



INTERNATIONAL CIVIL AVIATION ORGANIZATION
A United Nations Specialized Agency



PBN Procedure Design Course 2026

ICAO APAC FPP

Beijing, China

(7-25/Sep/2026)



TURN PROTECTION

TABLE OF CONTENTS AND REGULATORY REFERENCE



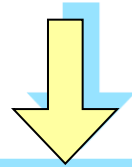
- Turn protection area
 - Section 2 chapter 2
 - Circular Arc method
 - Spiral method
 - Figure 2-21 to 2.2.6
 - Figure 2.2.10 to 2.2.13
- Non precision Approach procedure
 - Section 3 chapter 2 : initial and intermediate
 - Section 3 chapter 3 : Final and missed approach
- RNAV connection to ILS

DOC 8168 **Vol II Part III**

STRAIGHT PROTECTION AREA



XTT calculation



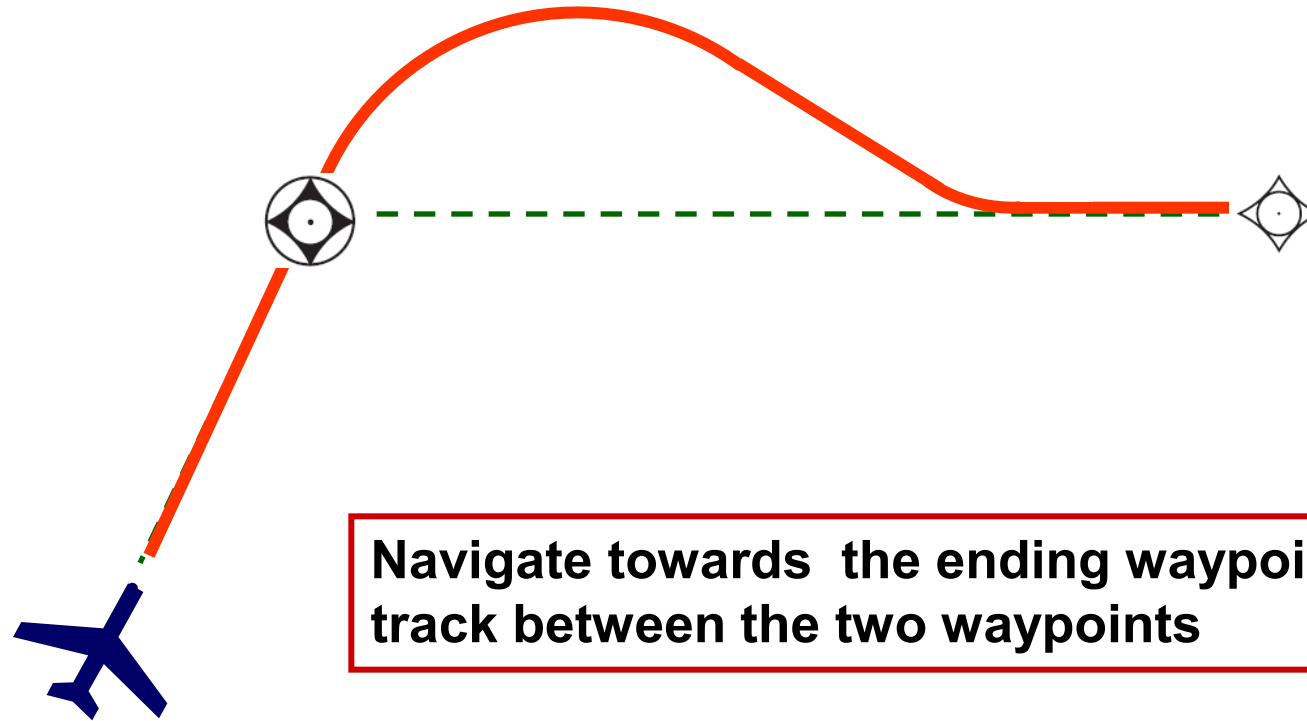
Area semiwidth
 $1/2 AW = 1.5 XTT + BV$

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

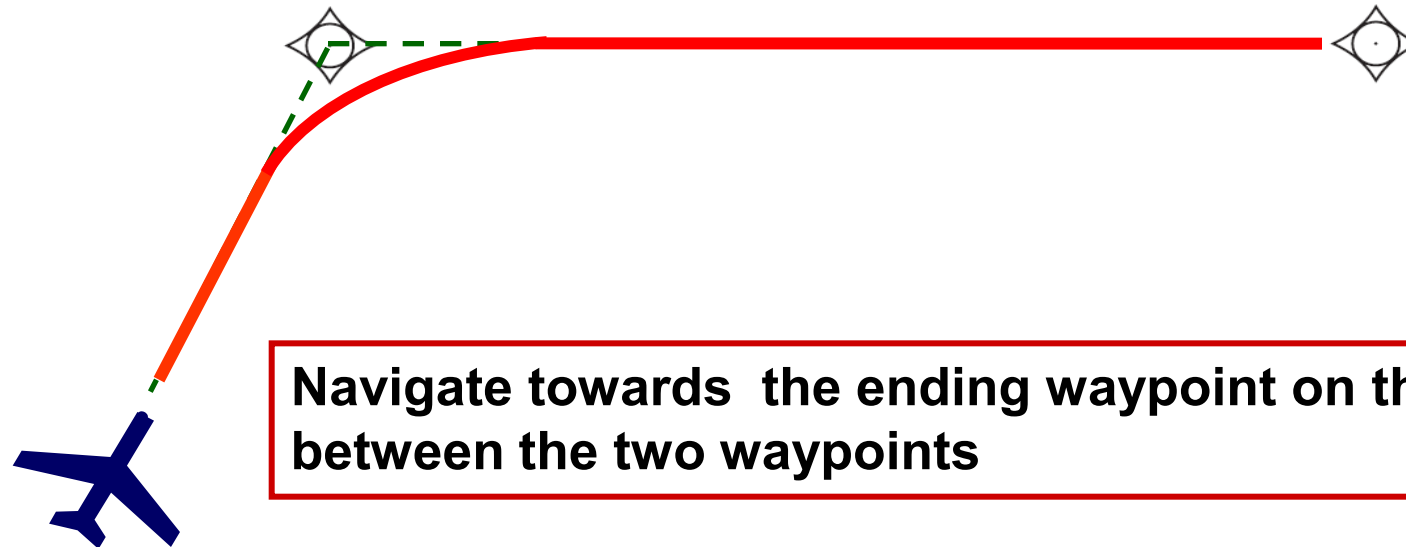
PATH TERMINATOR

Review and influence on the desired track

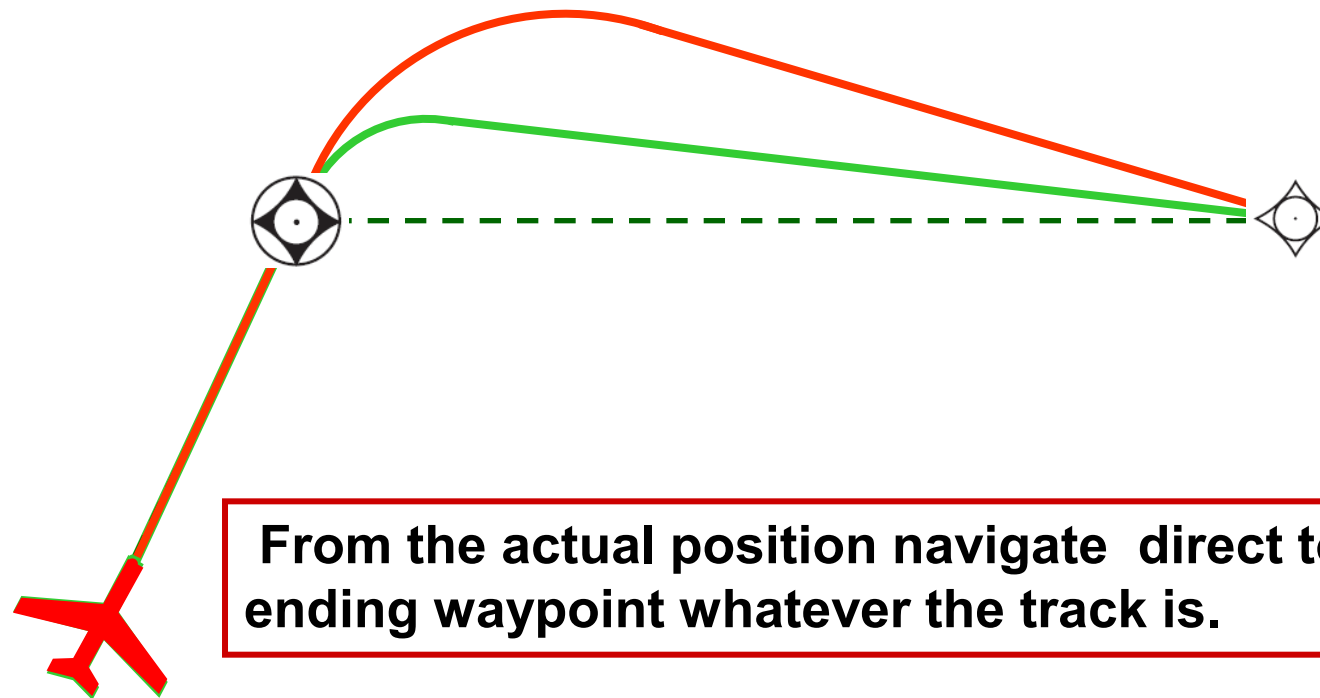
TF : TRACK BETWEEN FIXES (DOC 8168 Track to a fix)



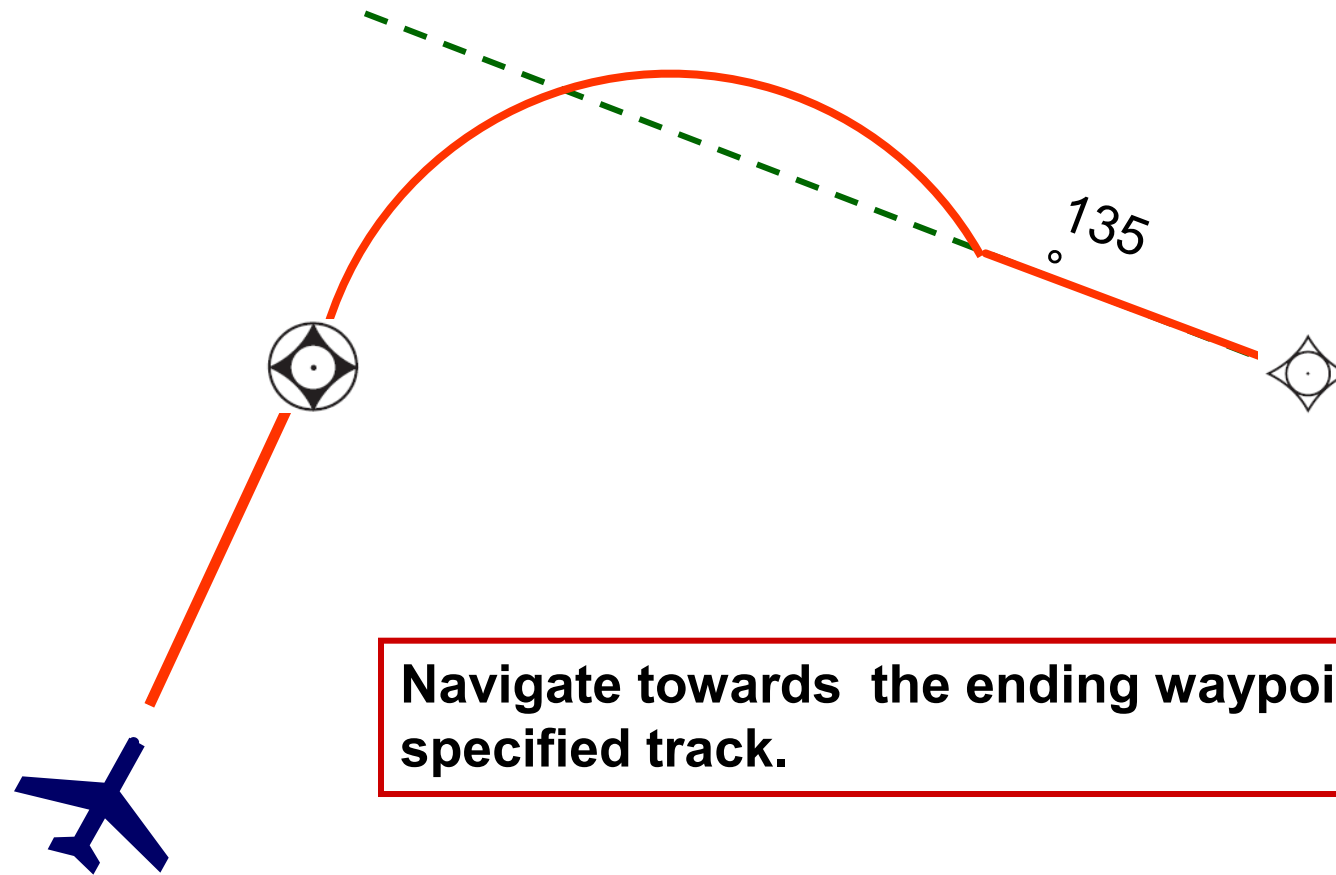
TF : TRACK BETWEEN FIXES (DOC 8168 Track to a fix)



DF : DIRECT TO a FIX



CF : COURSE TO a FIX



Navigate towards the ending waypoint on a specified track.

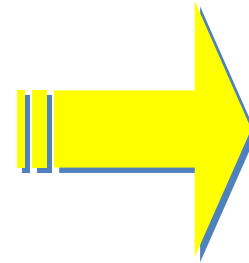
KEY POINT



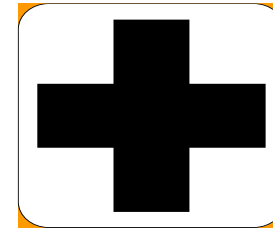
Type of waypoint

PATH Terminator

Protection area



Nominal trajectory



Sensor(s)
Aircraft Category

TURN CONSTRUCTION



WHAT' S NEW (regarding non RNAV procedure)

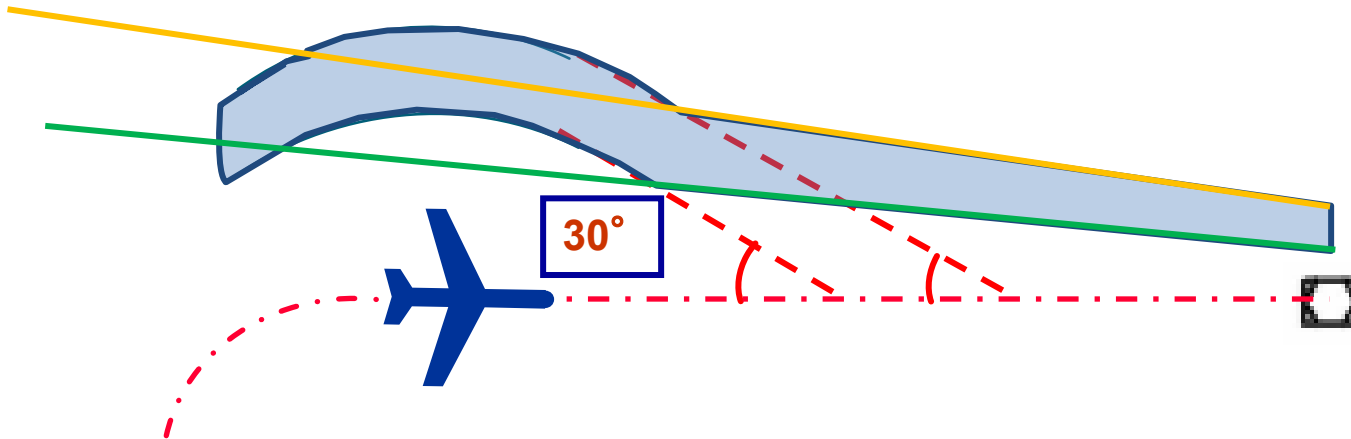
- Use of wind spiral for turn protections or circular arc method
- Max turn angle : 120° (no reversal)
- Bank angle delay for a fly-by WP is assumed by the system
- Protection deals with **max** TAS and **low** TAS

WHAT' S REMAINING ?

- Bank angle : 25° / 15°
- Pilot reaction delay : 6 sec / 3 Sec
- Descent and climb gradient
- MOC

CONNECTION METHOD: OUTER TURN

- Taper with 30° relative to the nominal track

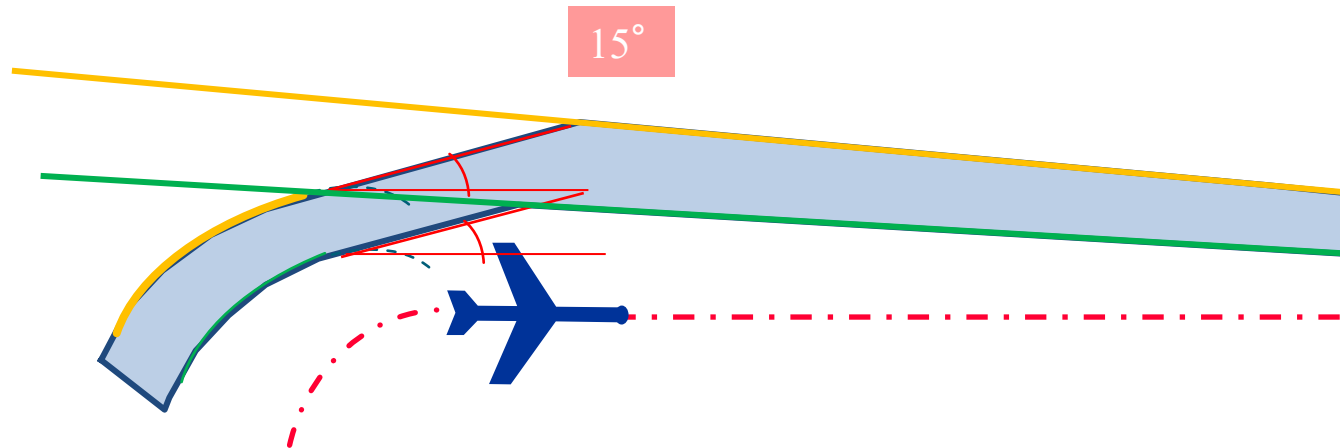


§ III-2-2-3.1.1

If the **resulting 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.

CONNECTION METHOD: OUTER TURN

- Tangent to spiral with a 15° angle according to nominal trajectory

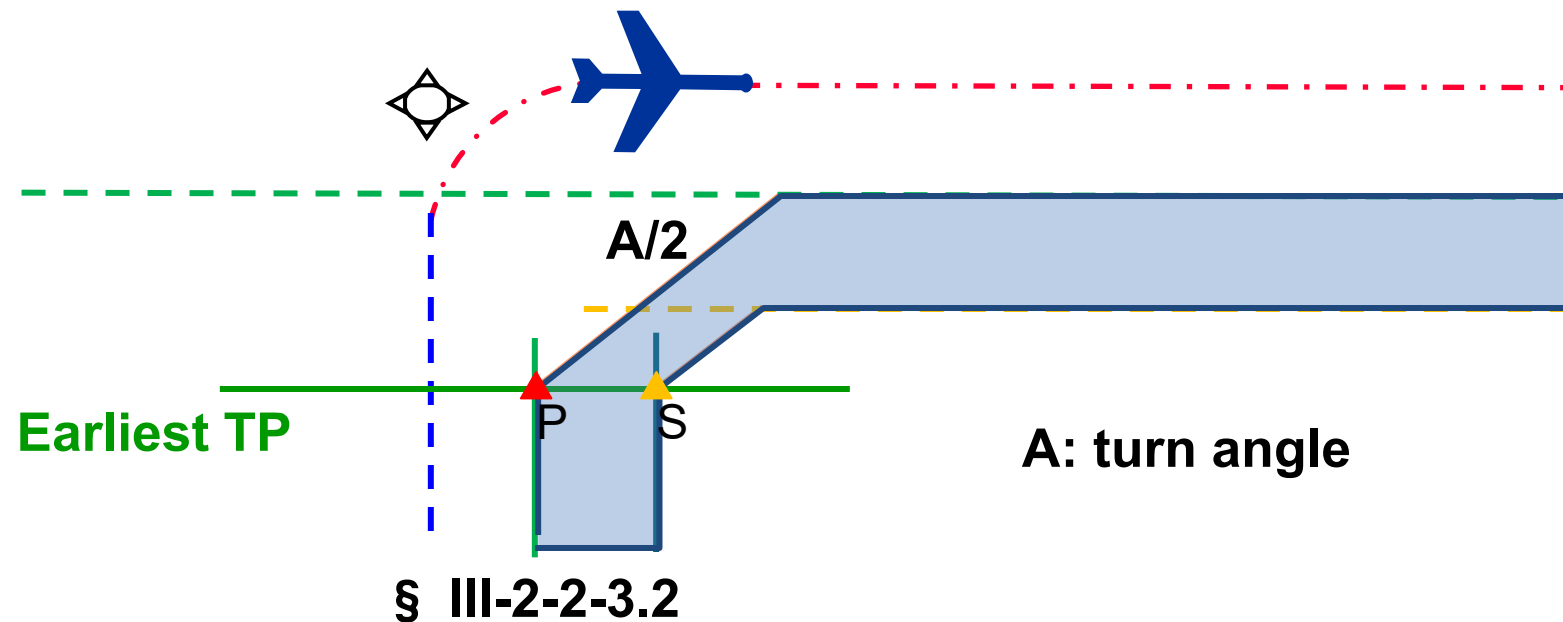


§ III-2-2-3.1.1

If the **resulting** area falls **within** the area of the **next leg** , these areas shall be joined with a **15°** splay line according to the **nominal** track of the **next leg** tangent to the wind spiral .

CONNECTION METHOD: INNER TURN

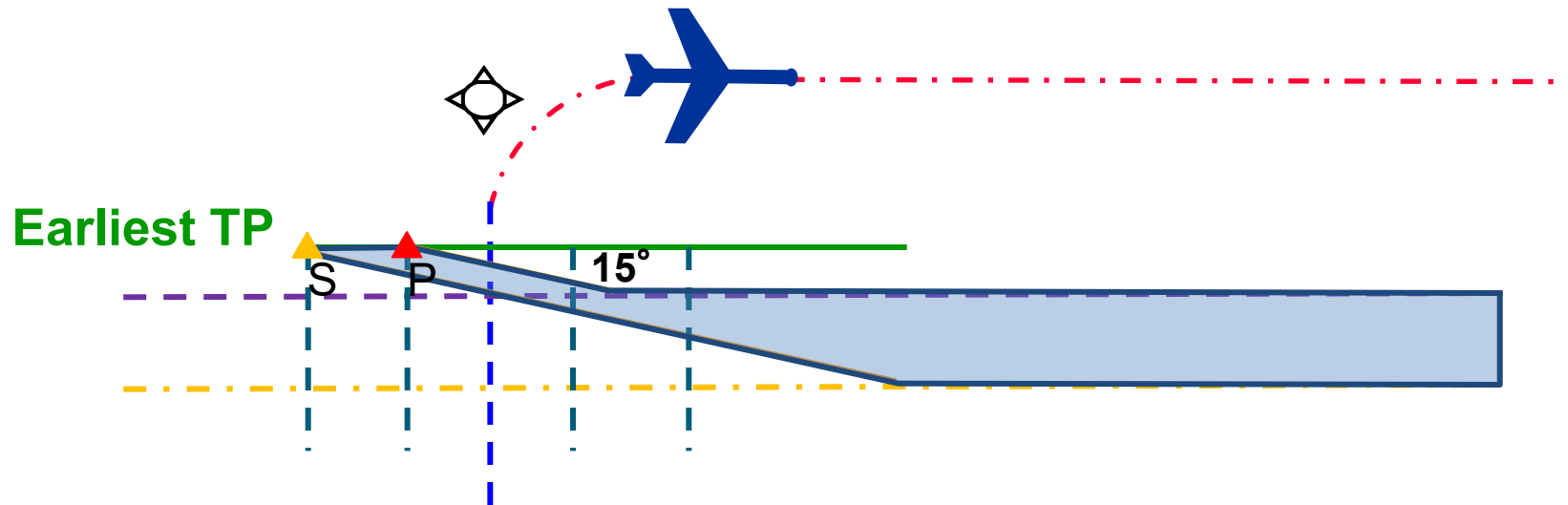
- Taper with half turn angle ($A/2$) relative to the nominal track



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.

CONNECTION METHOD: INNER TURN

- Spay with 15° relative to the nominal track



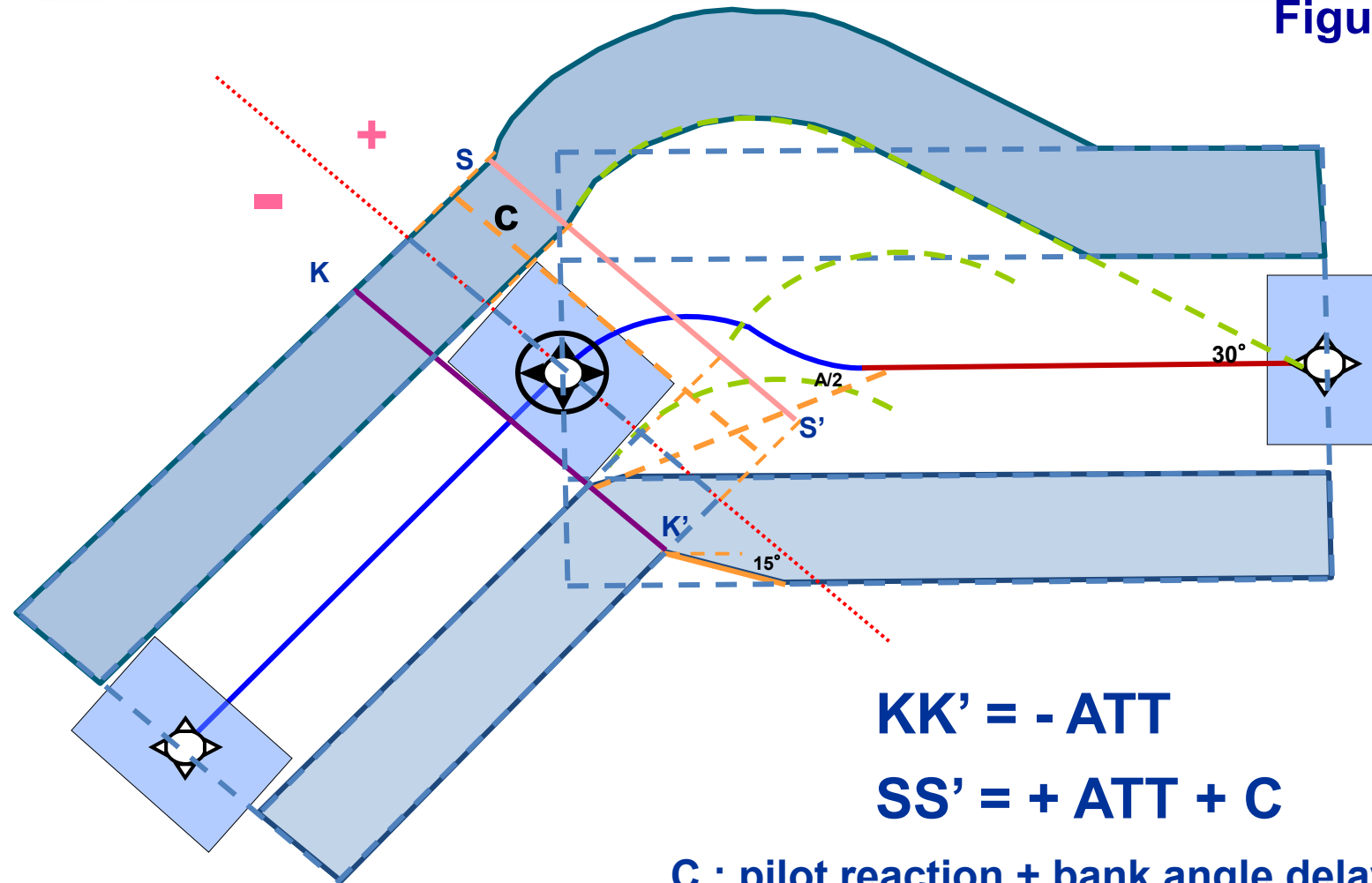
§ III-2-2-3.2

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.

TURN AT FLY OVER WAYPOINT : TF PROTECTION AREA



Figure III-2-2-3



$$KK' = - ATT$$

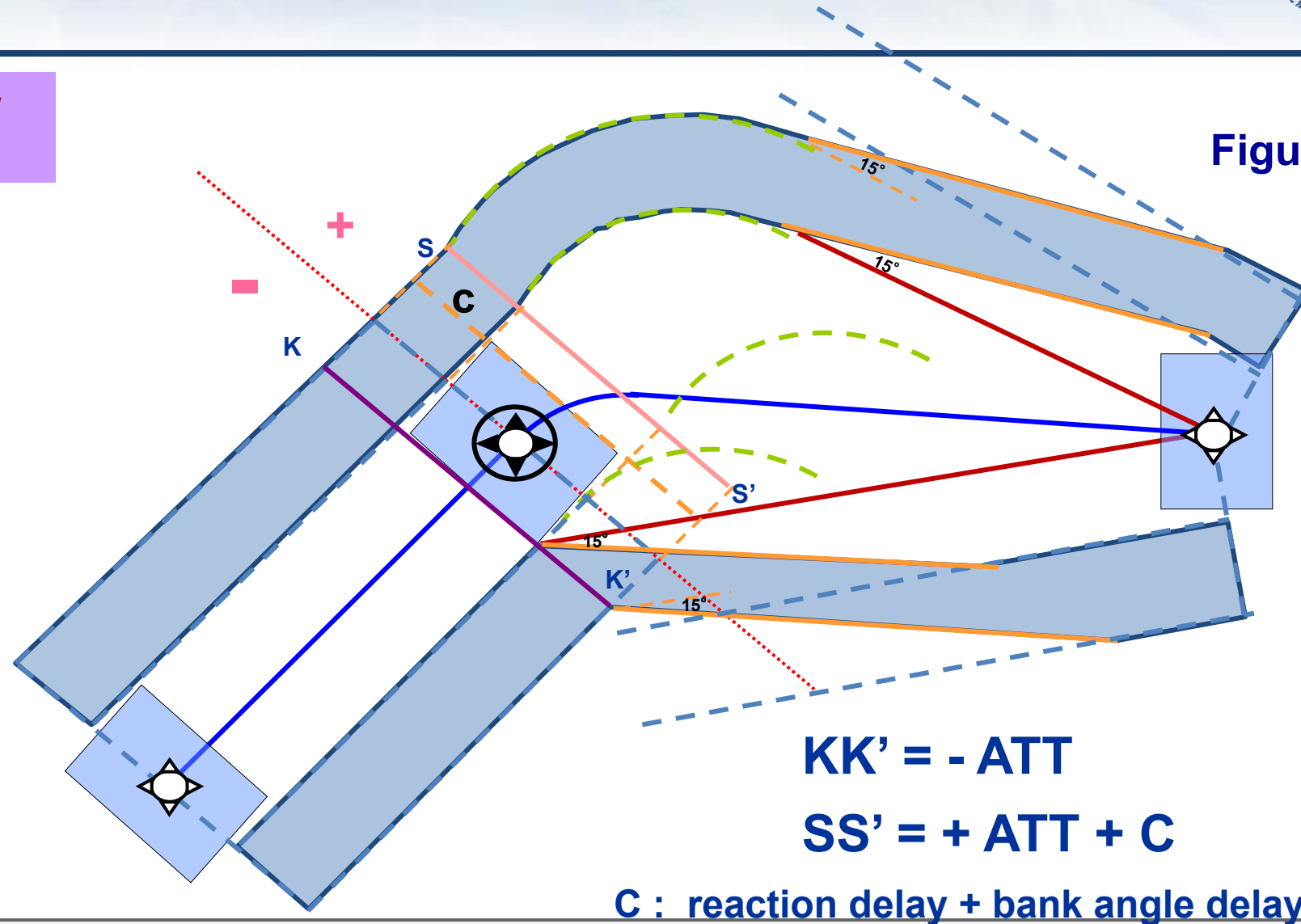
$$SS' = + ATT + C$$

C : pilot reaction + bank angle delay

FLY OVER WAYPOINT + DF LEG

💣 DF can be used after
FO waypoint or altitude

Figure III-2-2-6



REMINDER



- For protection with **DF** path terminator consider **earliest track** and **latest track**
- Connection method is different for **inner** and **outer side** of turn

TURN AT **FLY BY** WAYPOINT TF PROTECTION AREA **TURN ANGLE $\leq 90^\circ$**

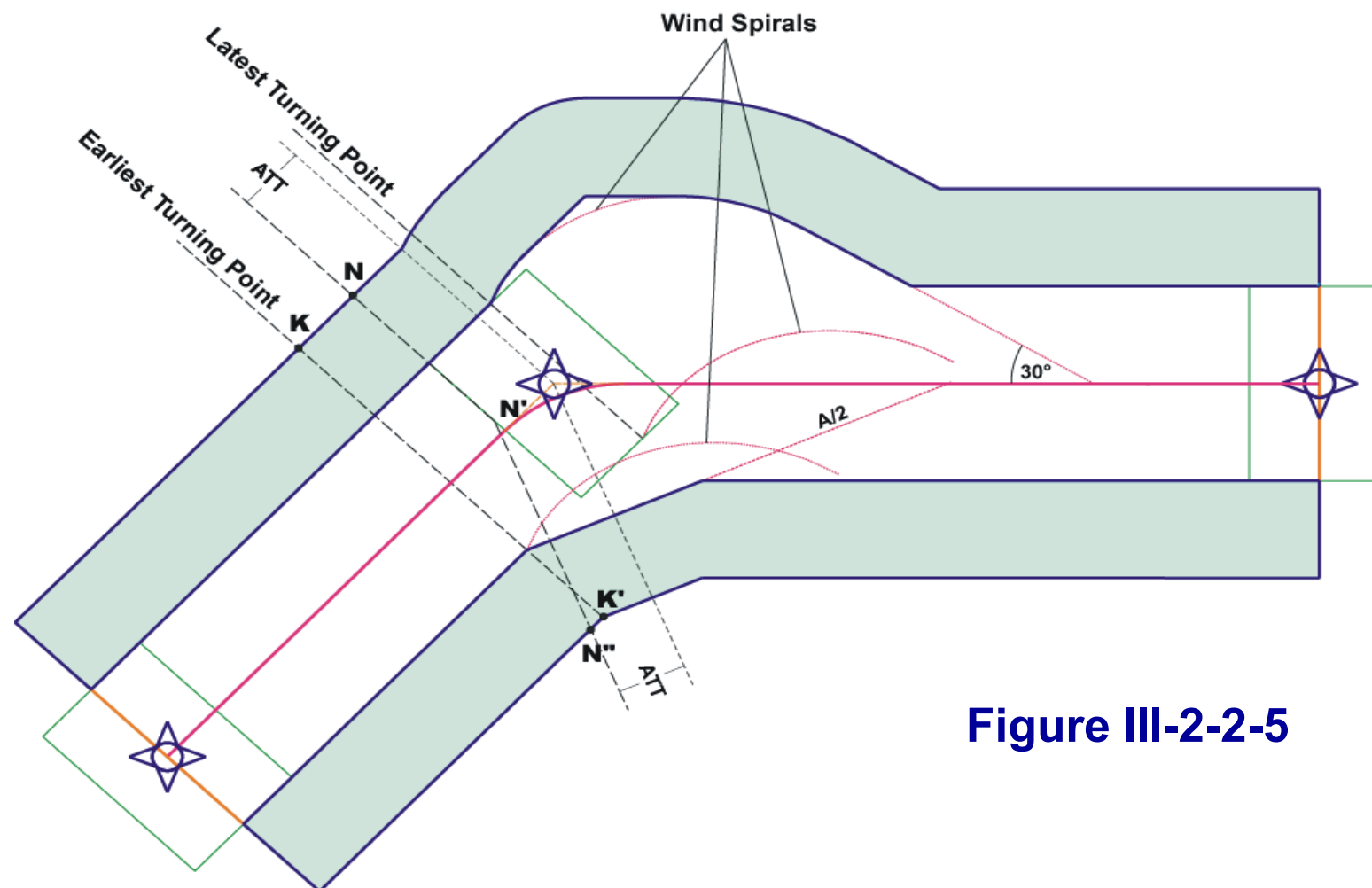


Figure III-2-2-5

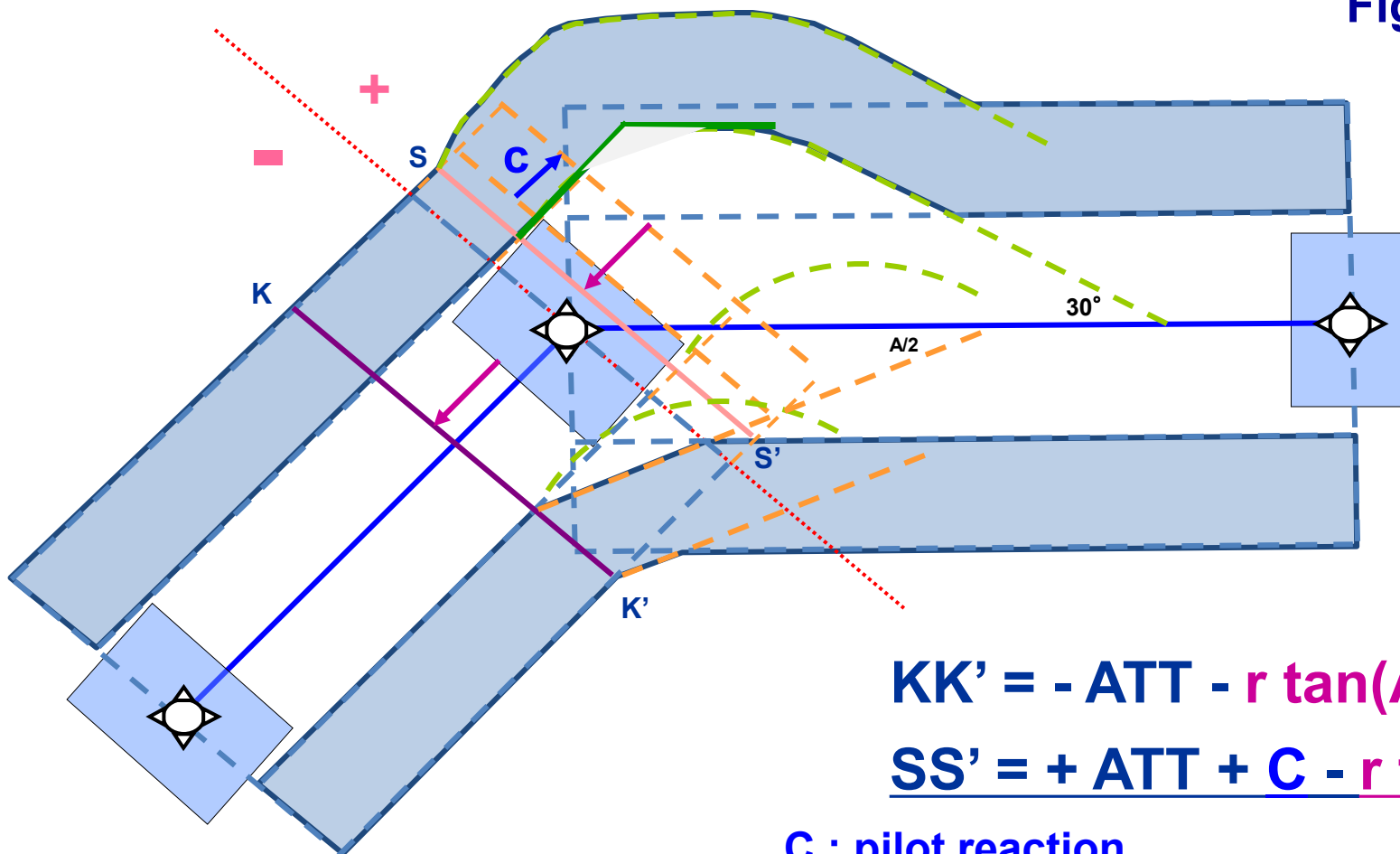
TURN AT FLY BY WAYPOINT

TF PROTECTION AREA **TURN ANGLE $\leq 90^\circ$**



Modelling low speeds

Figure III-2-2-5



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

$$SS' = + ATT + C - r \tan(A/2)$$

C : pilot reaction

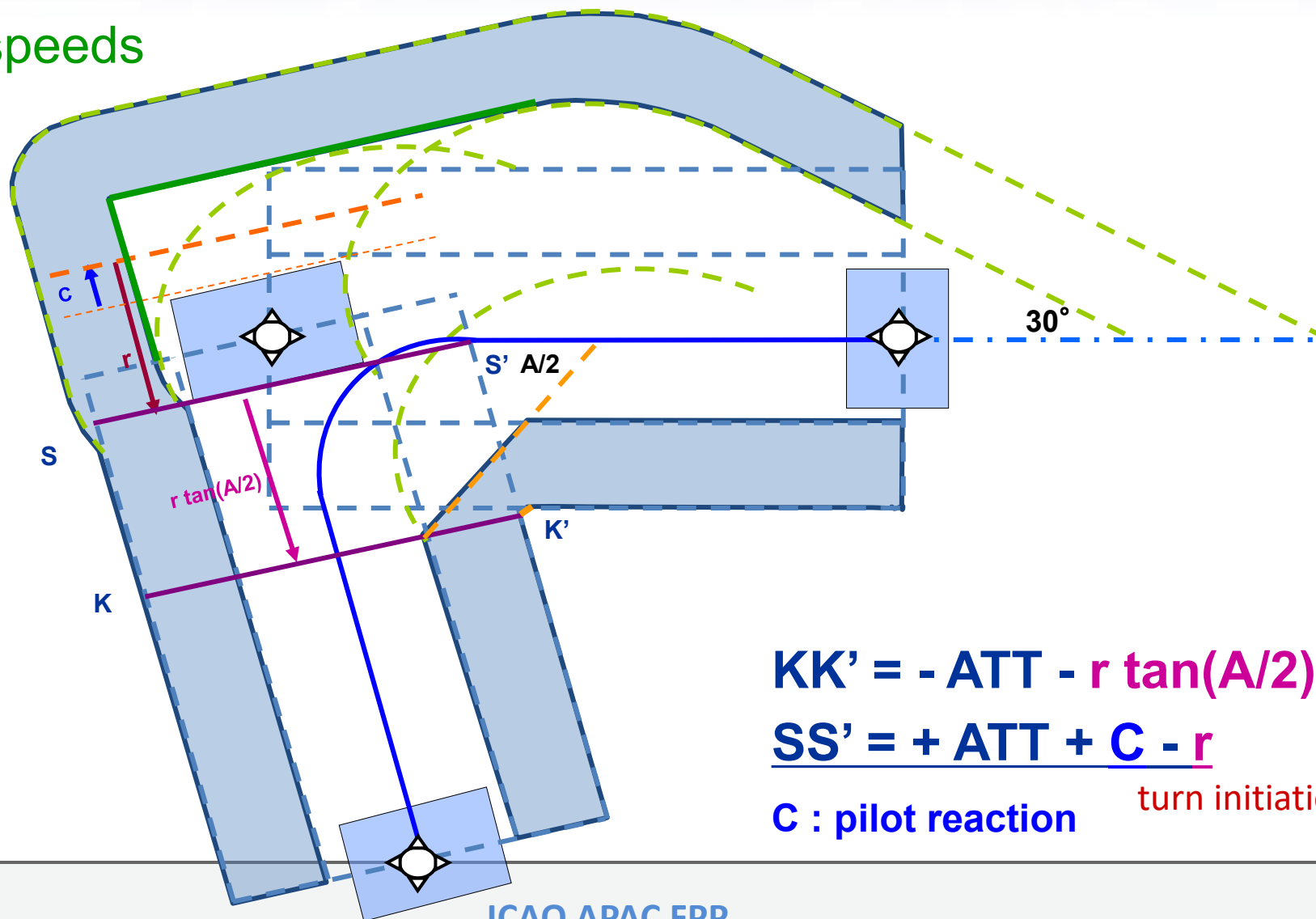
turn initiation distance

TURN AT FLY BY WAYPOINT

TF PROTECTION AREA TURN ANGLE $> 90^\circ$



Low speeds

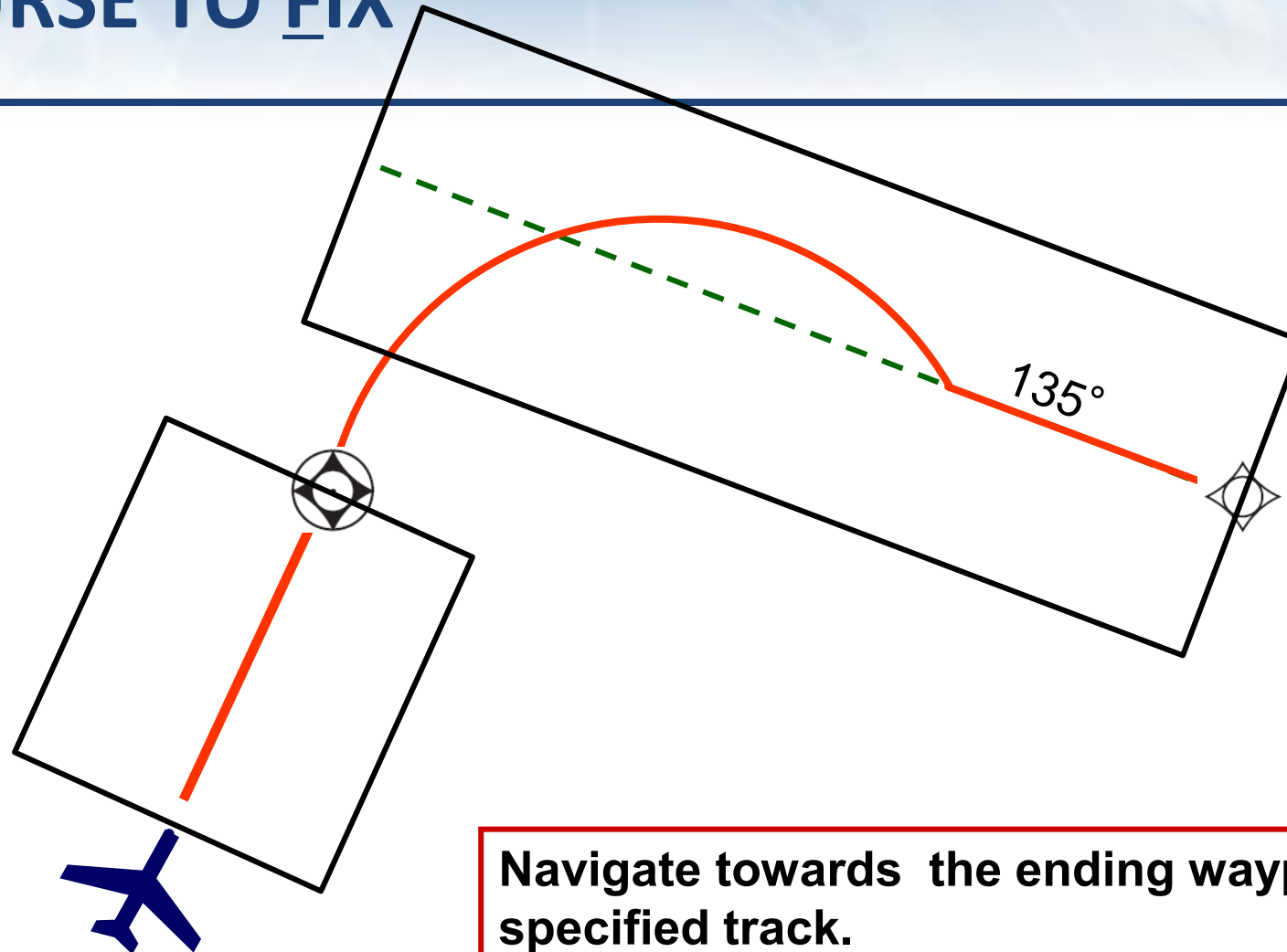


$$KK' = -ATT - r \tan(A/2)$$

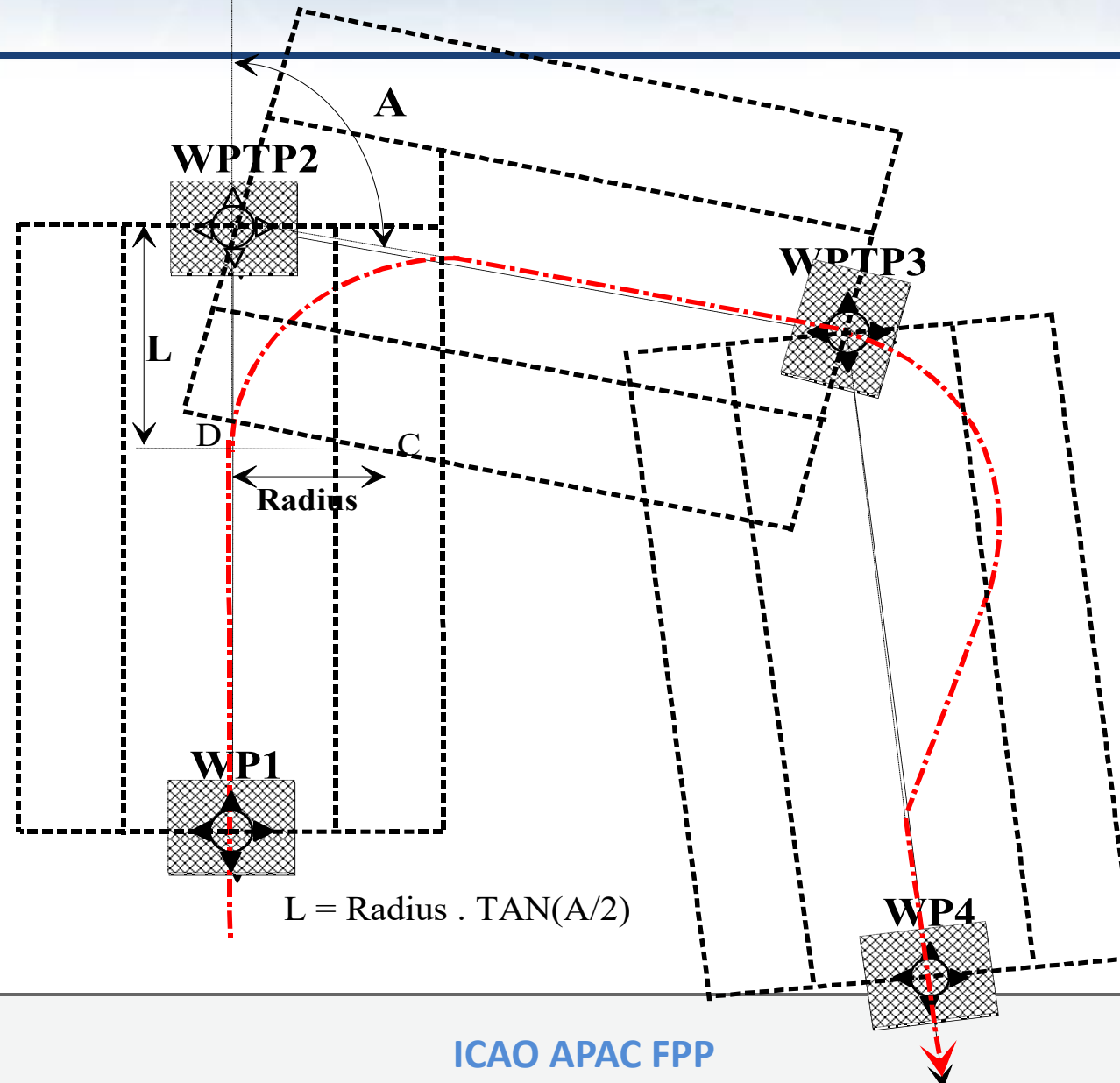
$$SS' = +ATT + C - r$$

C : pilot reaction turn initiation distance

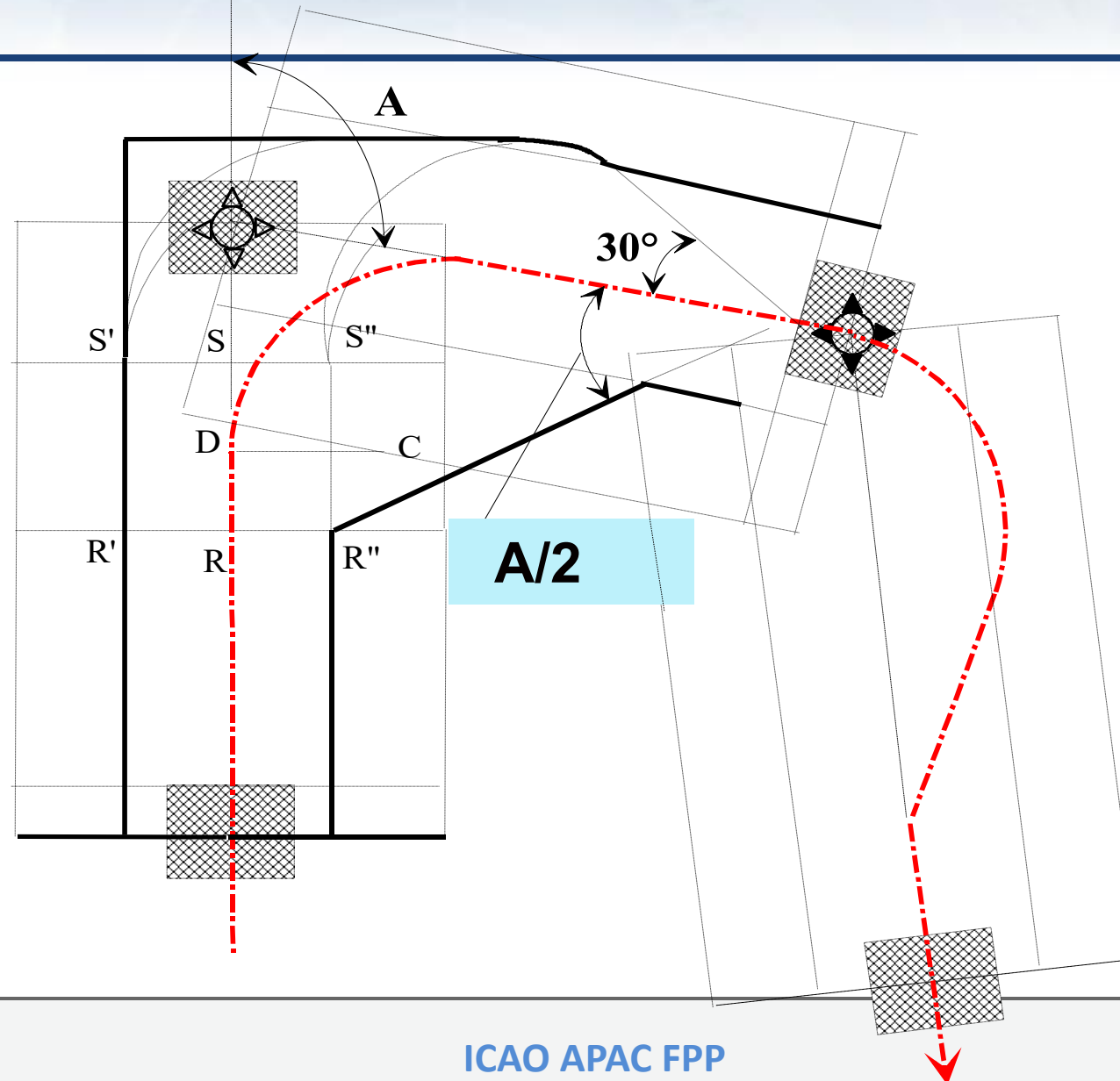
CF : COURSE TO FIX



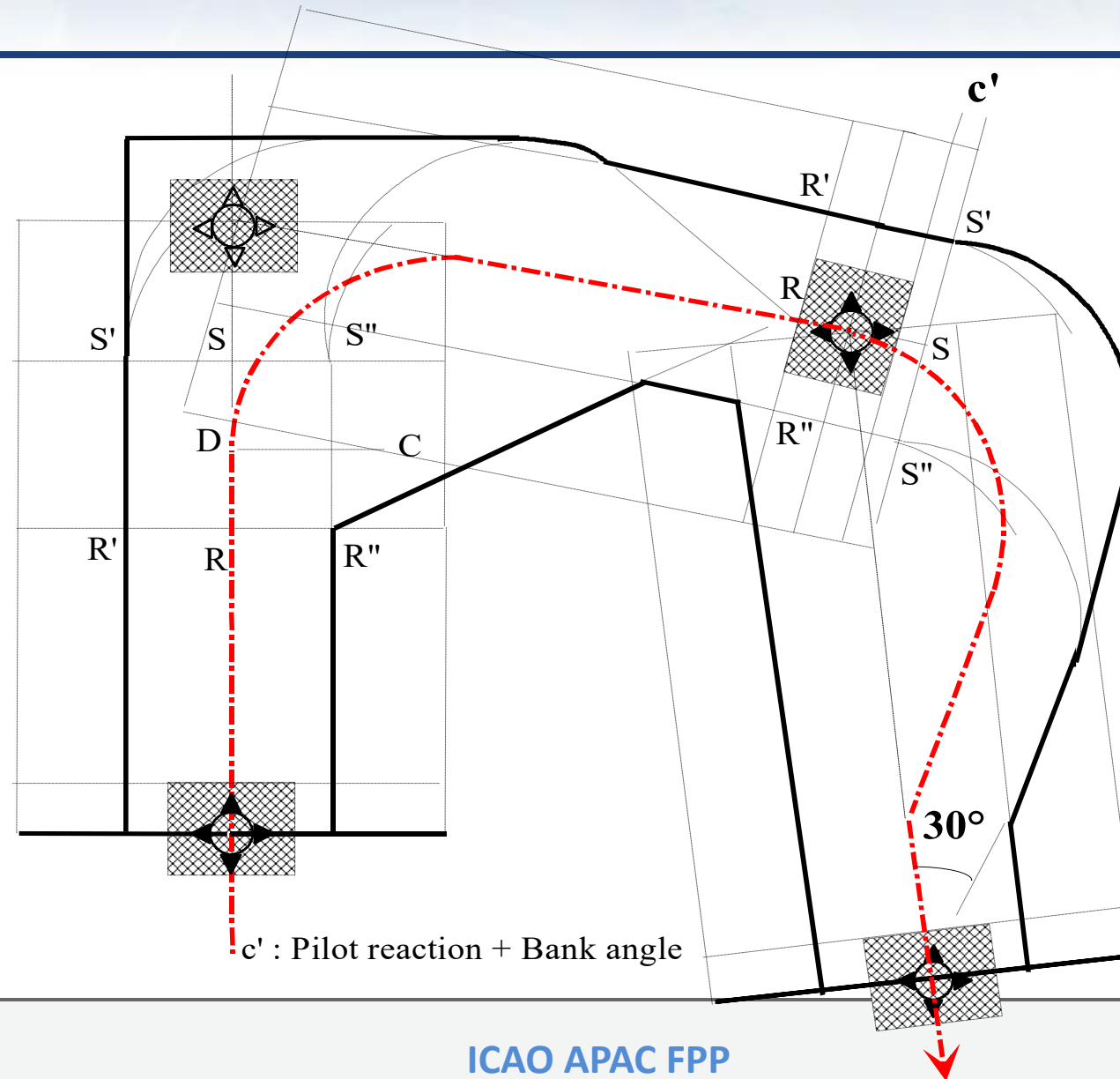
TF : PROTECTION AREA



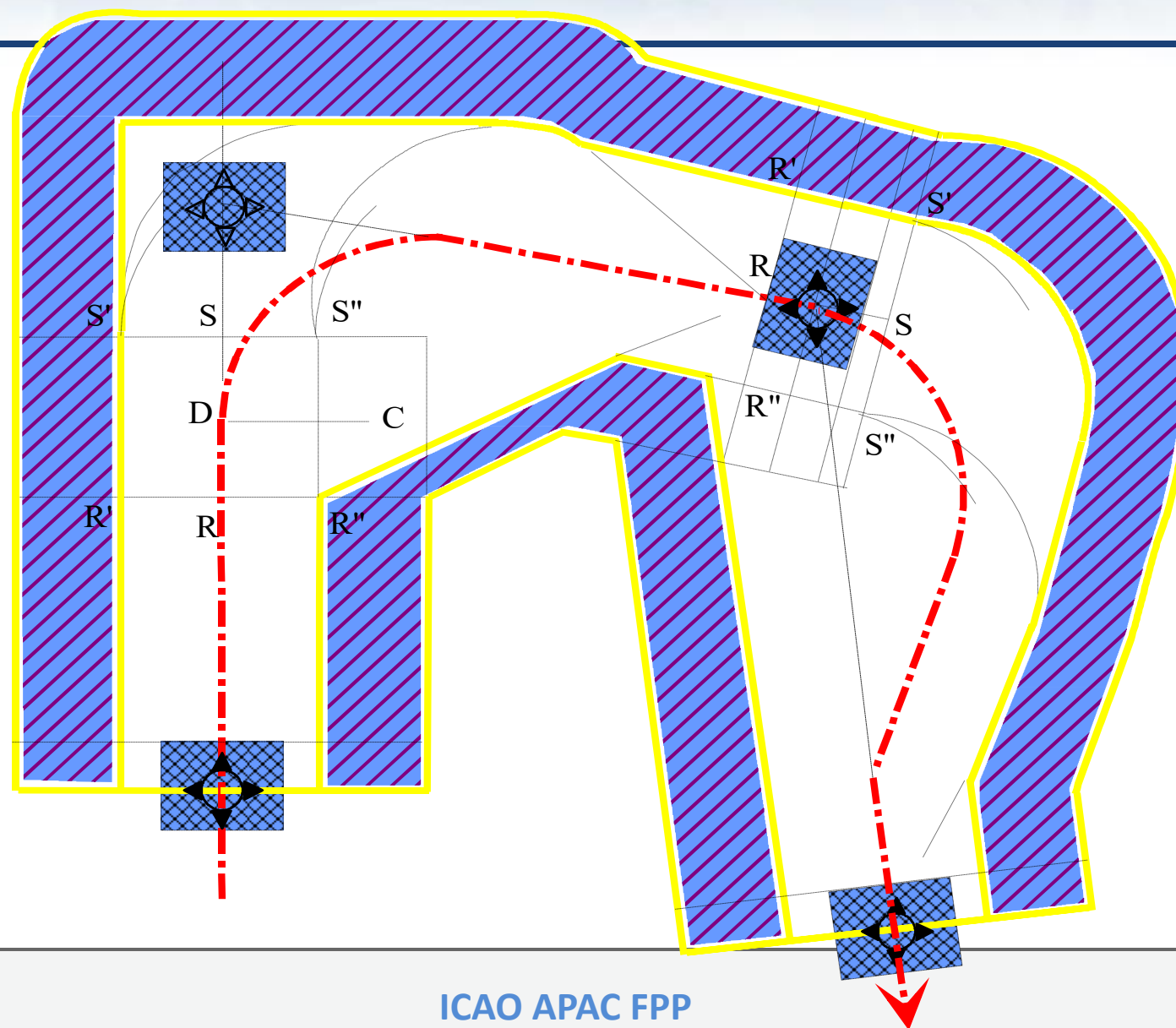
TF : PROTECTION AREA



TF : PROTECTION AREA



TF : PROTECTION AREA



REMINDER



- For protection of turn at **Fly by** waypoint accomodate **low speed** with **tangent to spiral**
- For **latest** turning point determination at **Fly by** waypoint, to accomodate **low speed** , turn initiation distance = $\min [r \tan A/2 , r]$

ARC METHOD

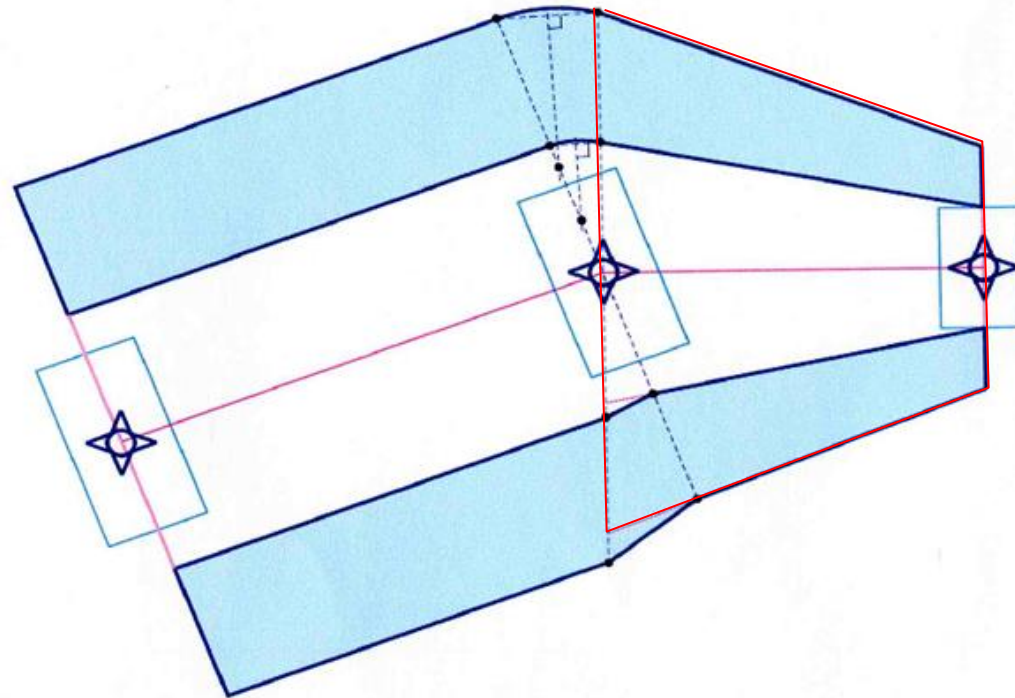
PROTECTION OF TURN

$\leq 30^{\circ}$ AT IAF/ IF

$\leq 10^{\circ}$ AT FAF

CIRCULAR ARC METHOD

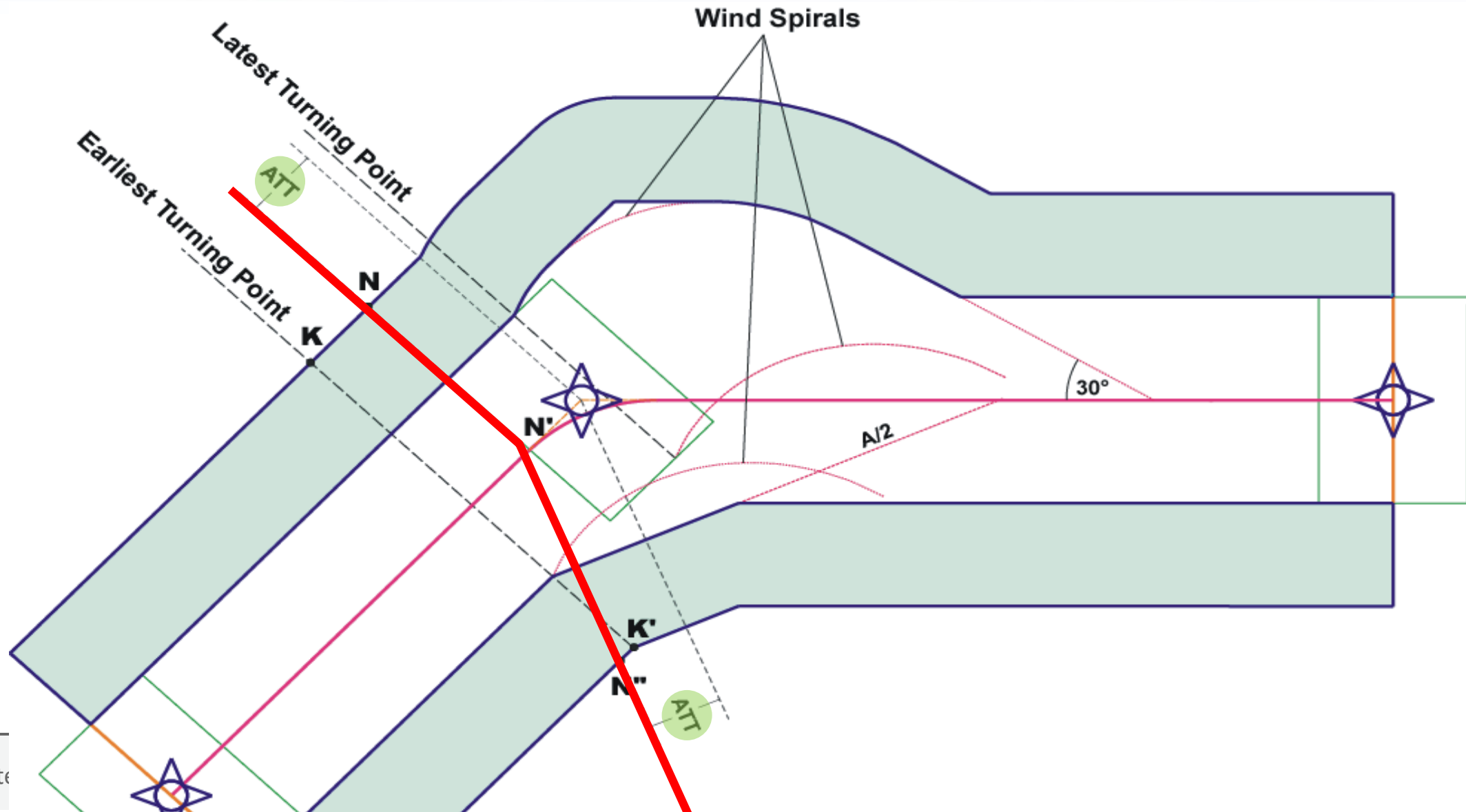
Used for turn less or equal to 30° for IAF and IF and less or equal to 10° at FAF



FLY BY WAYPOINT

WHERE DOES THE A/C START DESCENDING ?

TURN AT FLY BY WAYPOINT TF PROTECTION AREA



EARLIEST DESCENT LINE NN'N''

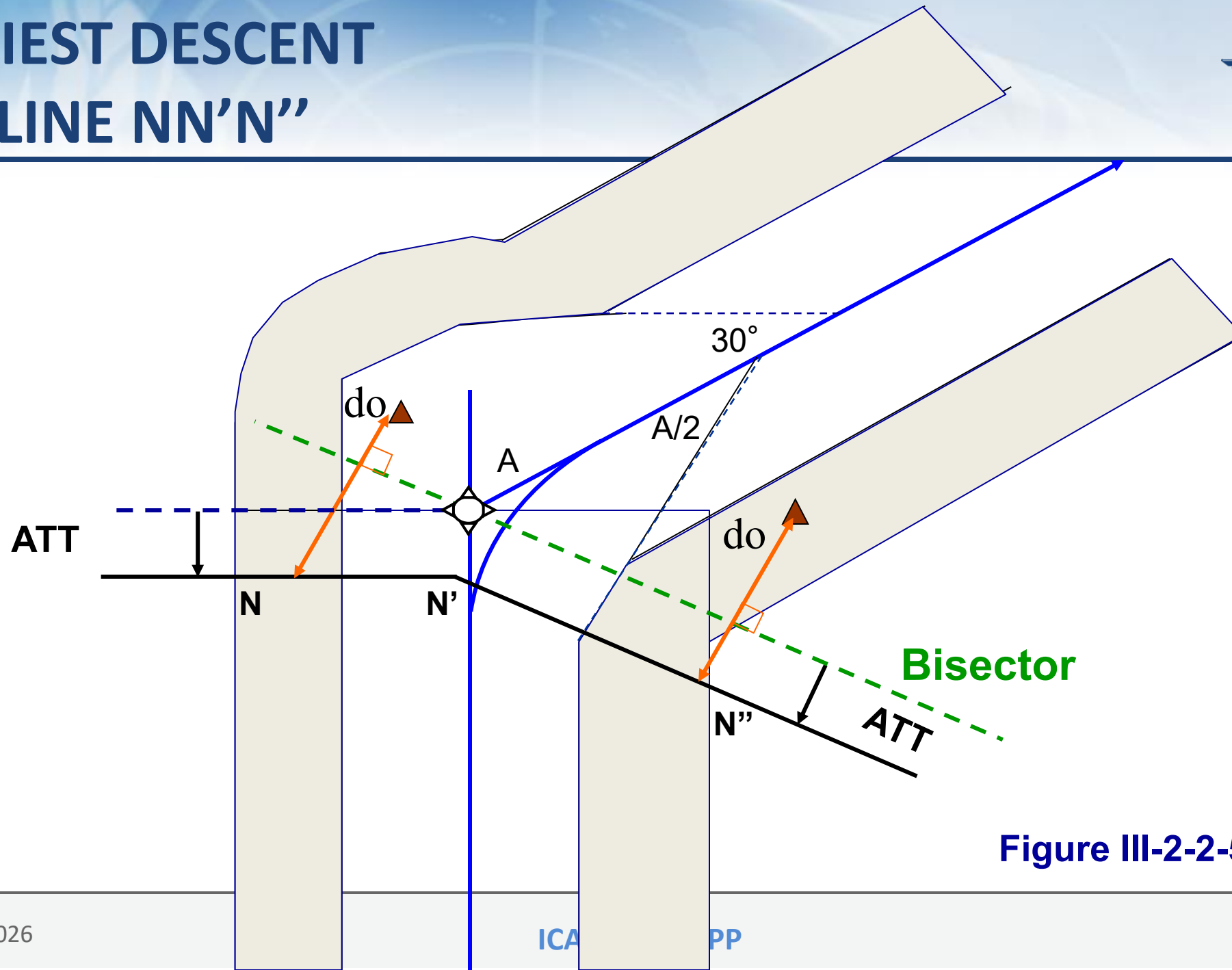


Figure III-2-2-5

