RNAV DEPARTURE

REGULATORY REFERENCE (1)

Vol II Part III

Section 3 chapter 1

RNAV1 ,RNAV2, Basic RNP1 departure criteria

Section 1 chapters 1 and 2 -

RNAV general criteria and turn protection

Vol II Part I

- **Section 3 chapters 1,2 and 3**
  - **Departure general criteria**

WHAT'S NEW (regarding non RNAV departure)?

- Minimum distances
- Turn at FB WP
- Turn at FO WP
- Use of wind spiral for all turn protections
- Max turn angle :120 ° (except for DF)
- No bank angle delay for a fly-by WP
- Protection deals with max TAS and low TAS

PROTECTION AREA

WHAT' S REMAINING ?

- DER
- Area1
- 15 ° max change of track for straight departure
- Bank angle : 15 °
- Pilot reaction : 3s
- Climb gradient
- MOC
- Average flight path for nominal trajectory
- Turn at an altitude

PROTECTION AREA

WHAT'S NEW (regarding previous departure RNAV criteria)?

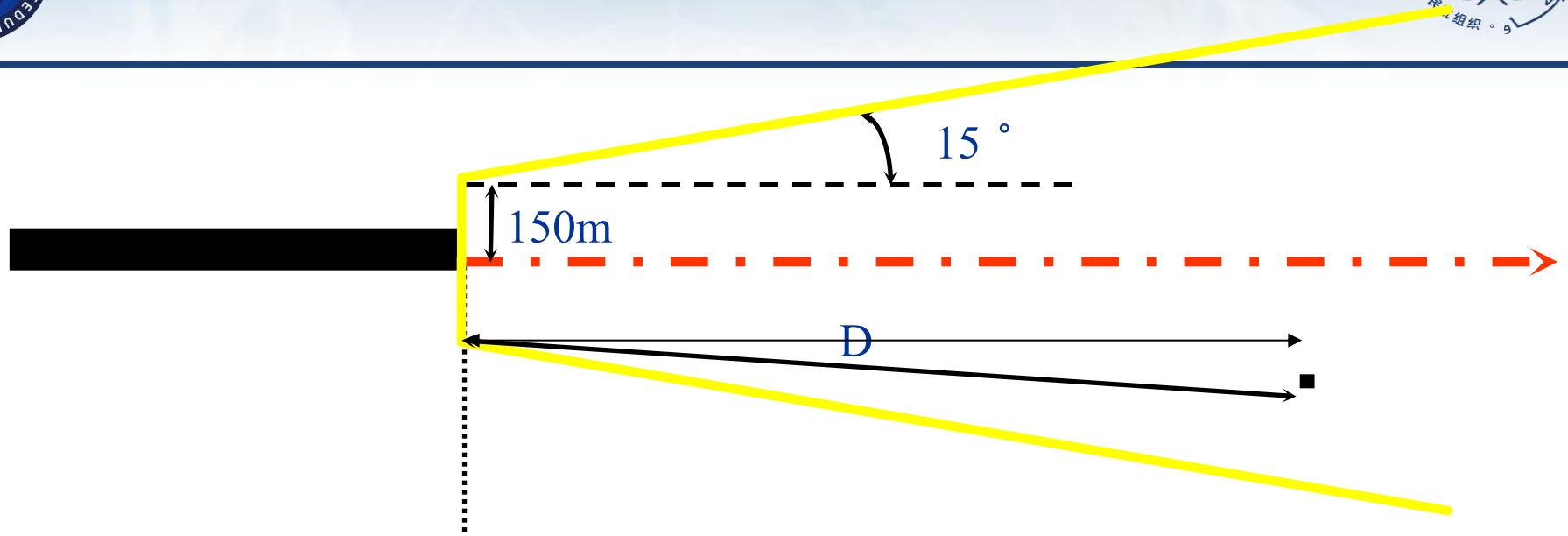
- PBN application : RNP1, RNAV1, RNAV2
  - ATT, XTT, ½ AW values
- Amended protection for Fixed radius (RF turn)
  - RF is only a recommended function for the studied nav spec (not covered in this course)
- Minimum turn angle : 5 ° except where free turn back to waypoint (DF leg used)

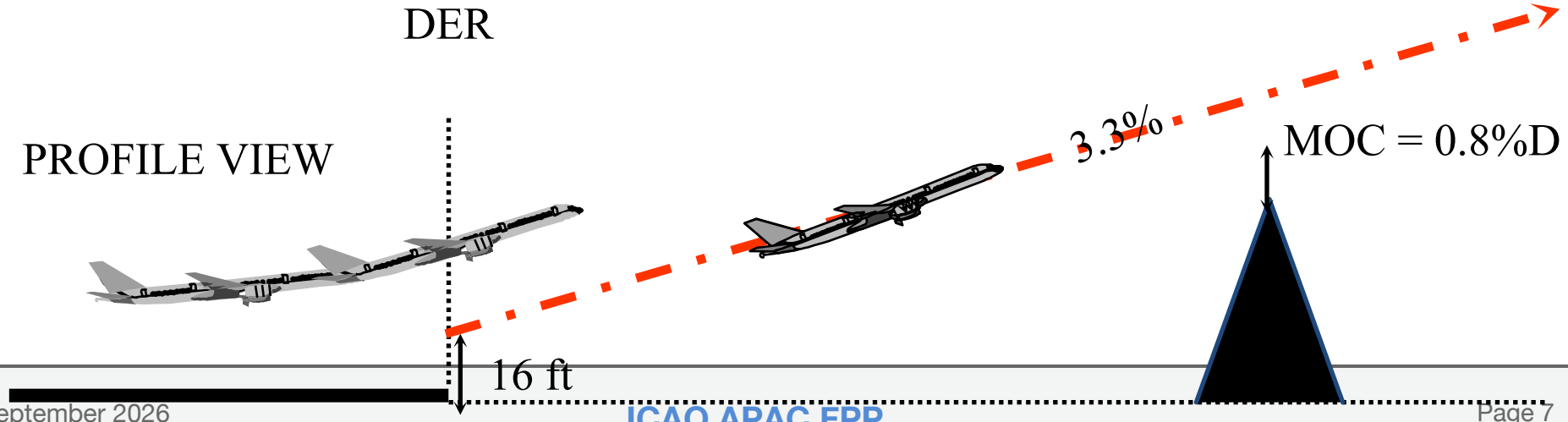
PROTECTION AREA

WHAT'S NEW (regarding previous departure RNAV criteria)?

- Criteria for initial departure
  - < 15 NM ARP
- Criteria for terminal departure
  - Within less than 30 NM around ARP
  - WHICHEVER the sensor
- Criteria for SID
  - For part of the track outside 30 NM from ARP
  - Whichever the sensor
- Merging Areas

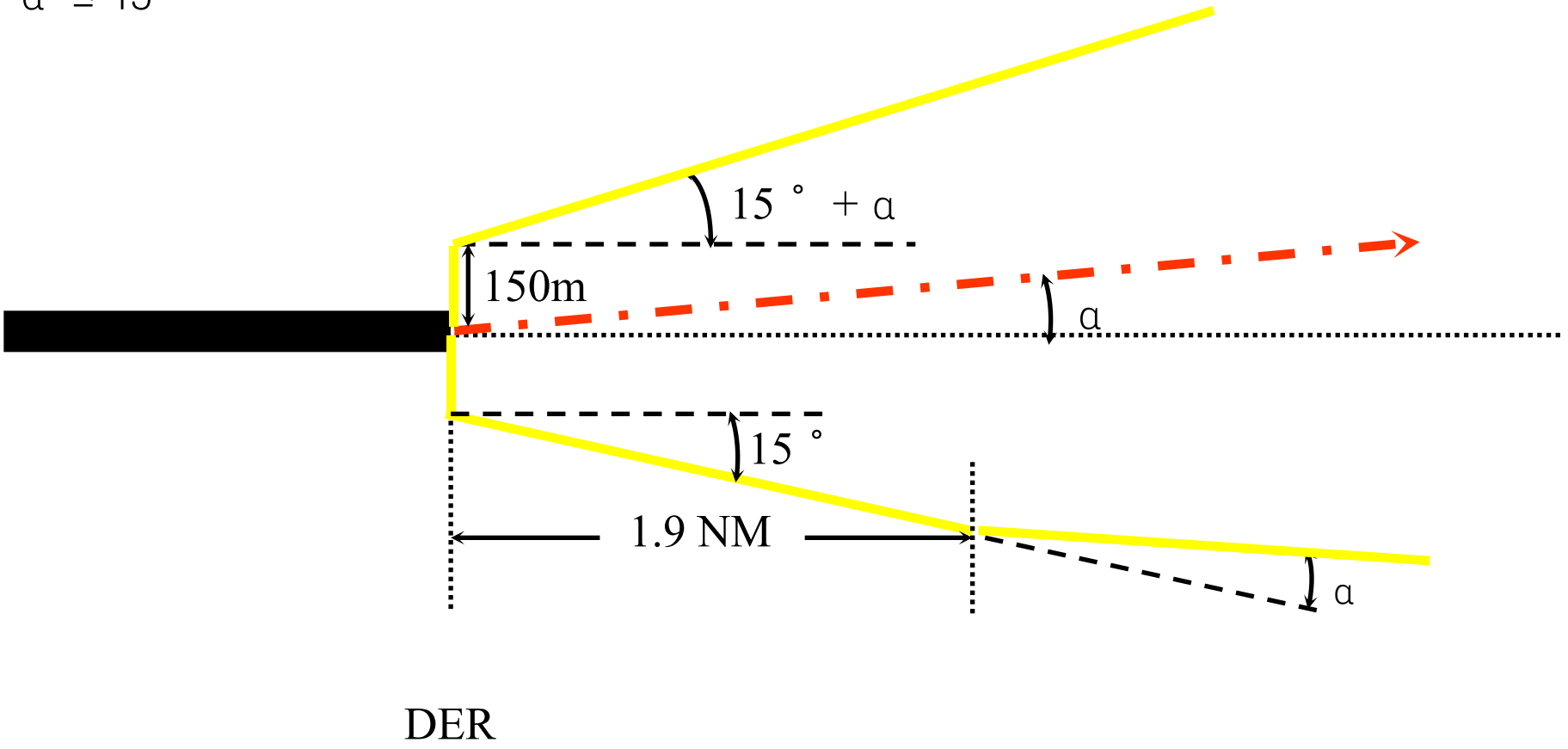
STRAIGHT INITIAL DEPARTURE





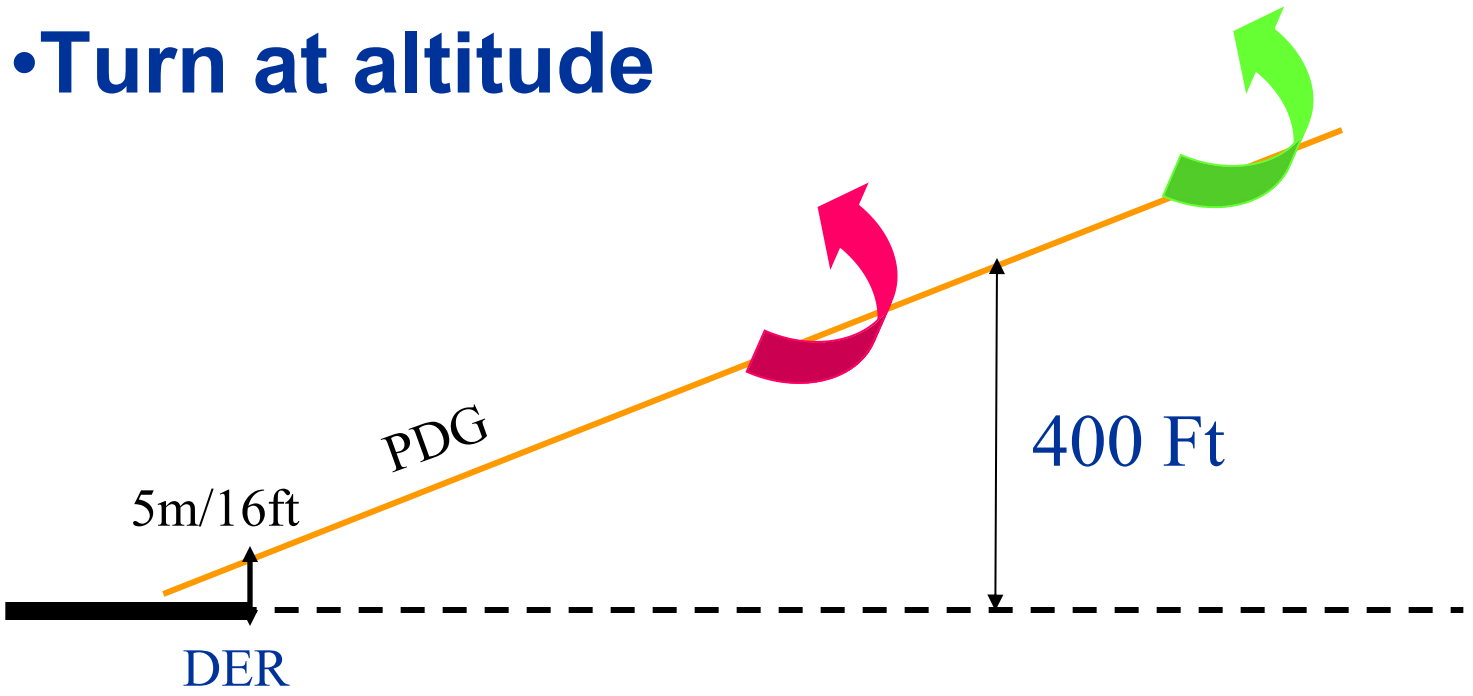
STRAIGHT INITIAL DEPARTURE NON ALIGNED with RUNWAY axis

α ≤ 15 °



LOWEST TURNING ALTITUDE

- **Turn at altitude**



According to ICAO : NO TURN BELOW 400 FT / 120 m

Operationally: NO TURN BELOW 500 FT

METHOD TO DESIGN A DEPARTURE PROCEDURE

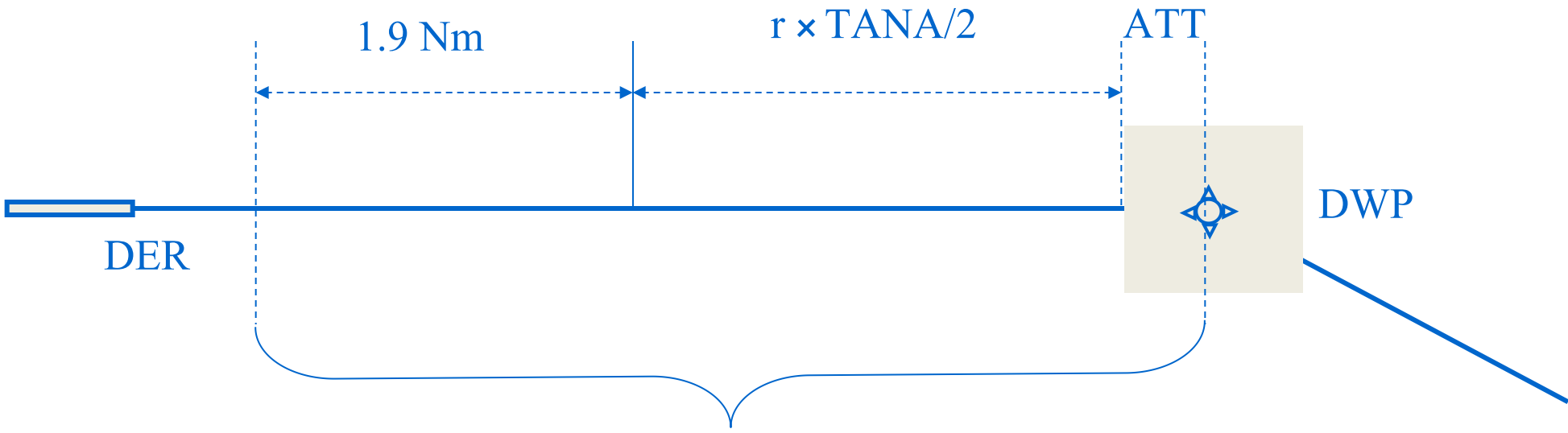
- According to airspace concept select the appropriate navigation application (e.g . RNP1, RNAV1,RNAV2)
- According to terrain constraint, noise abatement and operational issues define the nominal path
  - For cat C and D aircraft use average flight path
- Locate the first waypoint
  - Check minimum length of the first leg [DER- WP] according to the type of WP
- Draw the straight departure protection area
- Assess the obstacles (define OIS if needed) and deduce climb gradient

METHOD TO DESIGN A DEPARTURE PROCEDURE

- Draw the straight protection area of the next leg
  - Check minimum length of the leg according to the type of WP
- Draw the turn protection area according to the type of WP and connect to the straight area
- Assess obstacles and validate climb gradient, altitude at WPs and connection to en-route structure

MINIMAL LENGTH FOR FIRST LEG

- **Fly-by Waypoint**

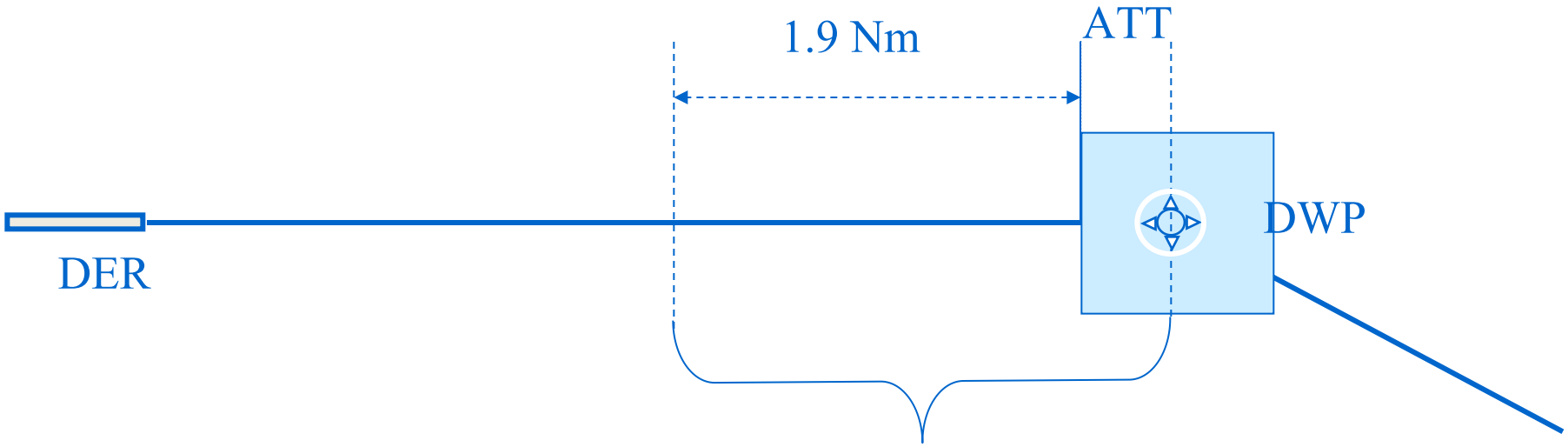


D min (Nm) = 1.9 + r × TANA/2 + ATT

Replace 1.9NM by (120m / PDG) / 1852 if PDG ≠3.3 %

MINIMAL LENGTH FOR FIRST LEG

- **Fly-over Waypoint**



D min (Nm) = 1.9 + ATT

Replace 1.9NM by (120m / PDG) / 1852 if PDG ≠3.3 %

GENERAL METHOD FOR CALCULATION OF PROTECTION AREA WIDTH

XTT value
(according to navigation specification)

Identify distance to ARP for Buffer Value (BV)

Semi-Area Width calculation
1/2 A/W = 1.5 XTT + BV

DIFFERENT PHASES OF FLIGHT FOR CLIMBING PHASE

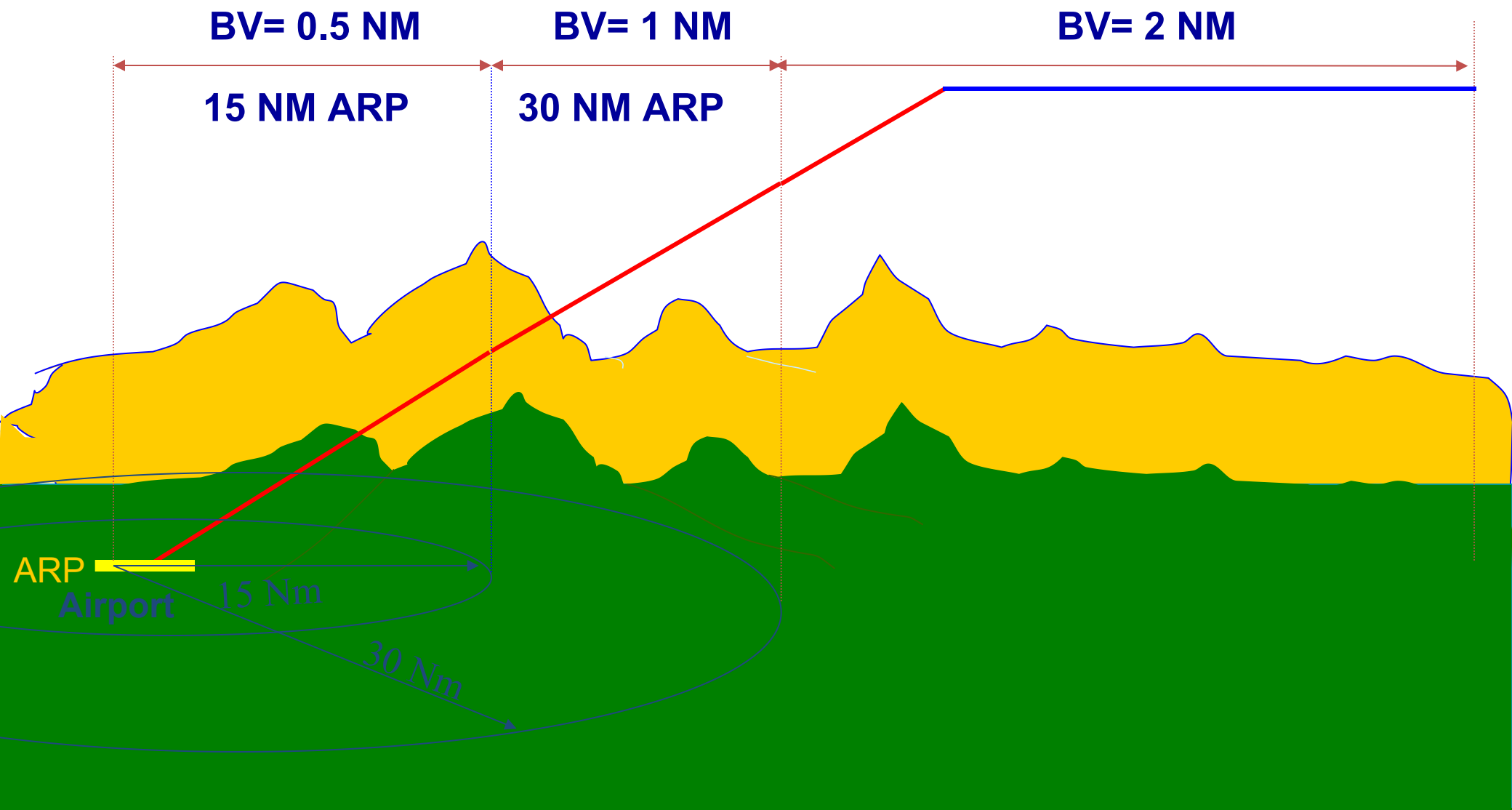


TABLE OF BUFFER VALUES

Phase of Flight	BV for CAT A-E	BV for CAT H
En-route : greater than 30 NM from departure ARP	2 NM	1 NM
Terminal within 30 NM of the ARP but more than 15 NM from ARP	1 NM	0.7 NM
SIDs within 15 NM of the ARP	0.5 NM	0.35NM

FLIGHT TECHNICAL ERROR
§ TABLE III1-1-1

Phase of Flight	FTE (95%) Specific to required navigation specification
En-route (GREATER THAN 56 km (30 NM) from ARP	RNAV 2 – 1.9 km (1 NM) RNAV 1 – 926 m (0.5 NM) *RNP 2 – 1.9 km (1 NM)* RNP 1 – 926 m (0.5 NM)
Terminal WITHIN 56 km (30 NM) of the ARP	RNAV 2 – 1.9 km (1 NM) RNAV 1 – 926 m (0.5 NM) RNP 1 – 926 m (0.5 NM)

Navigation specification		RNP	FTE	IMAL	ATT	XTT	BV	½ A/W
RNP1	Greater than 30 Nm ARP	1	0.5		0.8	1	2	3.5
	Terminal	1	0.5		0.8	1	1	2.5
	SID <15 NM ARP	1	0.5		0.8	1	0.5	2
RNAV2	Greater than 30 Nm ARP		1	2	1.6	2	2	5
	Terminal		1	1	0.8	1	1	2.5
	SID <15 NM ARP		1	1	0.8	1	0.5	2
RNAV1	Greater than 30 Nm ARP		0.5	2	1.6	2	2	5
	Terminal		0.5	1	0.8	1	1	2.5
	SID <15 NM ARP		0.5	1	0.8	1	0.5	2

Values are applicable for AIRPLANE and for GNSS sensor only

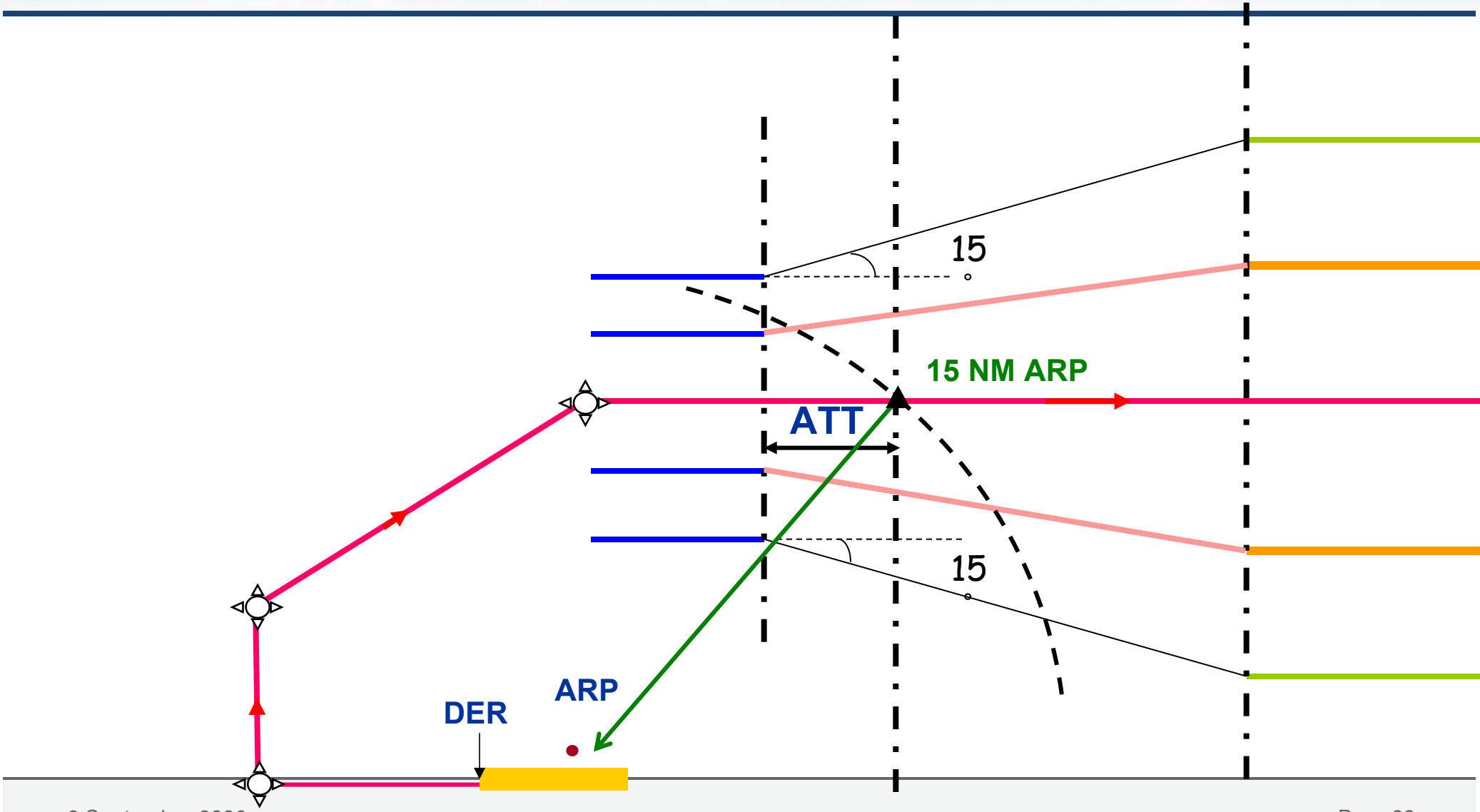
RNP 2 in en-route phase of flight (NM)
SID (>30 NM ARP)

XTT	ATT	½ A/W
2.00	1.60	5.00

MERGING AREAS PRINCIPLE FOR DEPARTURE STRAIGHT SEGMENT

- Area width of the subsequent segment is always equal or larger than the preceding one
- When larger : SPLAY with 15 ° from the EARLIEST ATT
- For RNP application and for RNAV application based on GNSS sensor, it occurs at 15 NM ARP and 30 NM ARP
  - Even if no waypoint is located at 15 NM DER nor at 30NM ARP

MERGING AREAS AT 15 NM ARP



MERGING AREAS AT 30 NM ARP

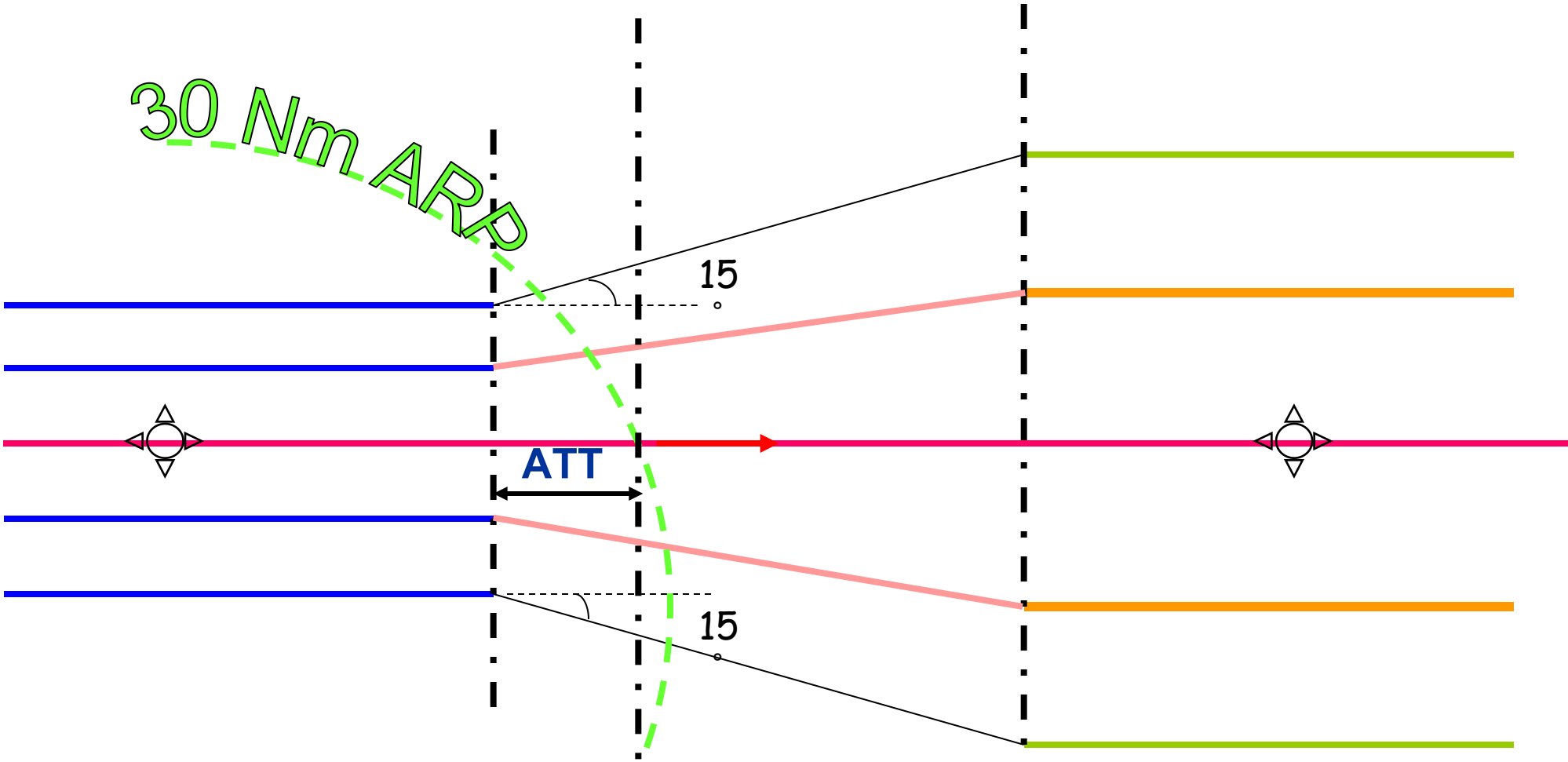
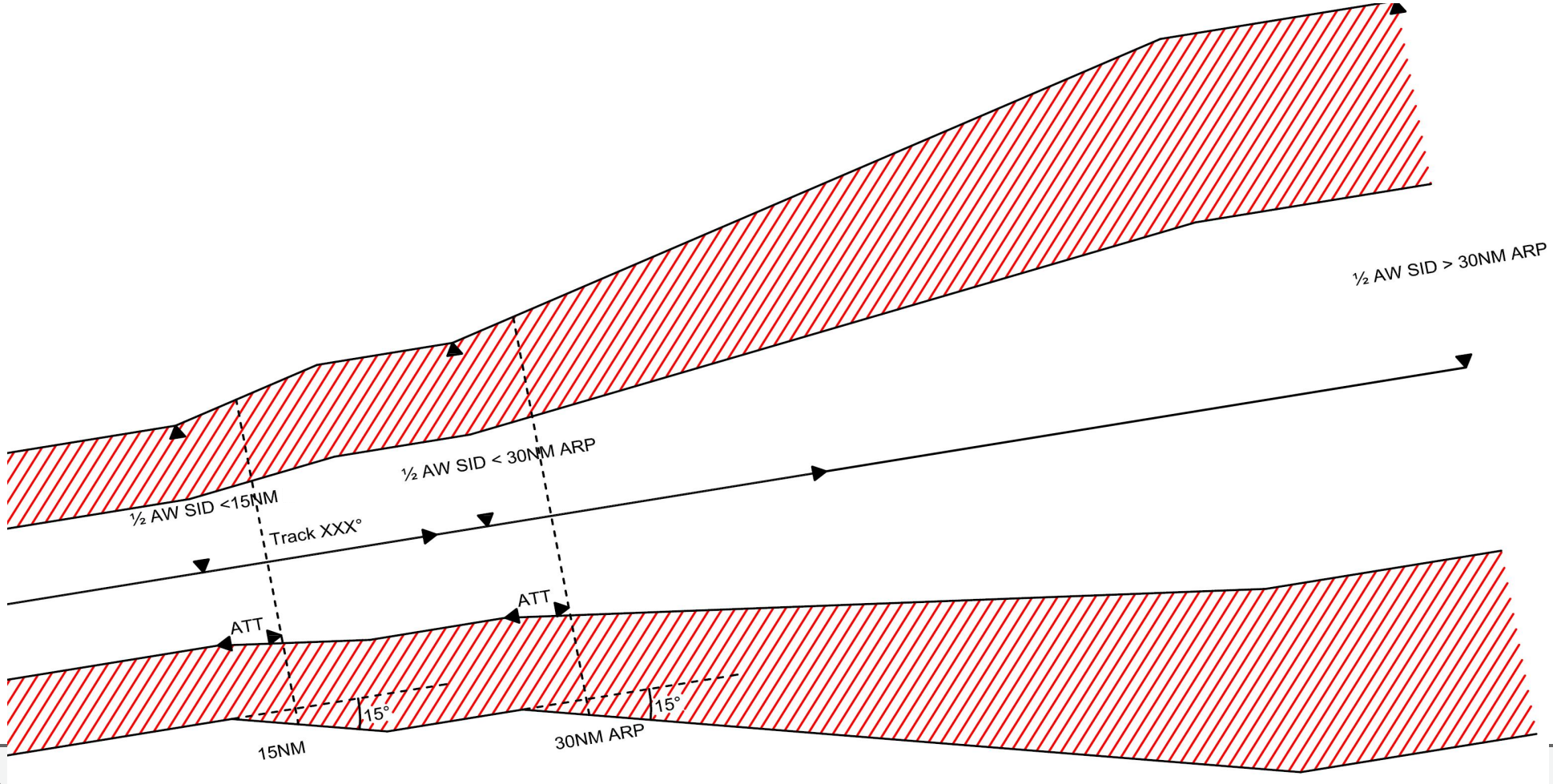


FIGURE III 1-1-2

- **Illustration of splays at 15 NM AND 30NM ARP**



FIRST STRAIGHT SEGMENT

- Find the value of ½ area width for the fictitious WP in the table part III section3 chapter 1 table III-3-1-1
- Calculate XTT and ½ AW for the first WP
- Draw the straight segment area between the DER and the first WP

TABLE III-3-1-1 AREA SEMI WIDTH OF FICTITIOUS AREA

Navigation application	Area semi-width (NM)
RNAV2	2.26 if DME DME 2 if GNSS
RNAV1	1.68 if DMEDME 2 if GNSS
RNP1	2

15 ° Splay from 150m / DER

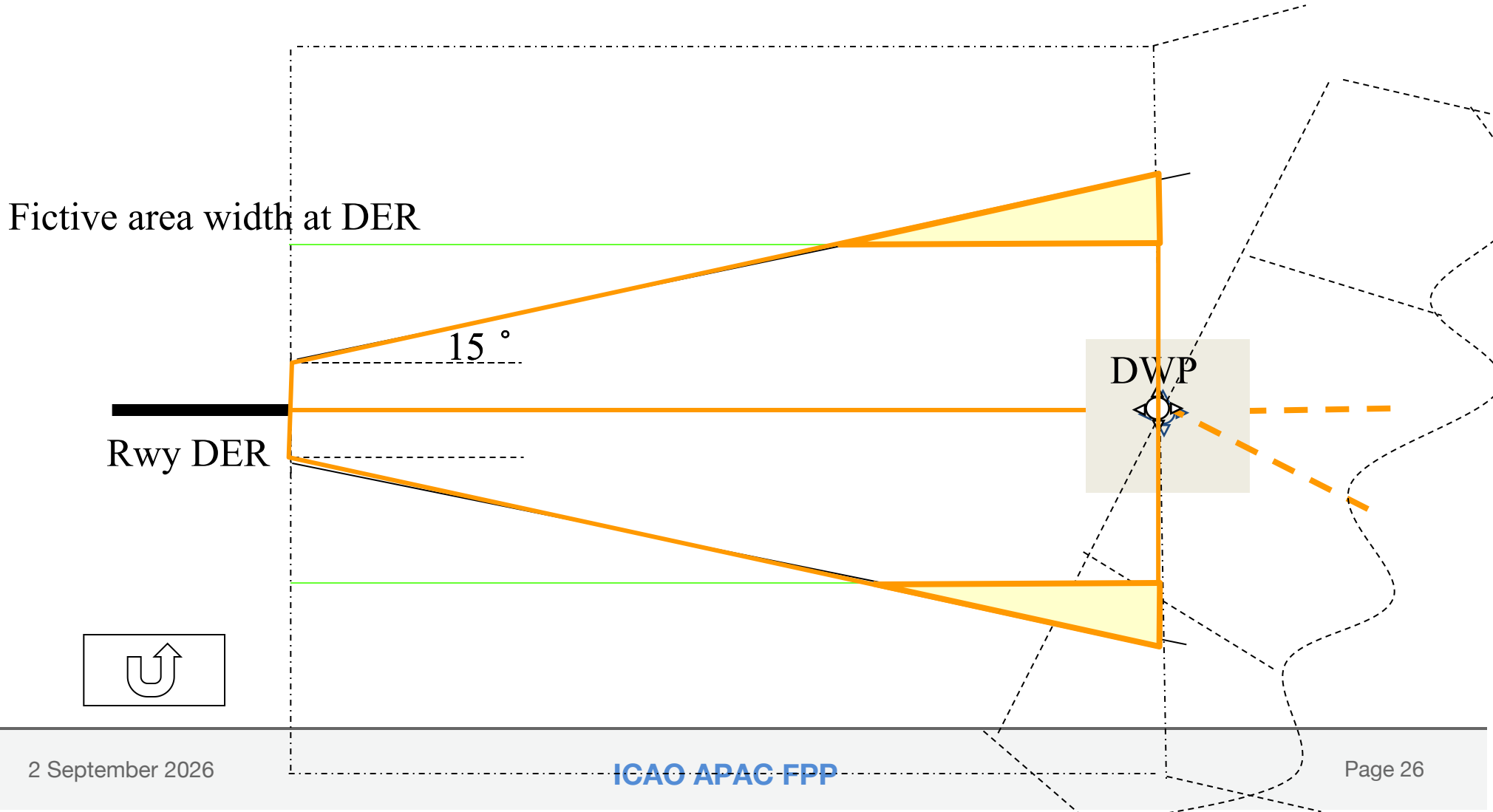
COMPARE

Area Width at DWP

> :Solution1

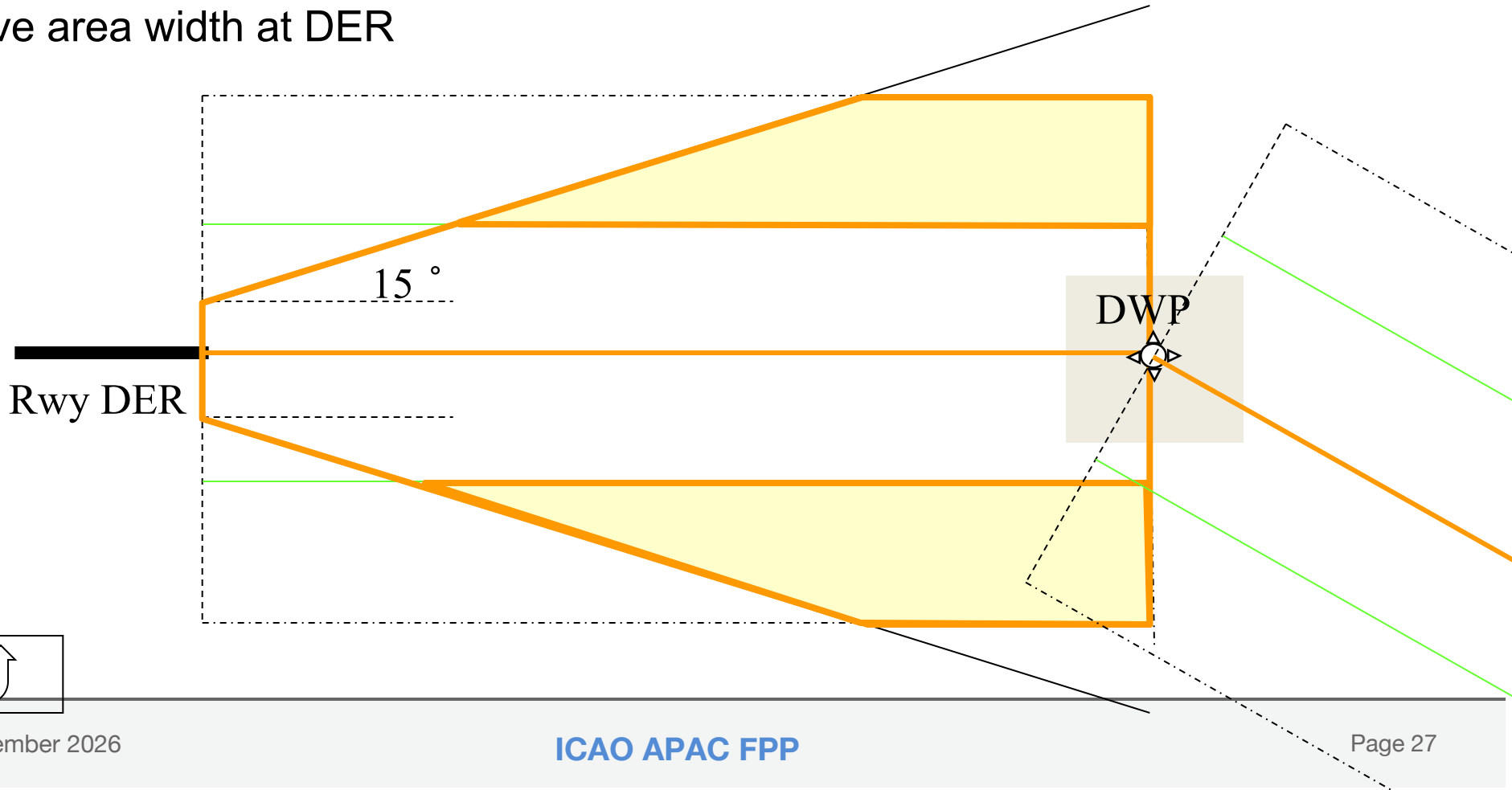
< :Solution2

AREA 1 < AREA AT DWP

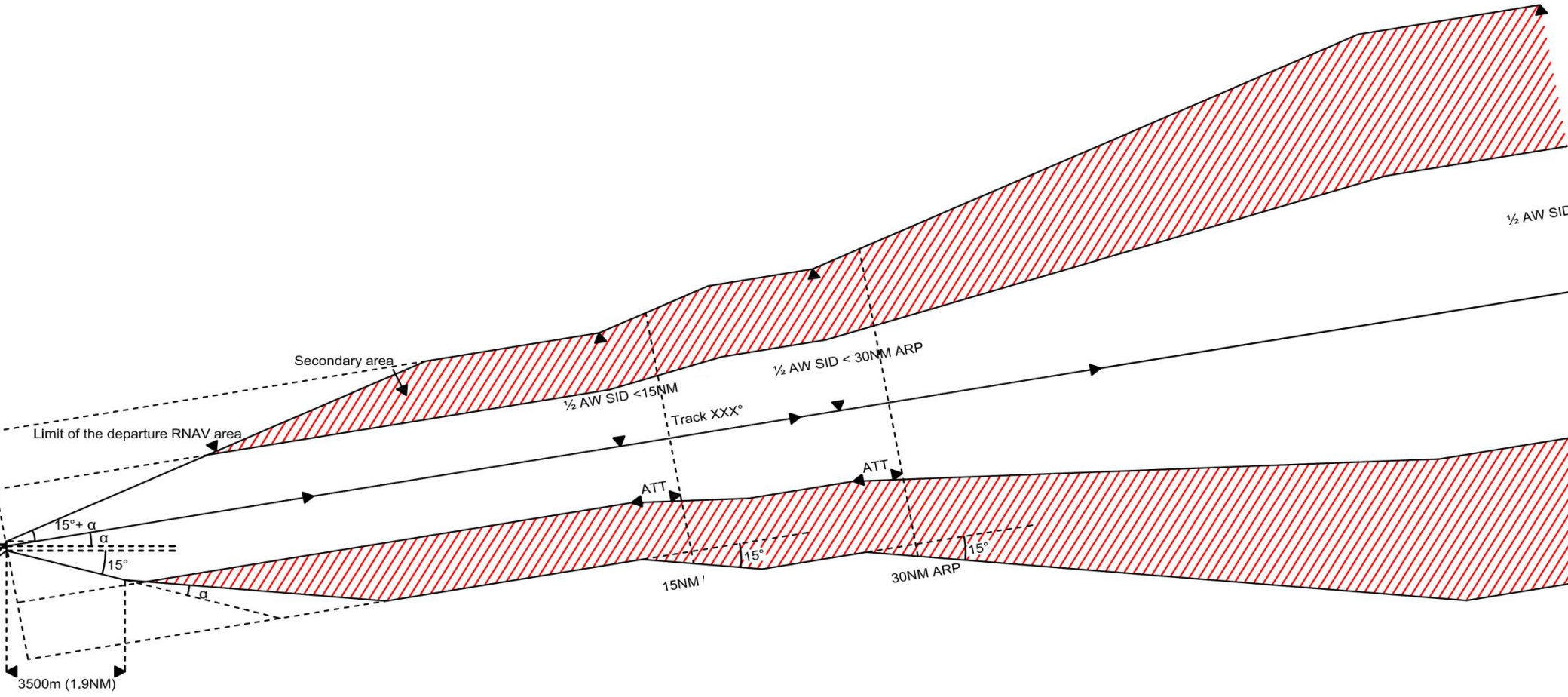


AREA 1 > AREA AT DWP

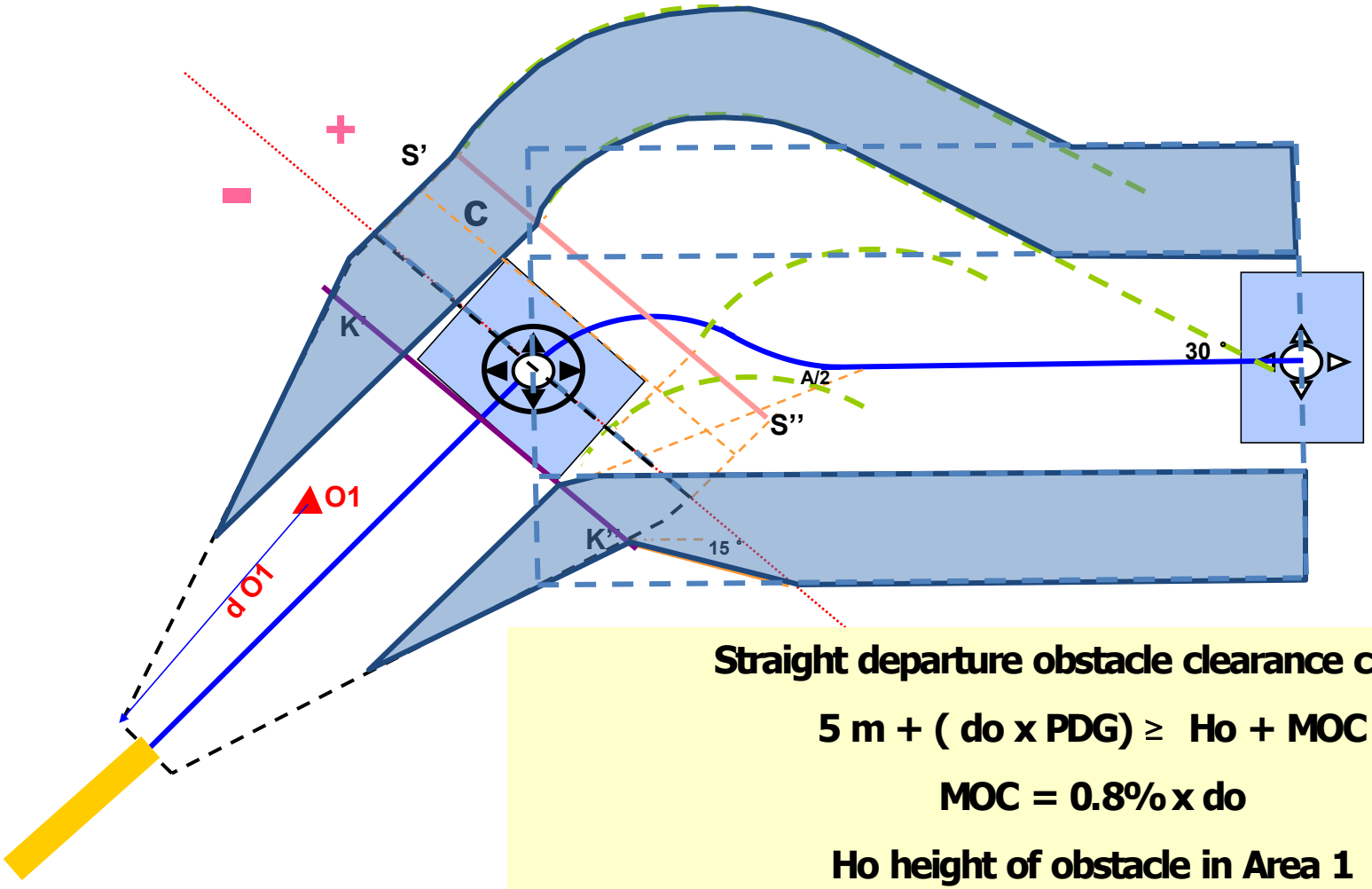
Fictive area width at DER



COMPLETE STRAIGHT DEPARTURE



TURN AT FLY OVER WAYPOINT
TF PROTECTION AREA



Straight departure obstacle clearance criteria

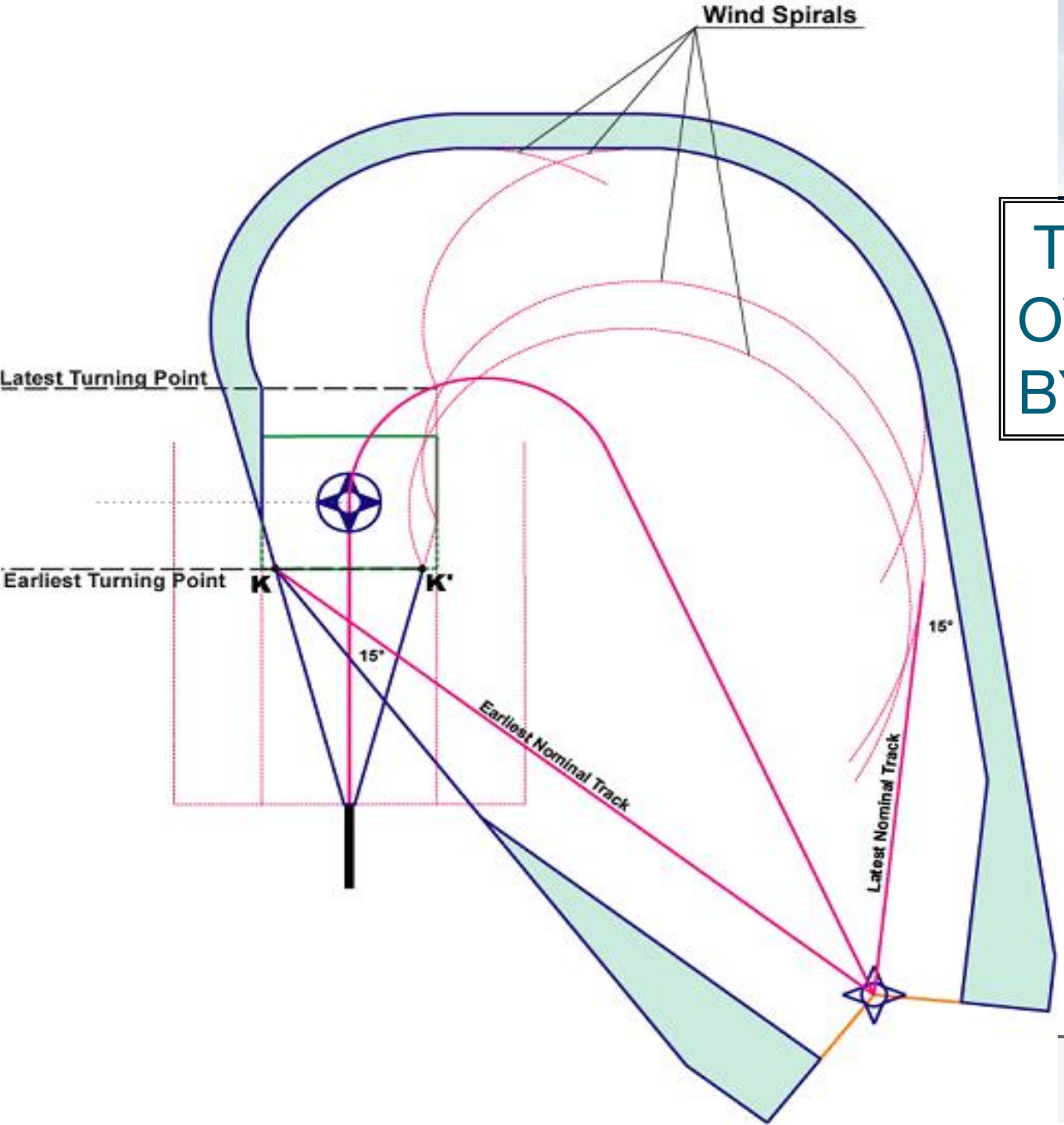
5 m + (do x PDG) ≥ Ho + MOC

MOC = 0.8% x do

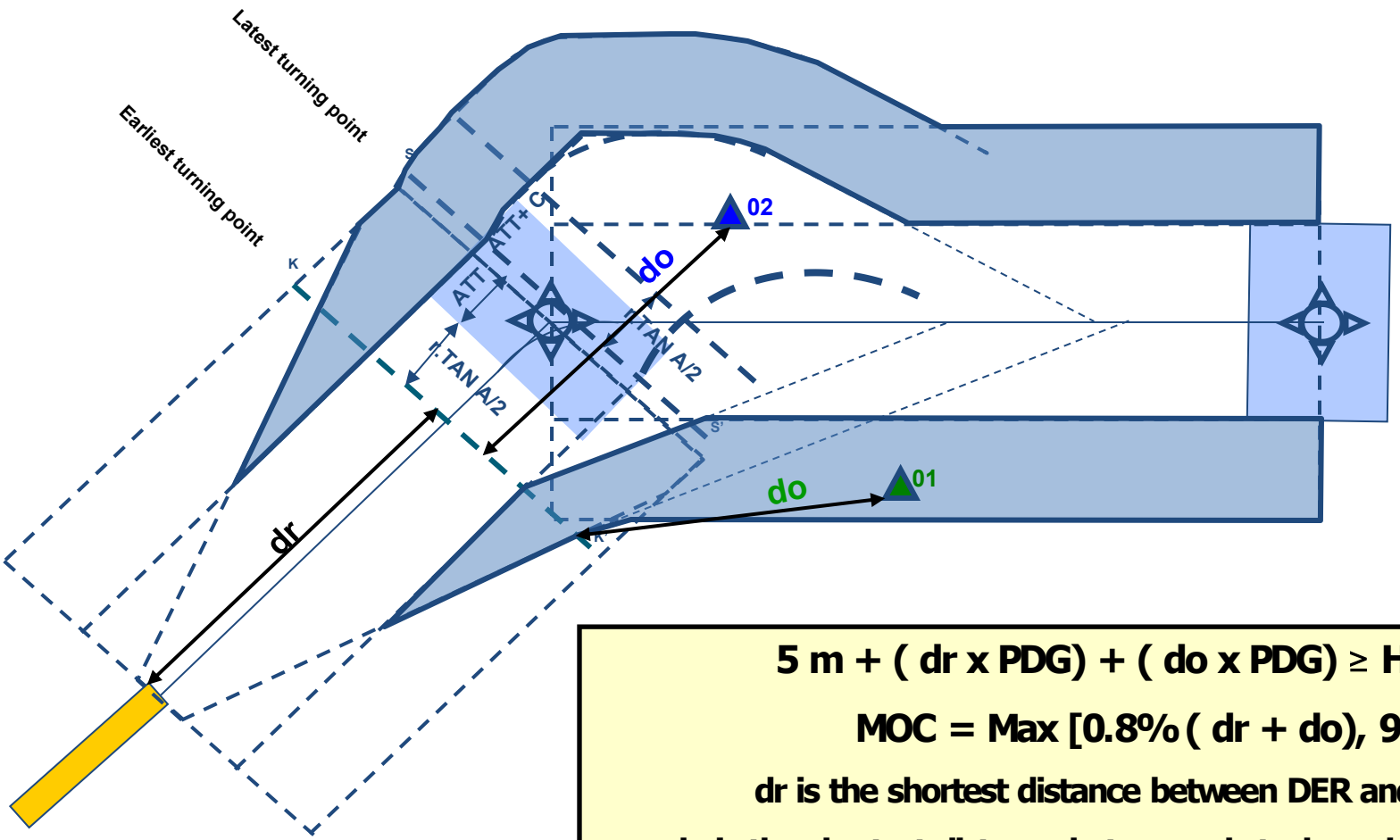
Ho height of obstacle in Area 1

do is the shortest distance between obstacle and DER

TURN AT FLY-OVER FOLLOWED BY DF LEG



TURN AT FLY BY WAYPOINT
TF PROTECTION AREA
TURN ANGLE < 90 °



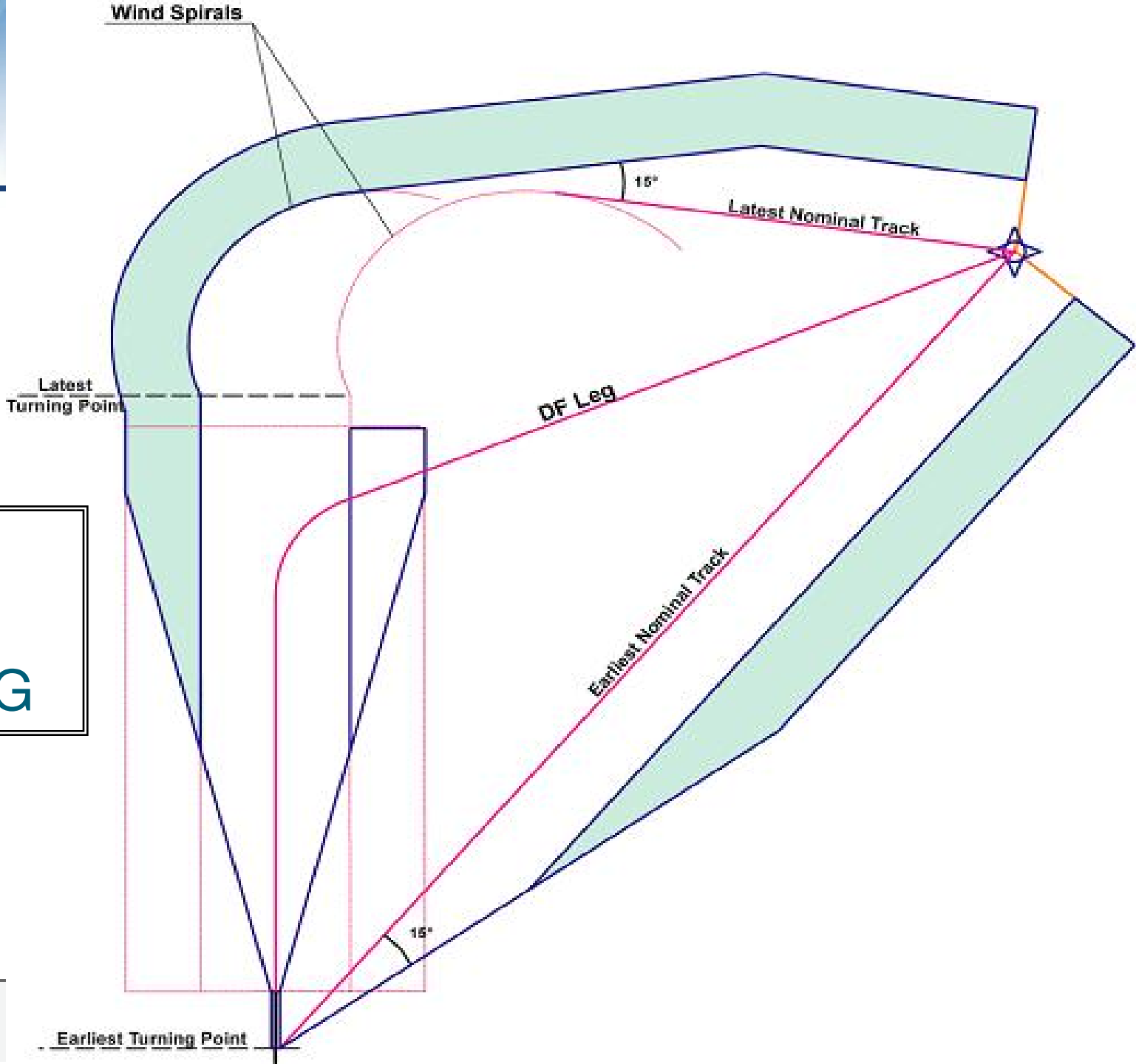
5 m + (dr x PDG) + (do x PDG) ≥ Ho + MOC

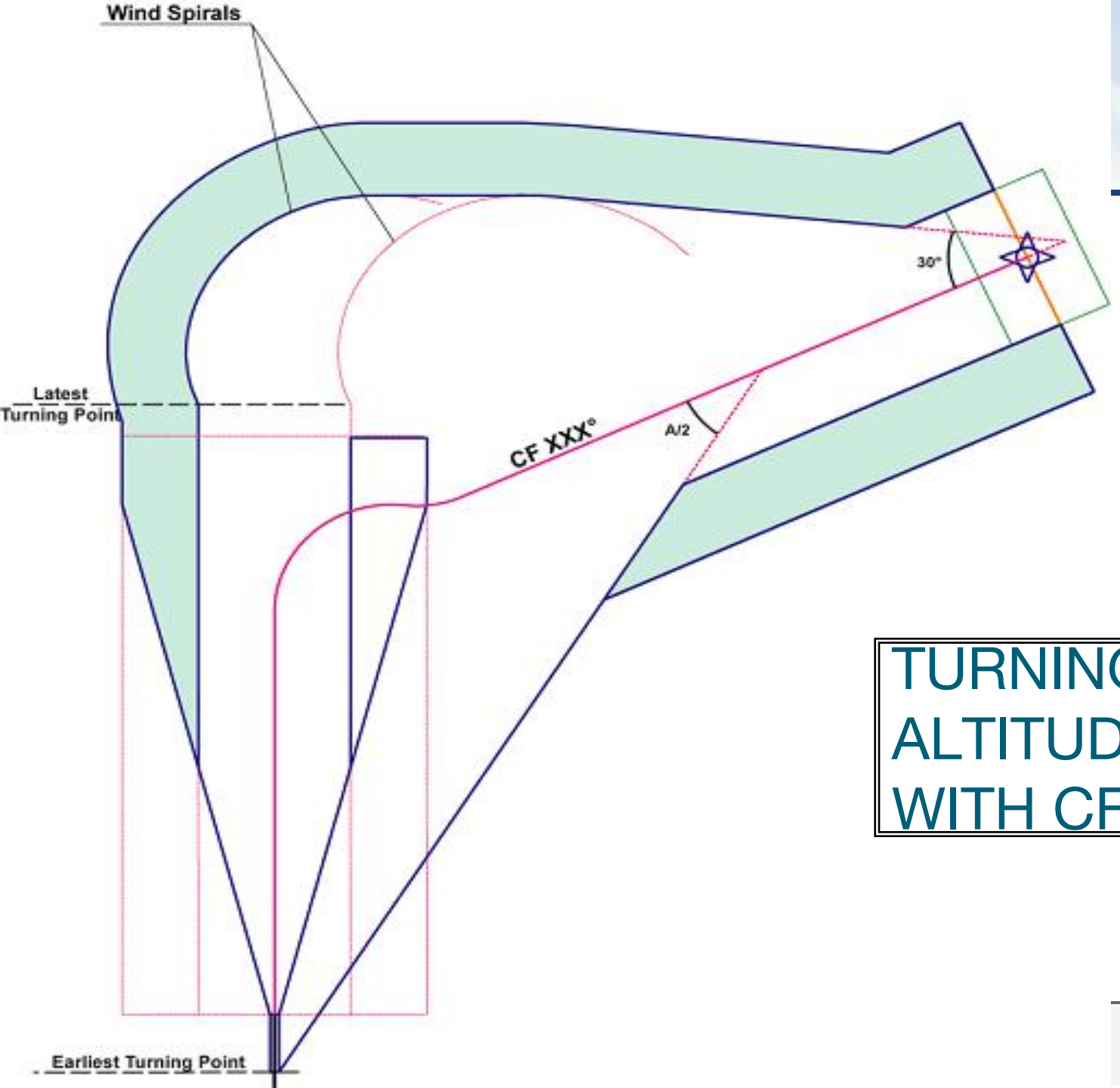
MOC = Max [0.8%(dr + do), 90 m]

dr is the shortest distance between DER and earliest TP

do is the shortest distance between obstacle and earliest TP

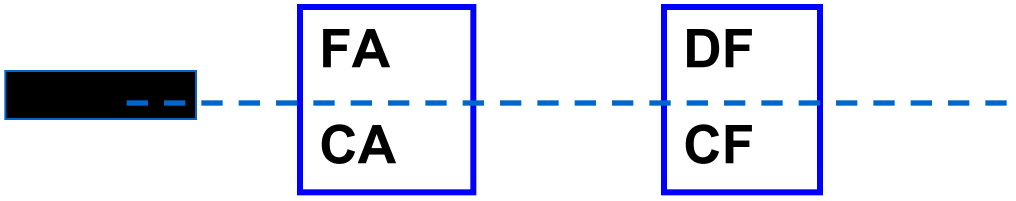
TURNING ALTITUDE WITH DF LEG

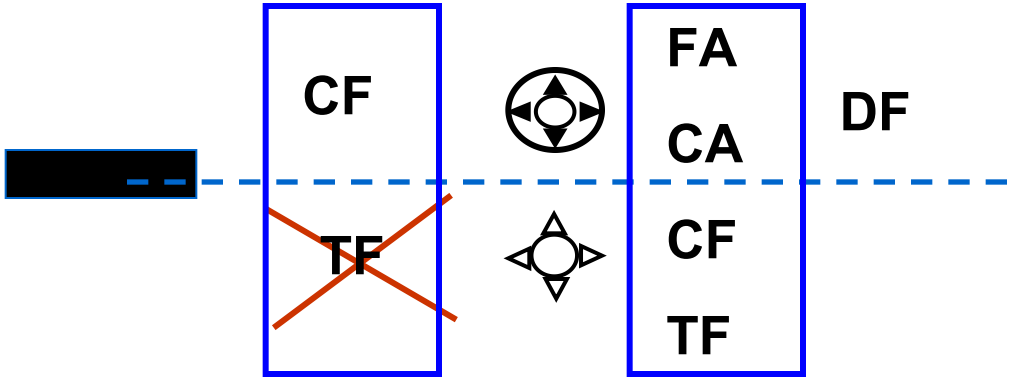




TURNING ALTITUDE WITH CF LEG

PATH TERMINATOR





TF : **T**rack between **F**ixes

CF : **C**ourse to **F**ix

DF : **D**irect to **F**ix

FA : **F**ix to **A**ltitude

CA: **C**ourse from fix to **A**ltitude

After the first WP, the standard sequencing rule is applicable

Any questions?