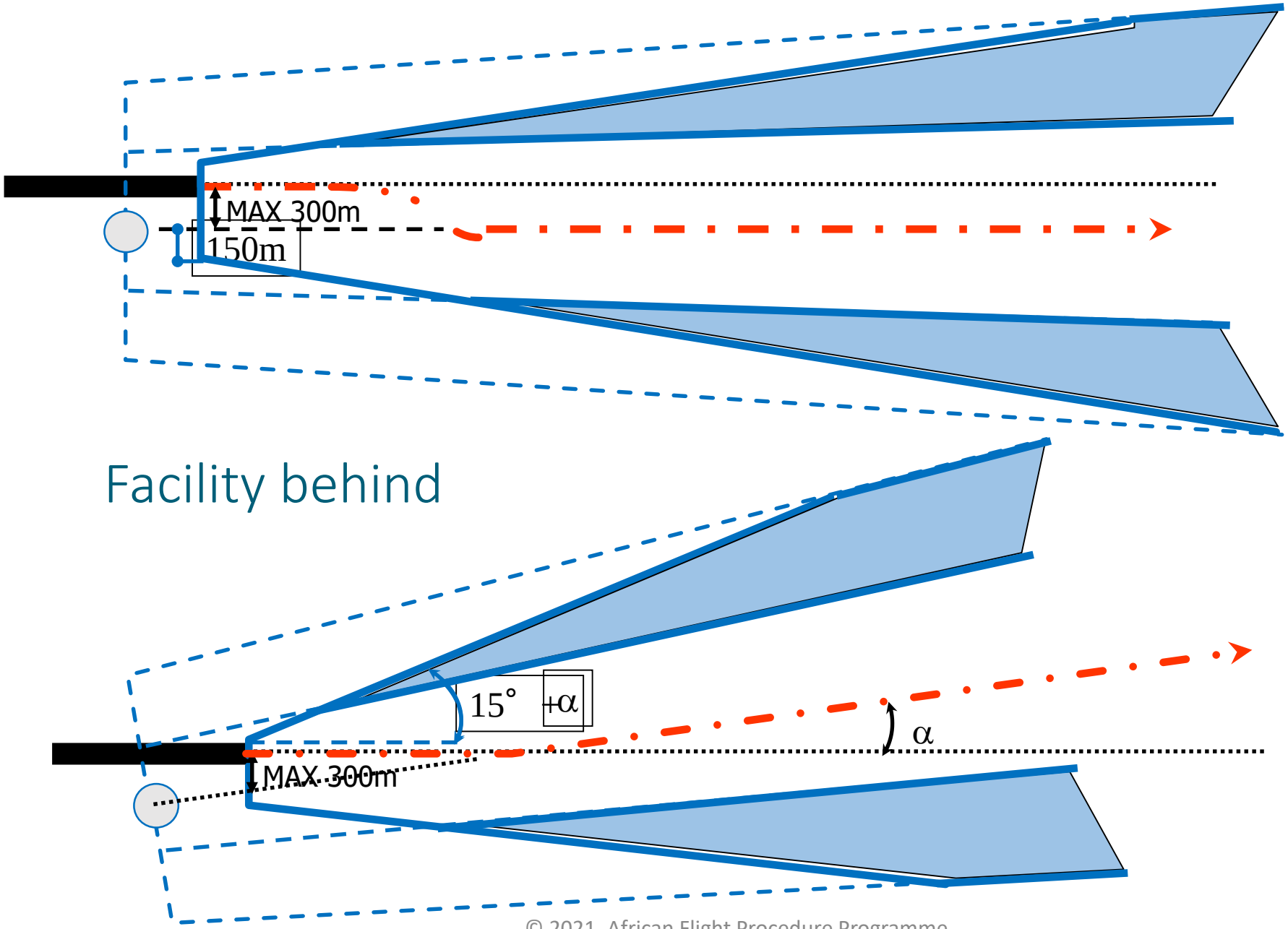
Protection area of the initial segment



Facility in front



Facility behind



Turning departure (>15°)

- Two type of turns:
  - ☞Turn at a designated TP ;
  - ☞Turn at a designated altitude/height (TNA/H):
    - Minimum height : 120 m /394 Ft;
    - Earliest turn : 600 m from the beginning of the RWY.
- Maximum track without guidance after turn: 5.4 NM (10 km).
- Protection area divided in:
  - ☞Turn initiation area:
    - Area within which the aircraft conducts a straight climb in order to reach the required MOC prior to the beginning of a turn 75 m
  - ☞Turn area:
    - Area is the area in which the aircraft is considered to be turning.

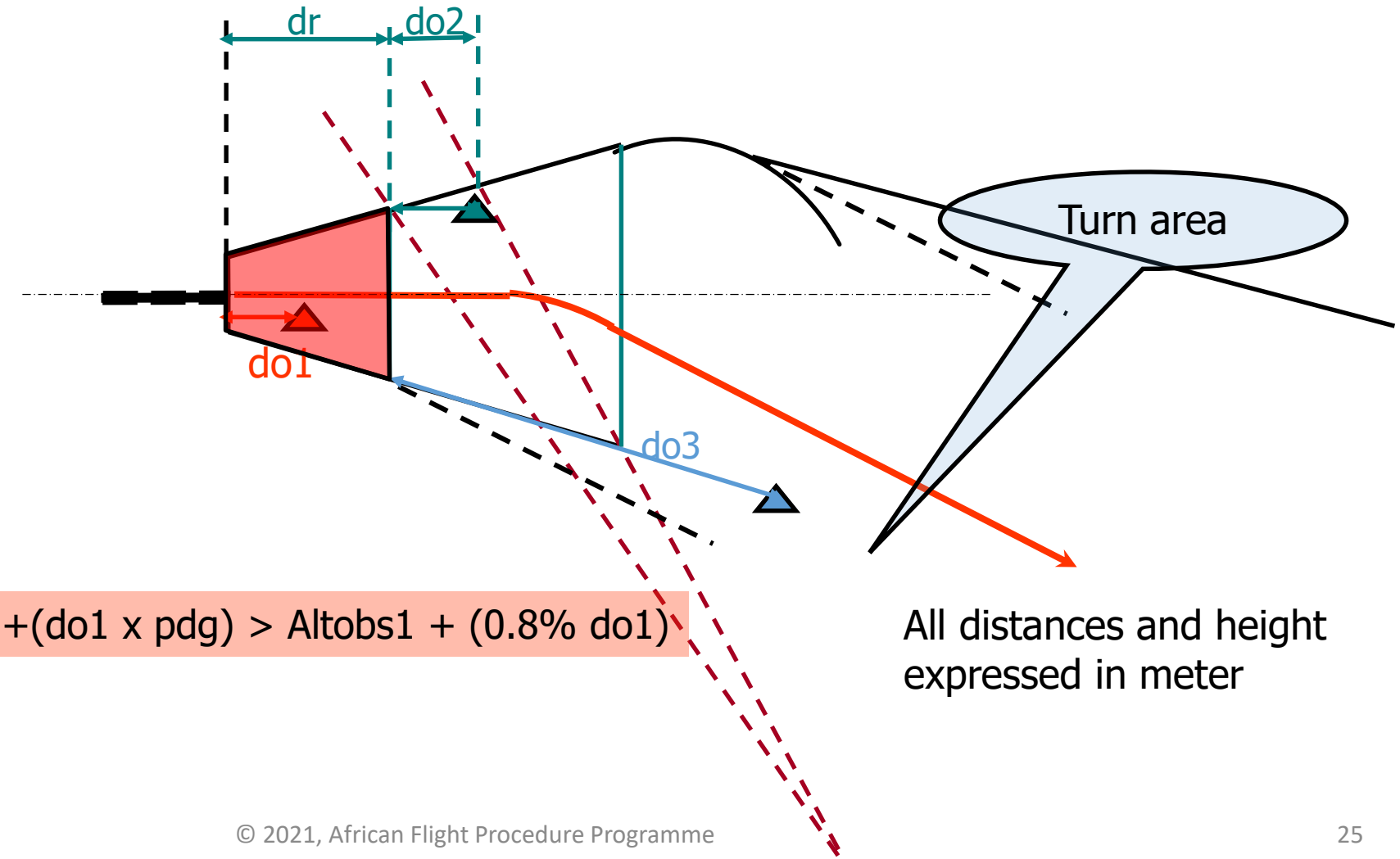
Turning departure (>15°)

- Turn parameters:
  - IAS max: **10%** more than **final missed approach**
    - Speed reduction published
  - Altitude:
    - **TNA** (in case of turn at an altitude);
    - **Altitude at the TP with 10% climb**.
  - Temperature **ISA + 15° (or calculated one);**
  - Bank angle : **15°;**
  - Reaction time + bank angle delay : **3s + 3s**
  - Wind : **30 kt** or statistical wind

Obstacle survey

Alt DER + 5 +(dr x pdg) + (do2 x pdg) > Alt o2 + MOC

MOC =max [0.8% (dr + do2),75m]



Alt DER + 5 +(do1 x pdg) > Altobs1 + (0.8% do1)

All distances and height expressed in meter

Summary

- Obstacle Clearance Altitude/Height
- MOC and OCA/H adjustments:
  - Mountainous areas;
  - Non-aligned straight-in approach;
  - Remote Altimeter setting;
  - Lower limit of OCA.

Questions:

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