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# PANS-OPS Flight Procedure Design Training for CAAs

**23 August – 03 September 2021**





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## 06 – Turns protection

(Doc. 8168, vol. 2, Part III, Section 2, Chap. 2, Part II, Section 2)





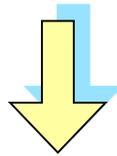
- 1. Straight segment protection**
- 2. Path terminators**
- 3. Turns construction**
- 4. Circular arcs method**
- 5. Start of descent in a turn**
- 6. Limits of segments**
- 7. Step down fixes**



# Straight segment protection

African Flight Procedure Programme (AFPP)

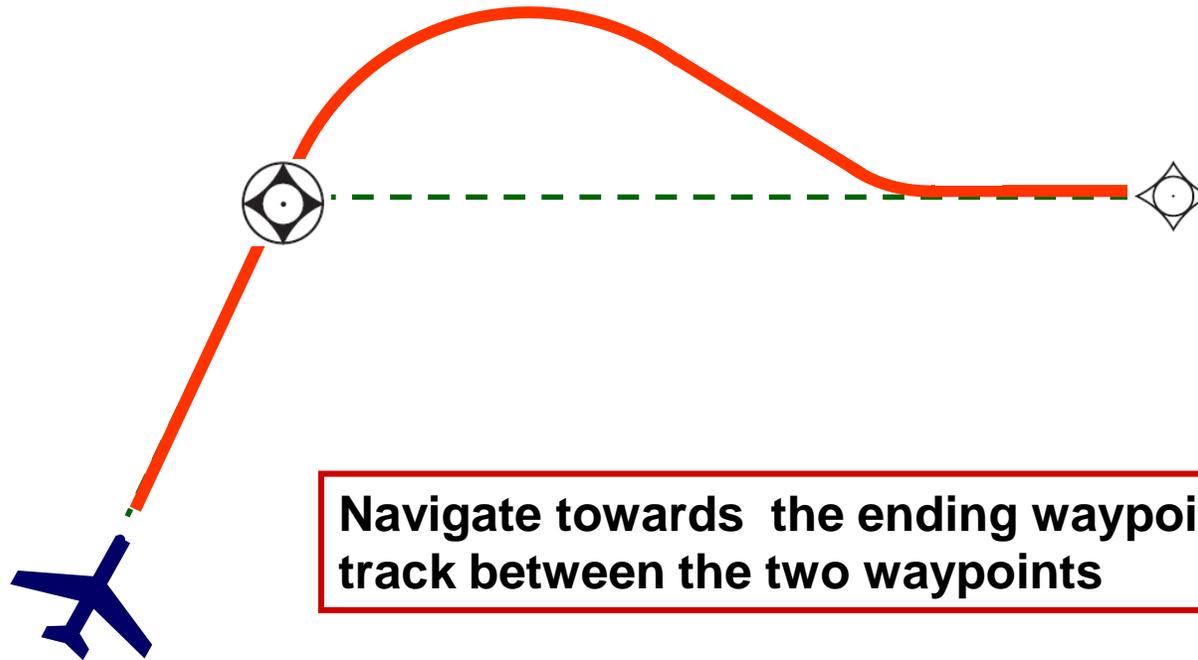
**XTT calculation**



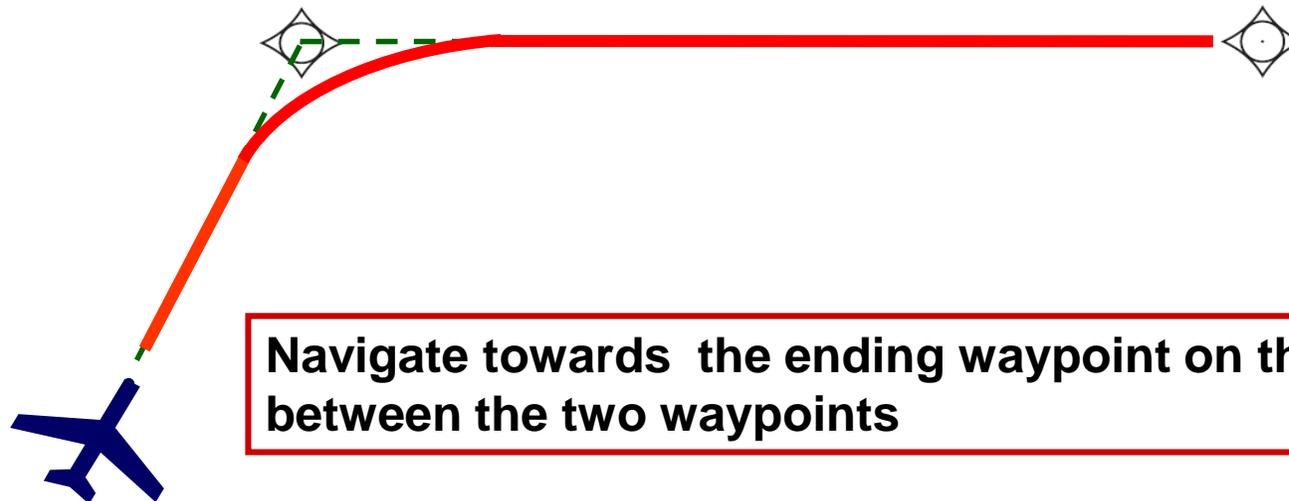
**Semi-Area width**  
 **$1/2 AW = 1.5 XTT + BV$**

**Straight protection  
area semi-width + merging  
methodology**

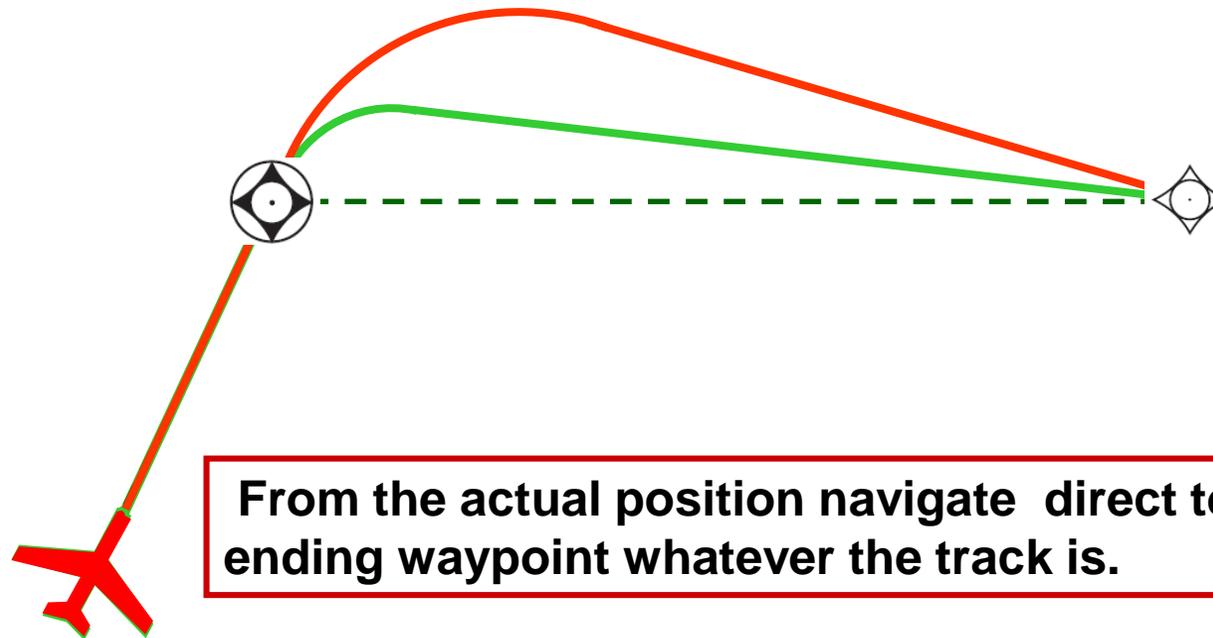
## Track between Fixes (TF)



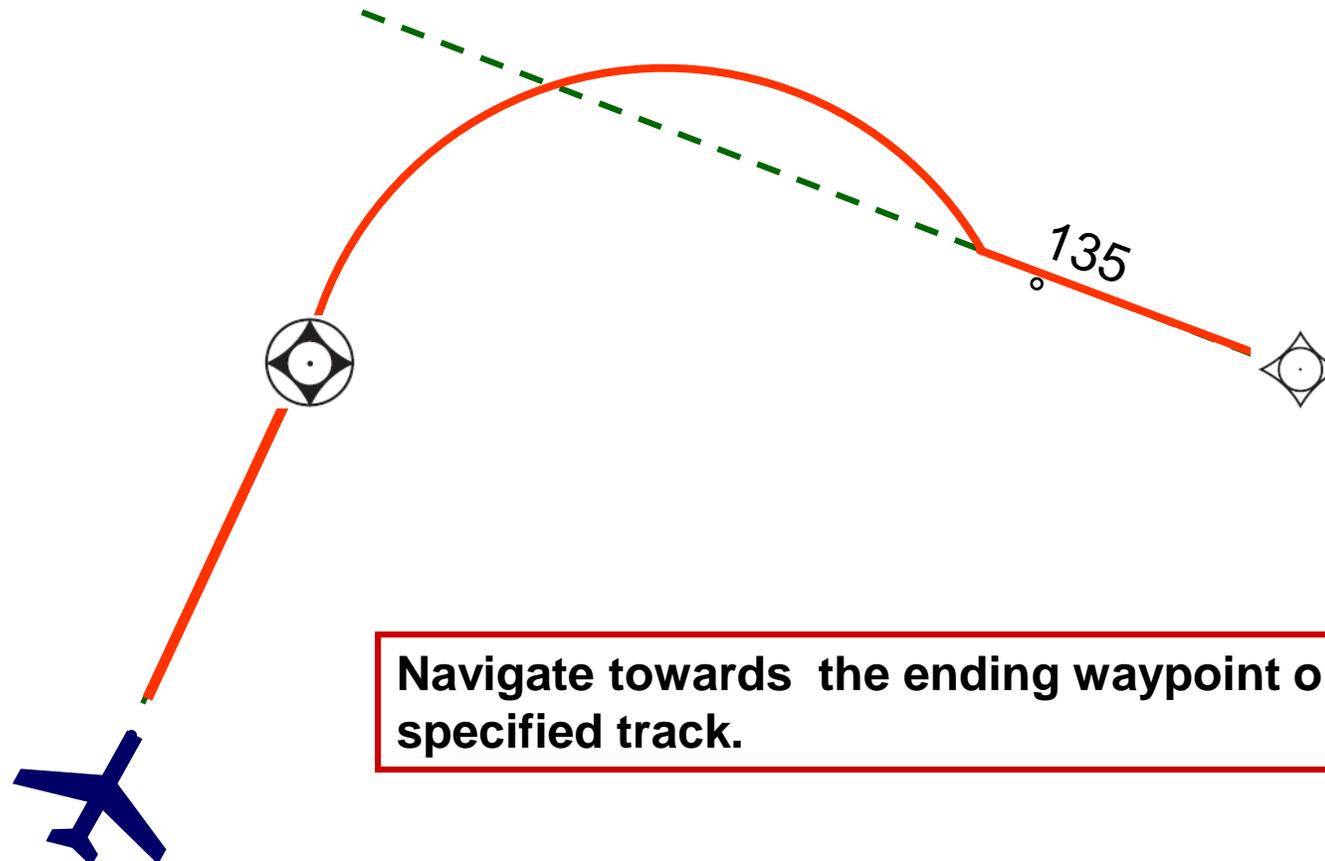
## Track between Fixes (TF)



## Direct to Fix (DF)

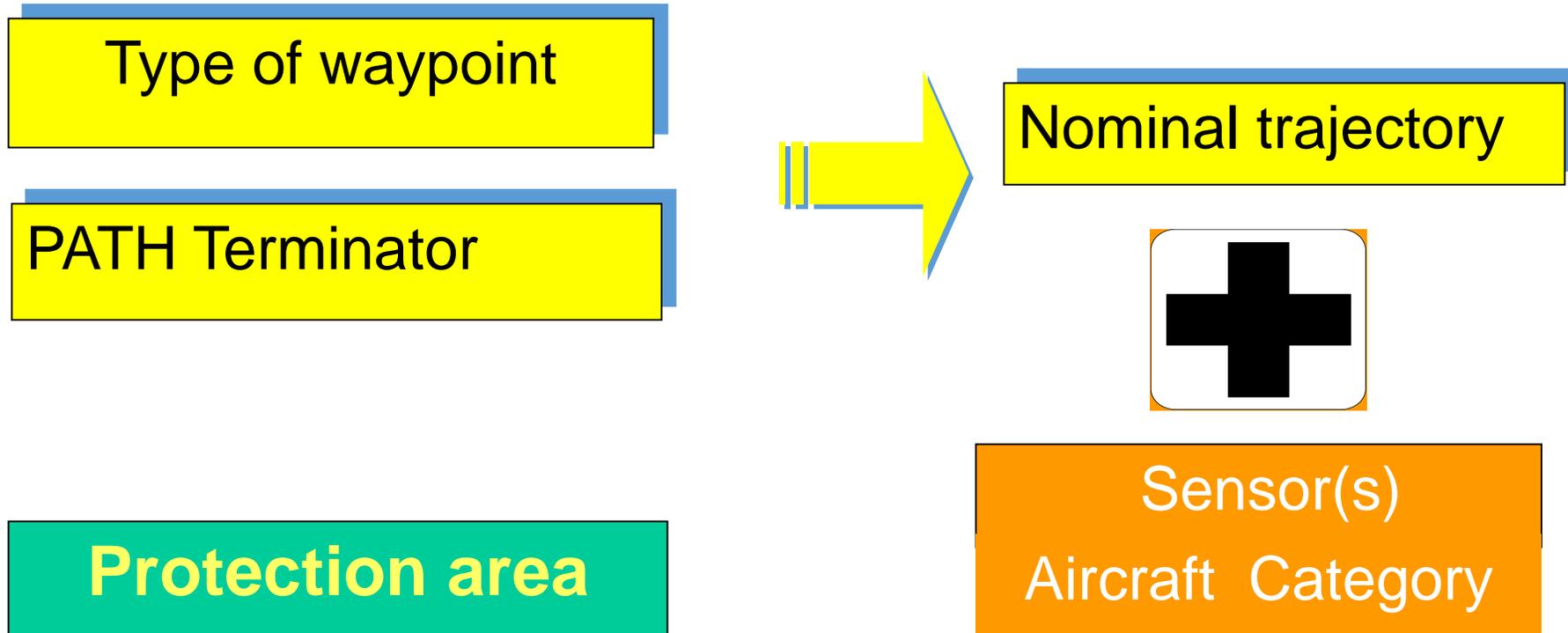


## Course to Fix (CF)



**Navigate towards the ending waypoint on a specified track.**

## Key points

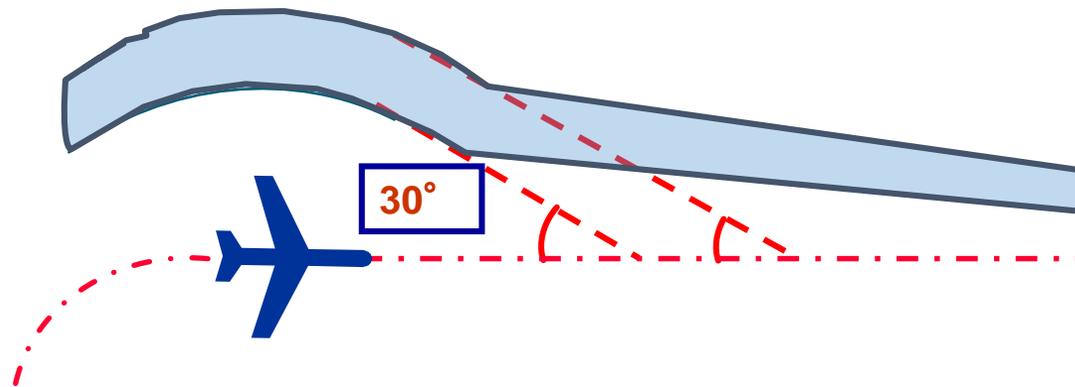




# Turns construction

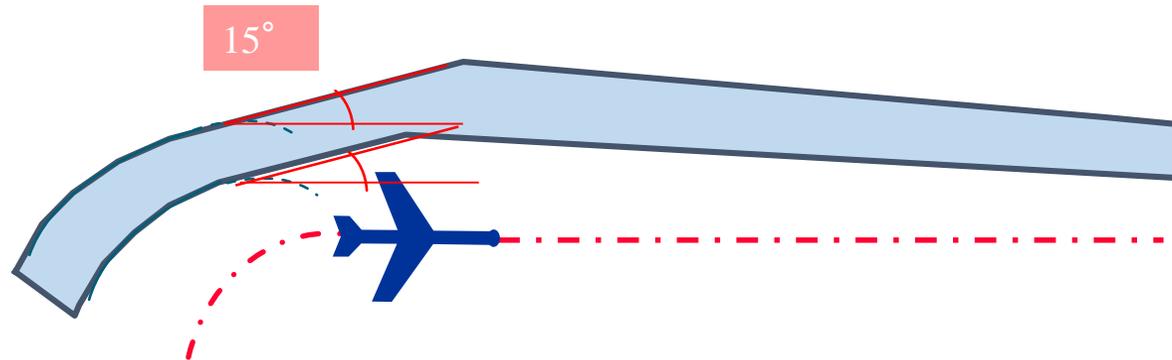


- Taper with **30°** relative to the nominal track:



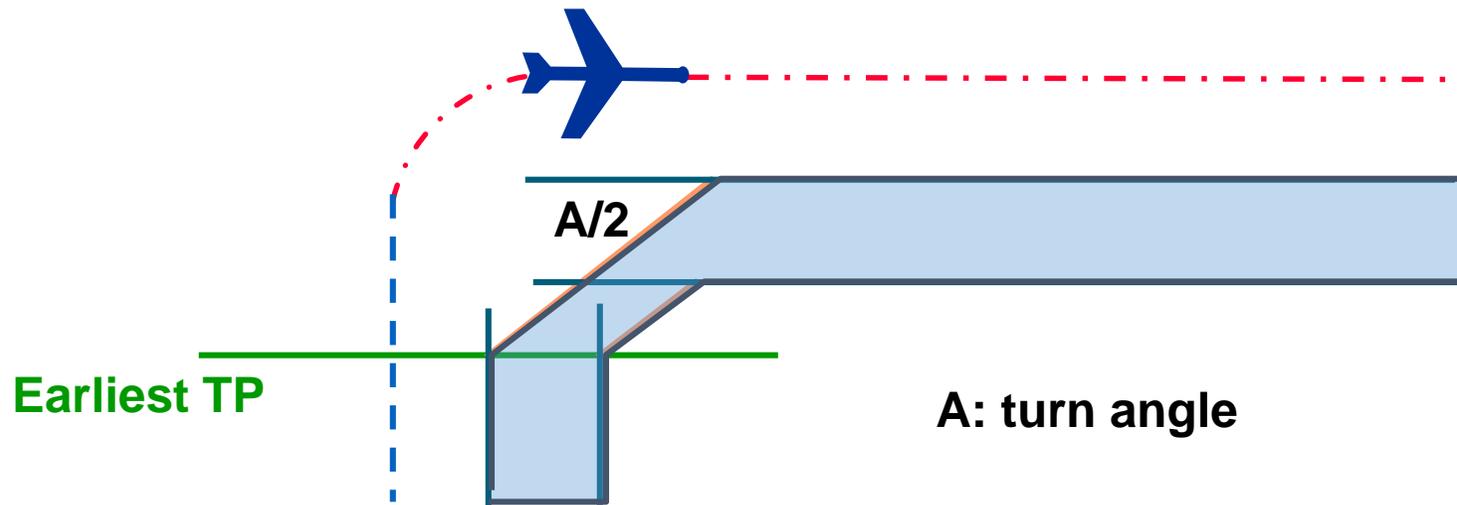
- If the **resulting turn protection area falls outside the area of the next leg**, these areas shall be joined by a line with **30°** to the **nominal track of the next leg tangent to the wind spiral**.

- Tangent to spiral with a  $15^\circ$  angle according to nominal trajectory

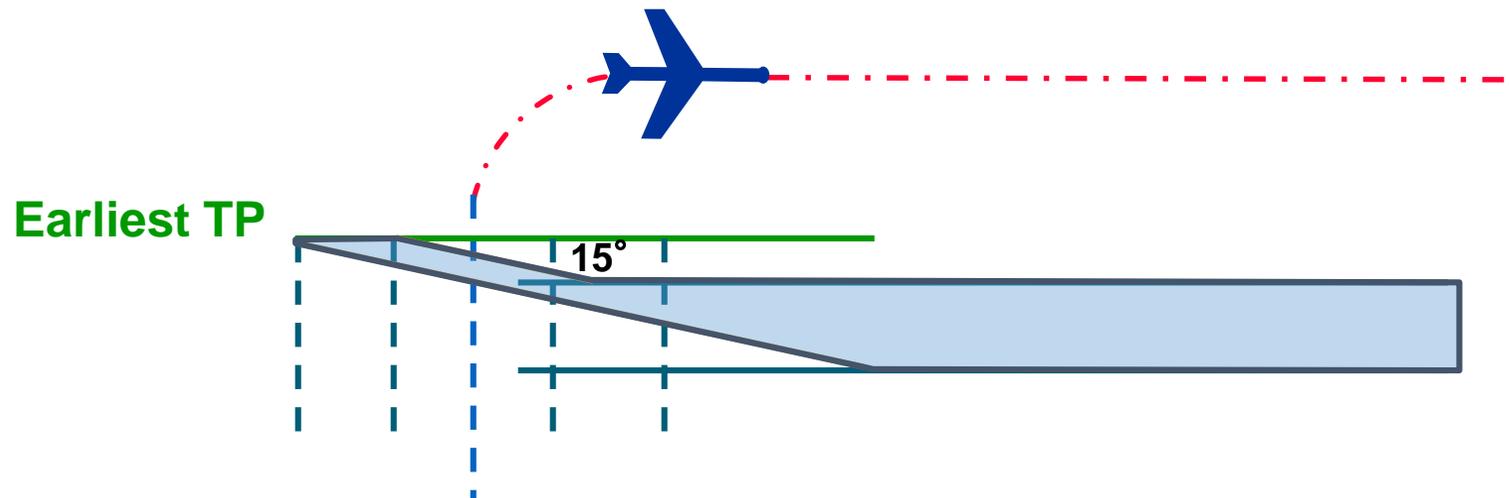


- If the **resulting** turn protection area falls **within** the area of the **next leg** , these areas shall be joined with a  $15^\circ$  splay line according to the **nominal track** of the **next leg** tangent to the wind spiral .

- ❑ If the **area** of the **previous leg** lies **outside** the area of the **next leg** the areas shall be joined at  $A/2$  to the **nominal track** of the **next leg** from the most constraining **earliest** turning point.
- ❑ Taper with half turn angle ( $A/2$ ) relative to the nominal track



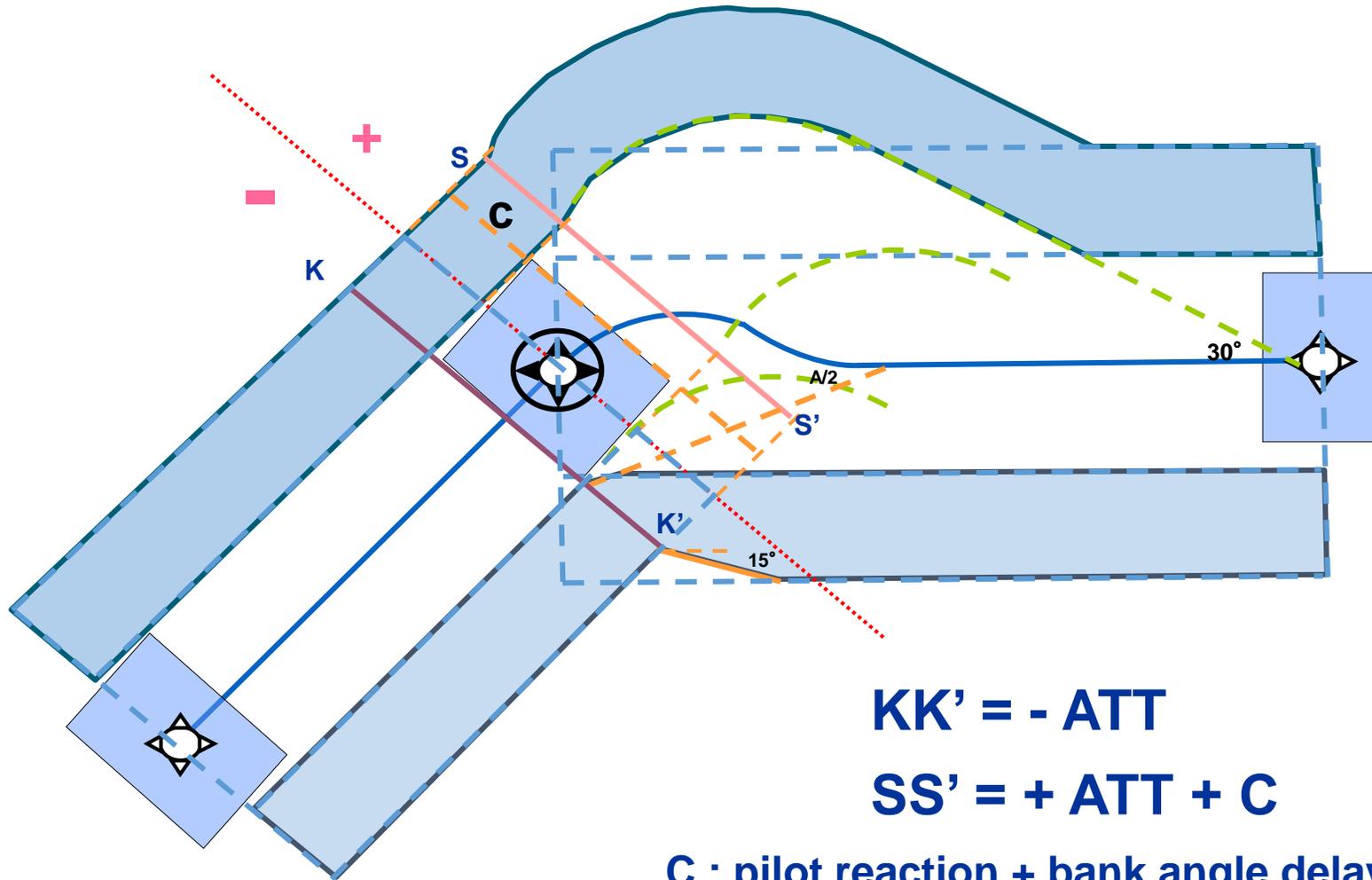
- ❑ If the area of the **previous leg lies within** the area of the **next leg** the area shall be **splayed with 15°** to the nominal track of the **next leg** from the most constraining **earliest turning point**.
- ❑ Spay with 15° relative to the nominal track.



# Turn at fly-over waypoint: TF protection area

African Flight Procedure Programme (AFPP)

Figure III-2-2-3



$$KK' = - ATT$$

$$SS' = + ATT + C$$

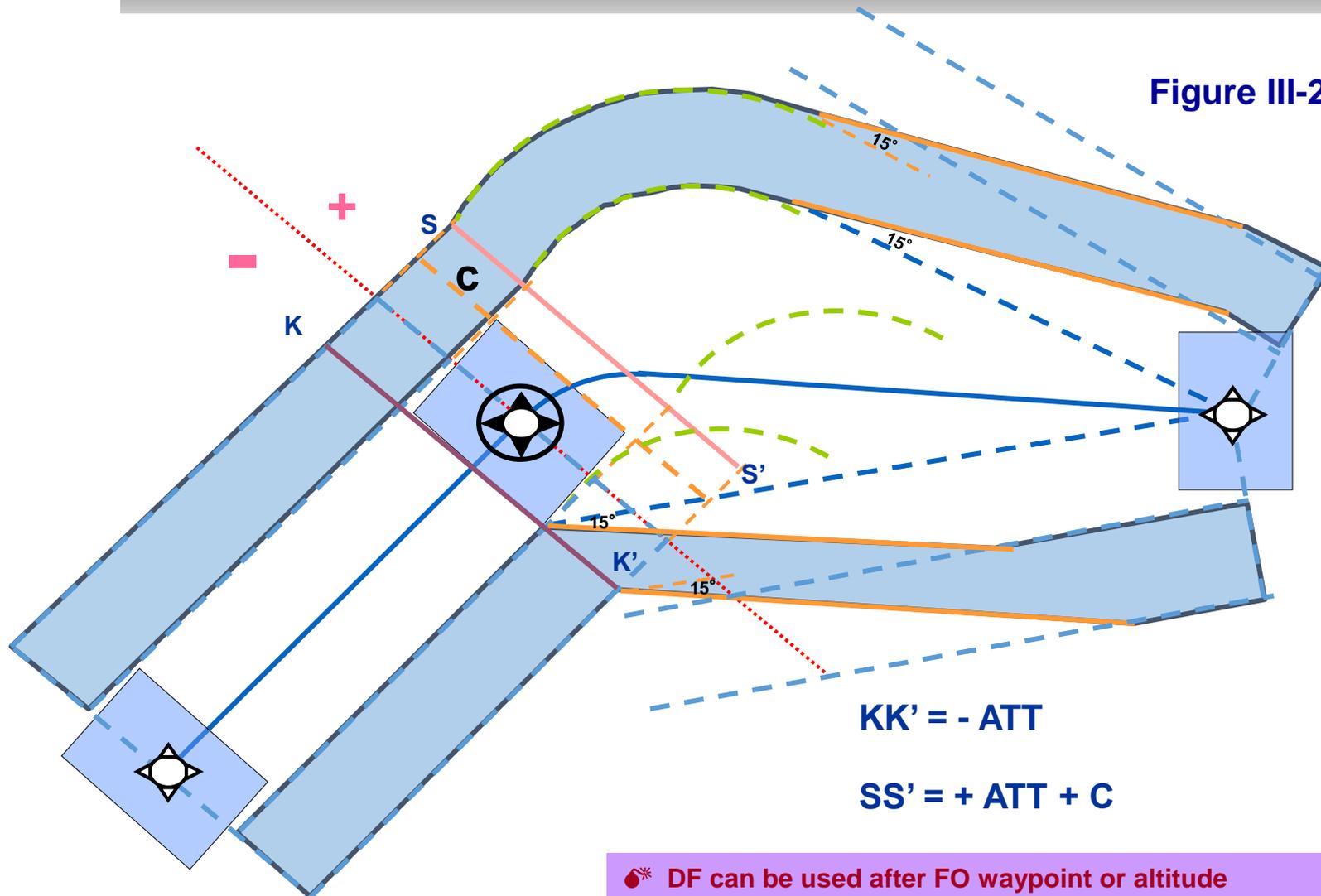
**C : pilot reaction + bank angle delay**



# Turn at fly-over waypoint: DF protection area

African Flight Procedure Programme (AFPP)

Figure III-2-2-6



DF can be used after FO waypoint or altitude



# Turn at fly-by waypoint: TF protection area (Angle $\leq 90^\circ$ )

African Flight Procedure Programme (AFPP)

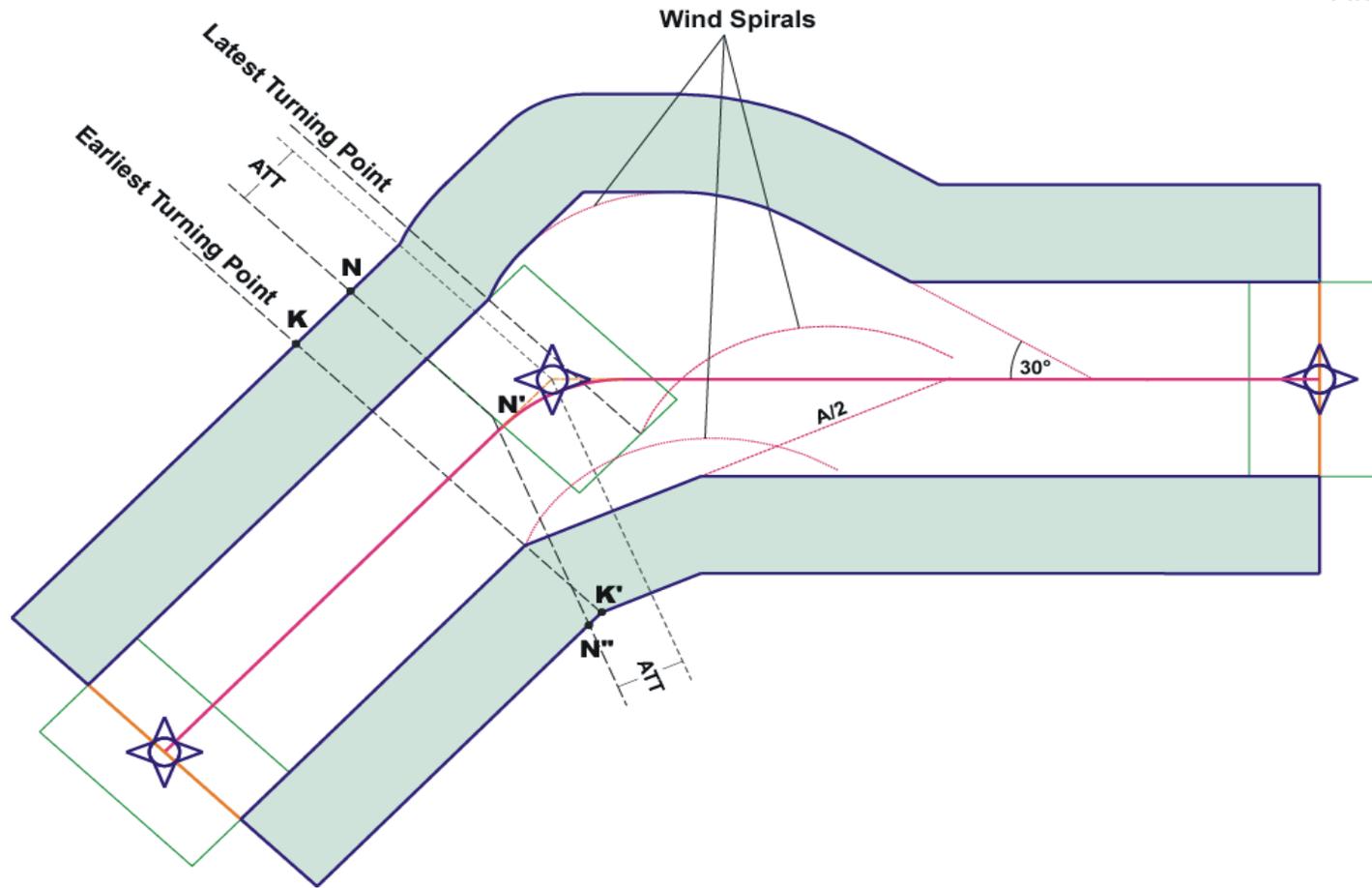


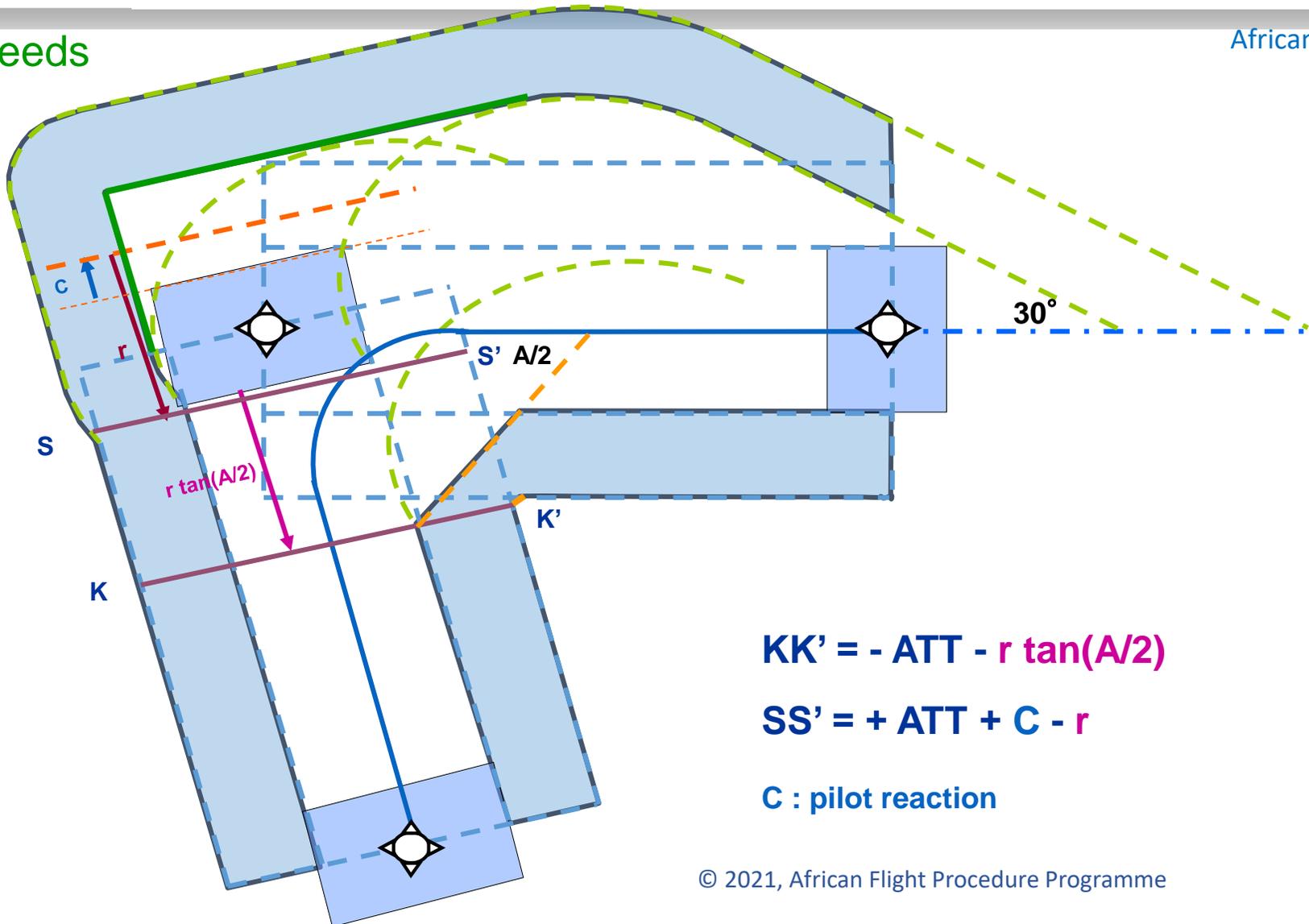
Figure III-2-2-5



# Turn at fly-by waypoint: TF protection area (Angle > 90°)

African Flight Procedure Programme (AFPP)

Low speeds



$$KK' = - ATT - r \tan(A/2)$$

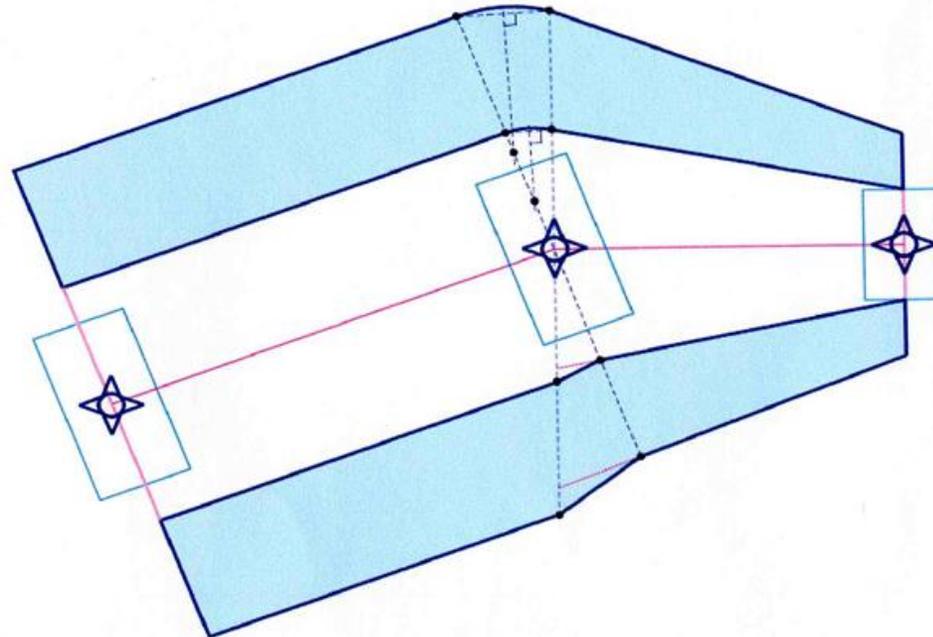
$$SS' = + ATT + C - r$$

C : pilot reaction

□ Used for turns smaller than or equal :

☞ 30° for IAF and IF;

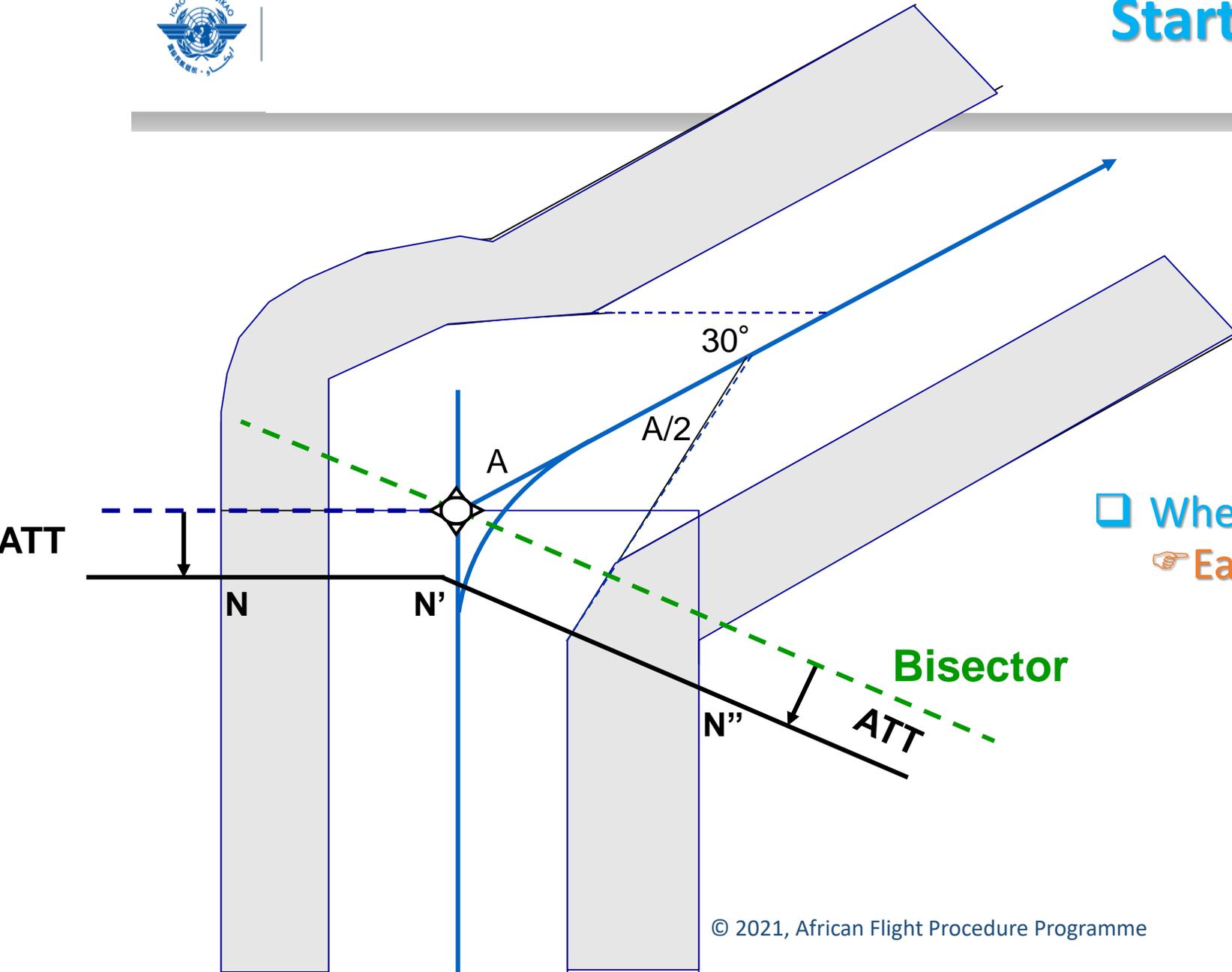
☞ 10° at FAF.





# Start of descent in a turn

African Flight Procedure Programme (AFPP)



❑ Where does the A/C start descending ?  
👉 Earliest Descent Line NN'N''

Figure III-2-2-5



# Limits of segments

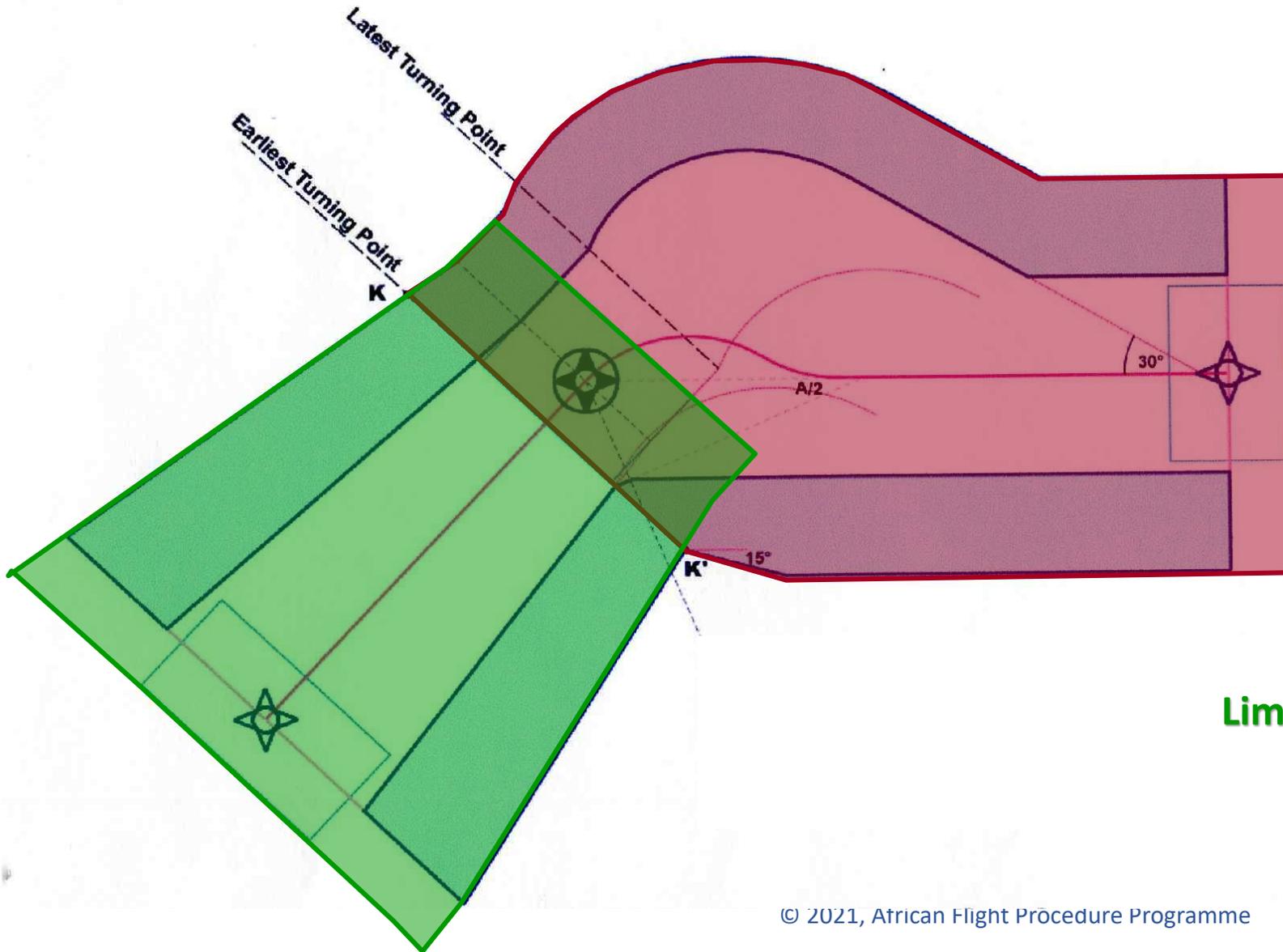
African Flight Procedure Programme (AFPP)

- ❑ No ICAO clear reference (Proposed here by France).
- ❑ The earliest limit will be defined by the more constraining of the line KK' and NN'N'' lines:
  - ☞ Earliest limit of the segment following the turn is defined by the more constraining earliest limit of the WP regarding its use;
  - ☞ Latest limit = latest tolerance of the ending waypoint.
    - A pilot can descend down to the MOCA of the segment up to the ending waypoint of the segment
- ❑ For descending segment, the MOCA of the preceding segment is higher or equal than the MOCA of the next segment



# Limits of segments: FO waypoints

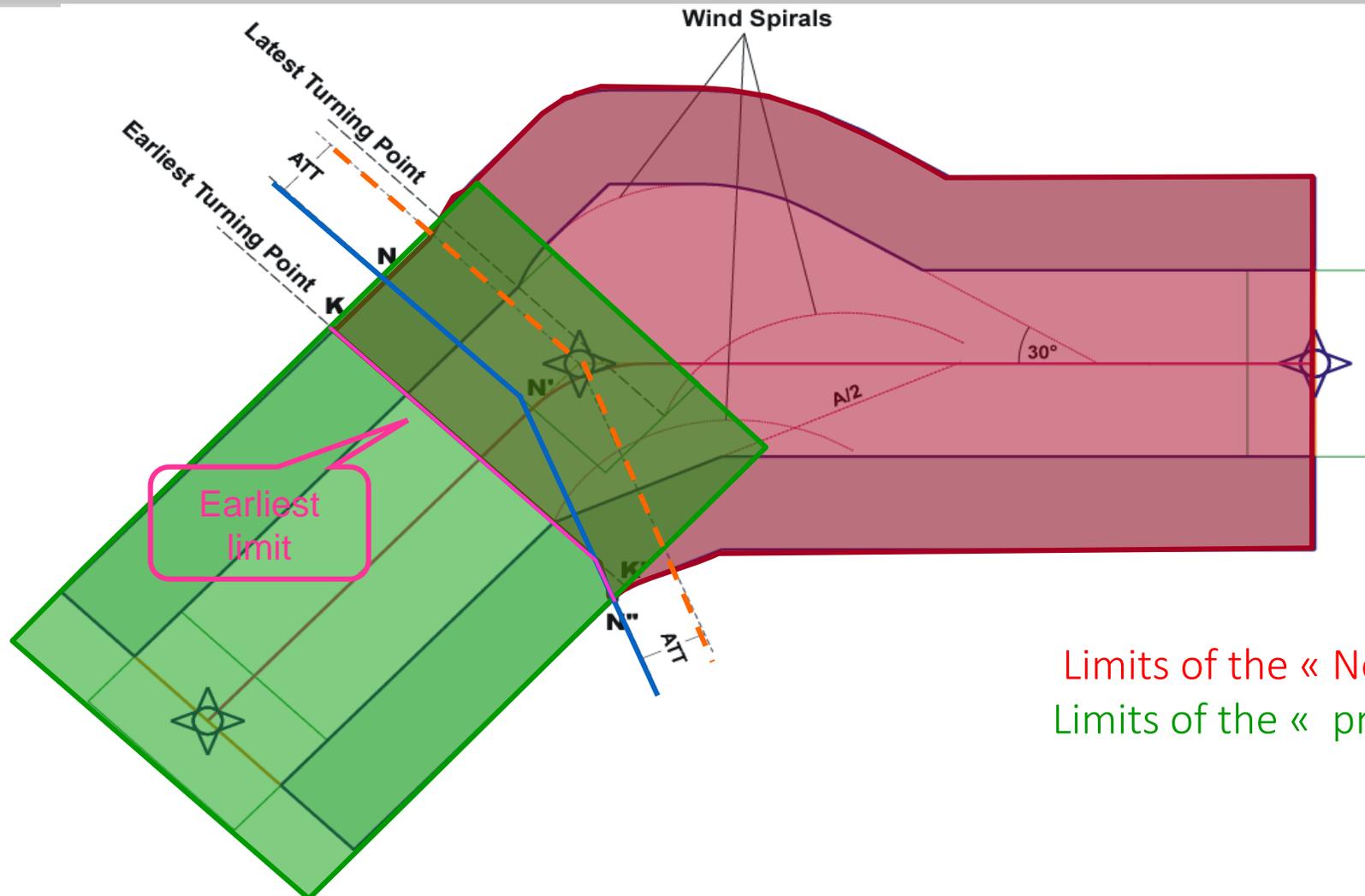
African Flight Procedure Programme (AFPP)



**Limits of the « Next segment »**  
**Limits of the « preceding segment »**

# Limits of segments: FB waypoints

Flight Procedure Programme (AFPP)

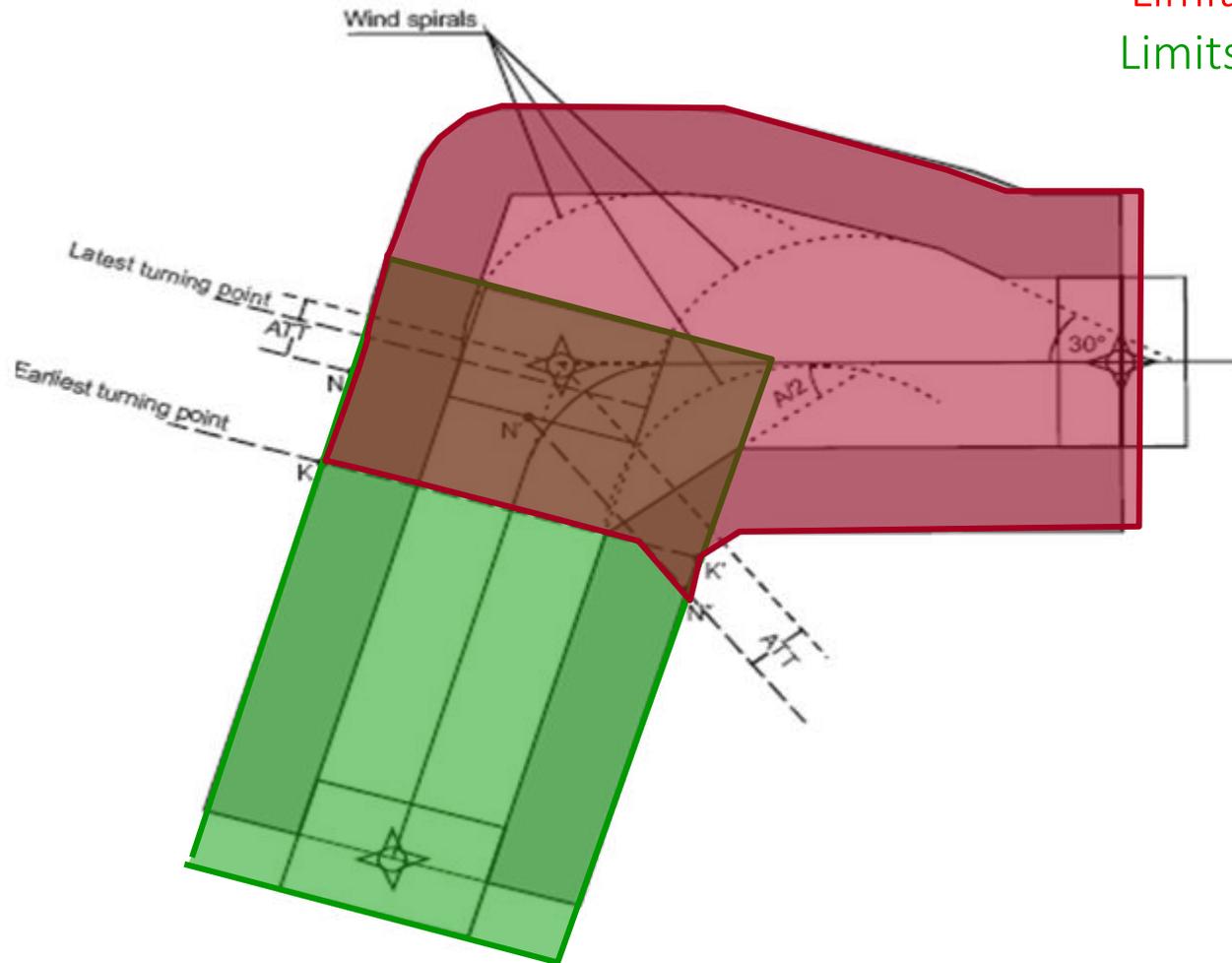


Limits of the « Next segment »  
Limits of the « preceding segment »



## Limits of segments: FB waypoints

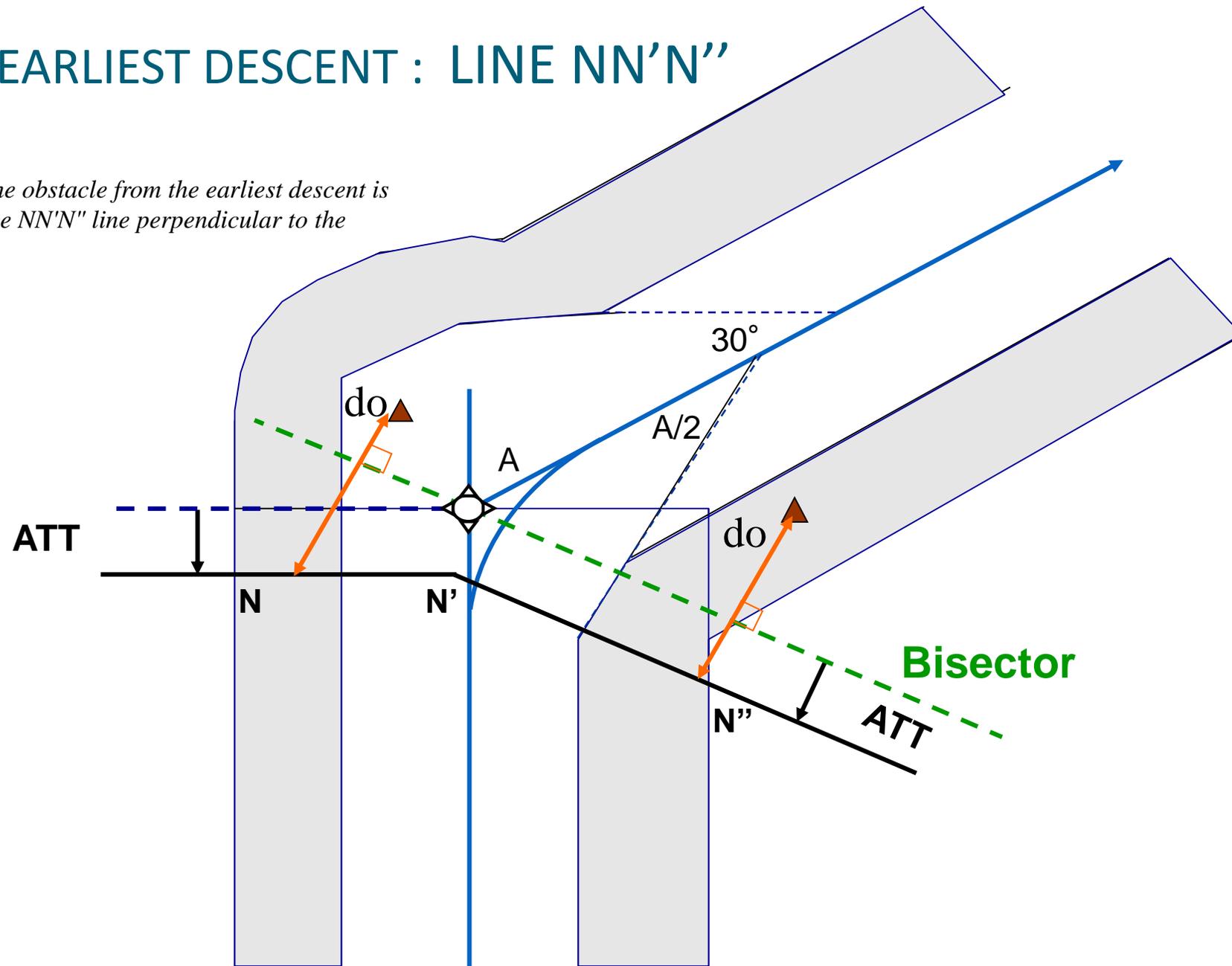
African Flight Procedure Programme (AFPP)



Limits of the « Next segment »  
Limits of the « preceding segment »

# EARLIEST DESCENT : LINE NN'N''

*The distance to the obstacle from the earliest descent is measured from the NN'N'' line perpendicular to the bisector.*





# Step down fixes

African Flight Procedure Programme (AFPP)

## □ Goal:

☞ How to determine which obstacles cannot be considered for OCH calculation?

## □ The basic systems do not accommodate SDF coding:

☞ Managed manually by the pilot

☞ Distance to the next waypoint provided

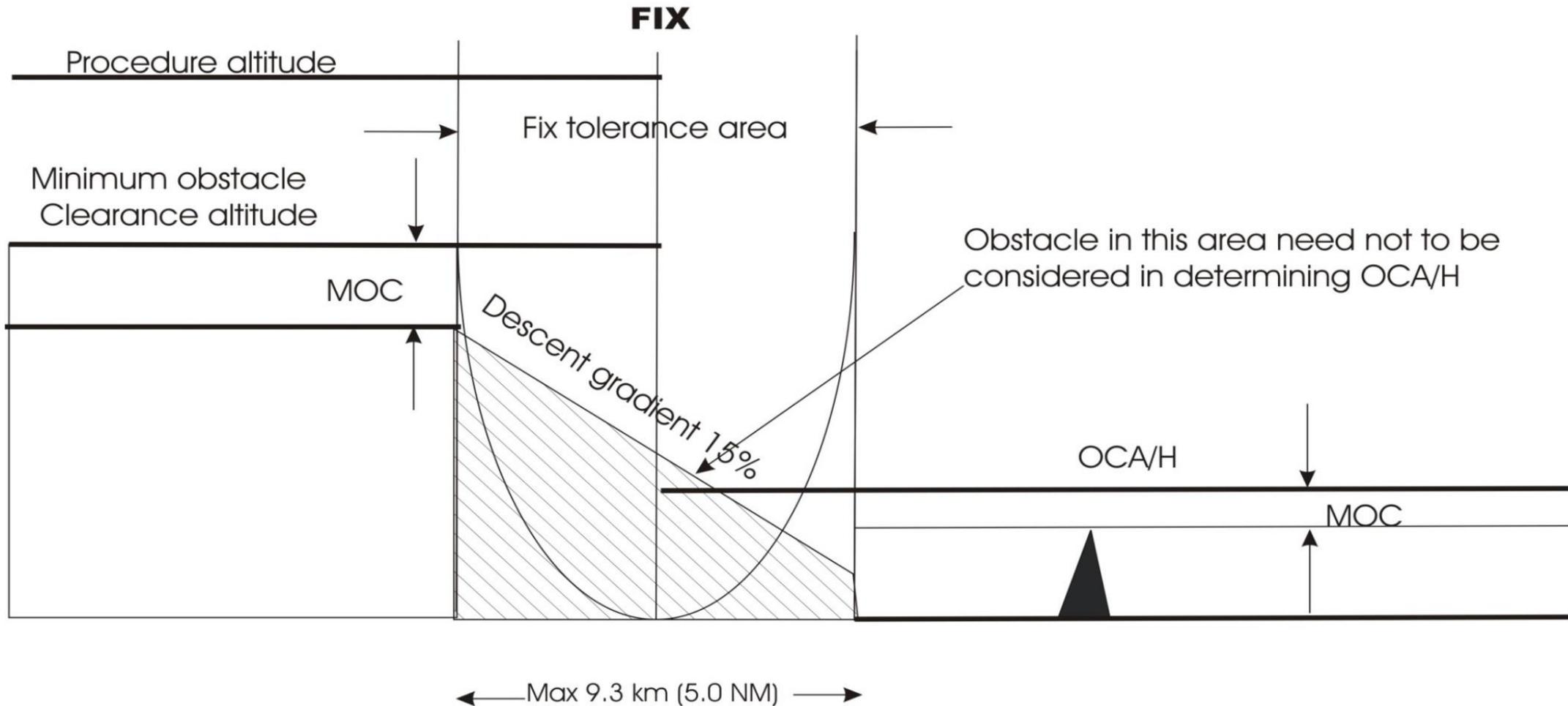
## □ In final segment maximum of 2 SDFs

## □ Safety issue : SDF should be avoided



# Step down fixes

African Flight Procedure Programme (AFPP)



North American  
Central American  
and Caribbean  
(NACC) Office  
Mexico City

South American  
(SAM) Office  
Lima

ICAO  
Headquarters  
Montreal

Western and  
Central African  
(WACAF) Office  
Dakar

European and  
North Atlantic  
(EUR/NAT) Office  
Paris

Middle East  
(MID) Office  
Cairo

Eastern and  
Southern African  
(ESAF) Office  
Nairobi

Asia and Pacific  
(APAC) Office  
Bangkok

# Questions:

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