CIVIL AVIATION
AUTHORITY OF NEPAL

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RNP AR IMPLEMENTATION IN NEPAL

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CIVIL AVIATION AUTHORITY OF NEPAL

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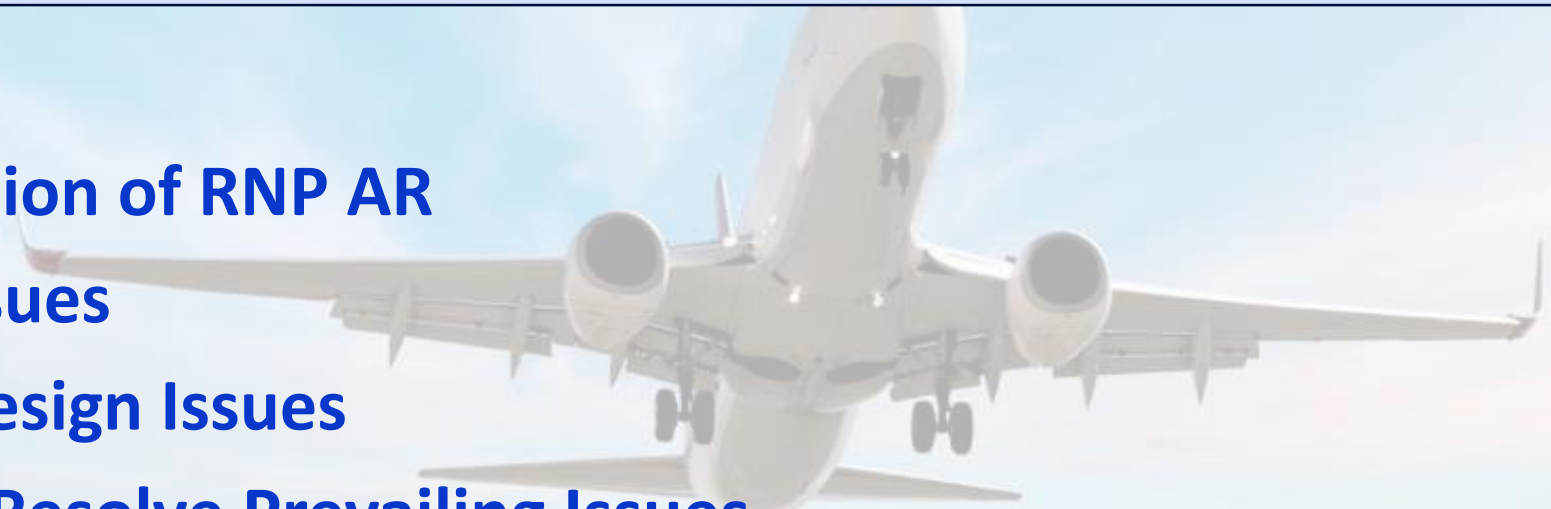

1. Background
2. Implementation of RNP AR
3. Beginning Issues
4. Procedure Design Issues
5. Activities to Resolve Prevailing Issues
6. Safety Activities
7. Operators Tendency for RNP AR
8. RNP AR Operating Fleets
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10. Future Planning
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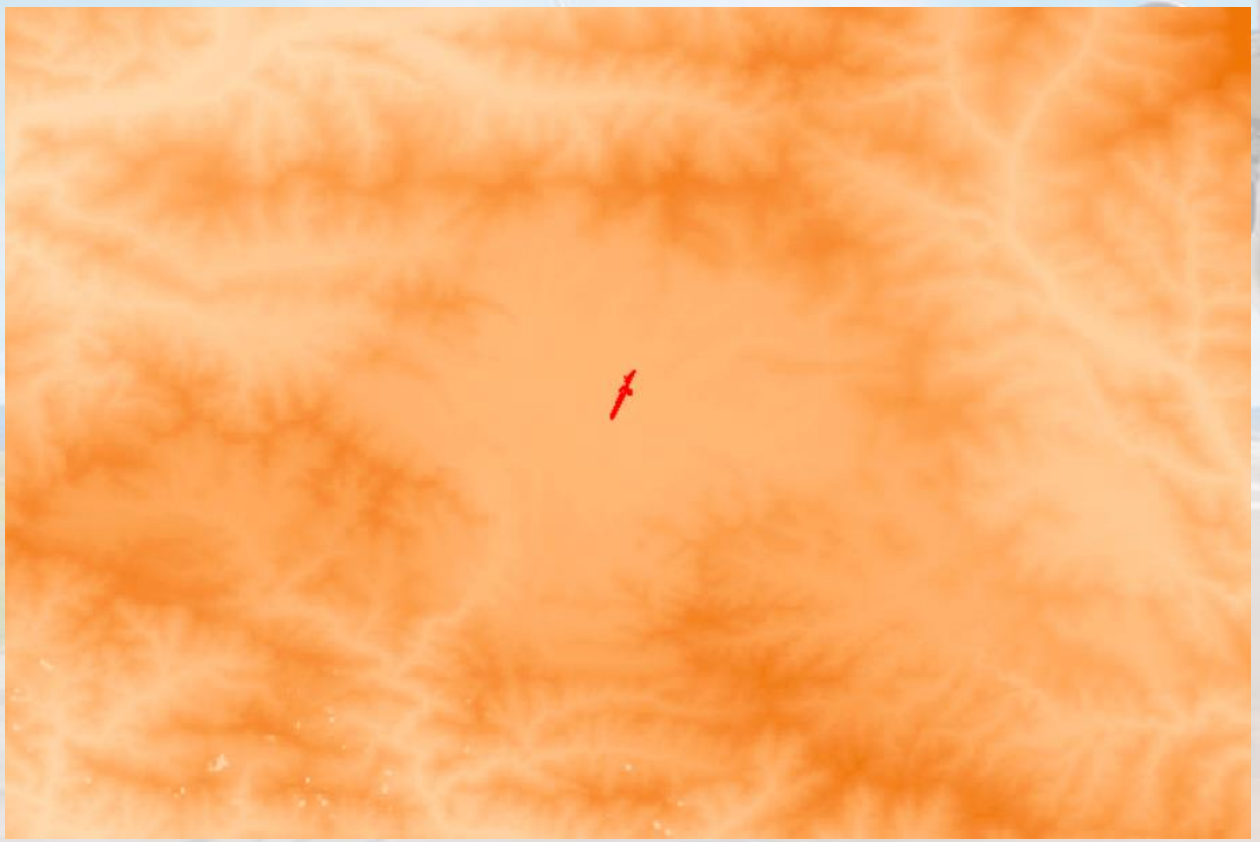
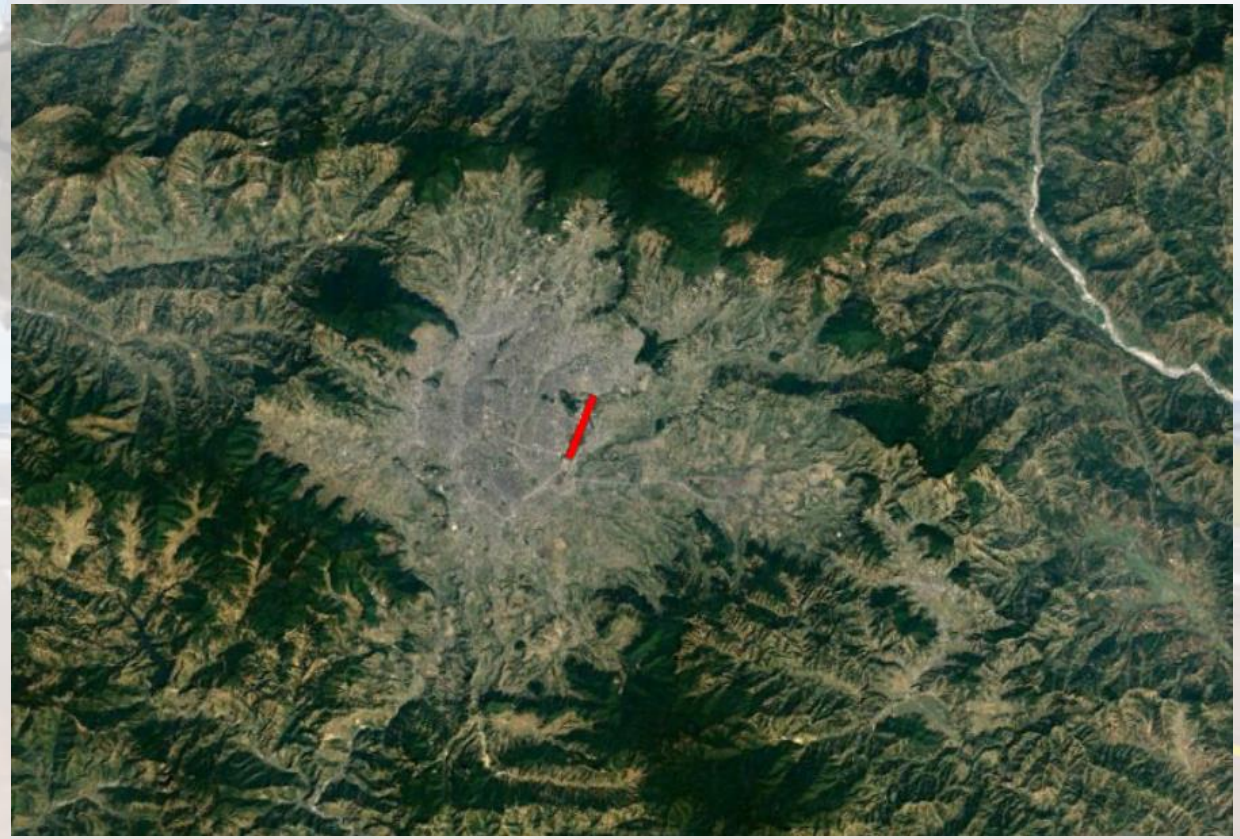
1. Background

- Tribhuvan International airport (TIA) being situated inside the bowl-shaped Kathmandu valley is well known for its challenging surrounding terrain

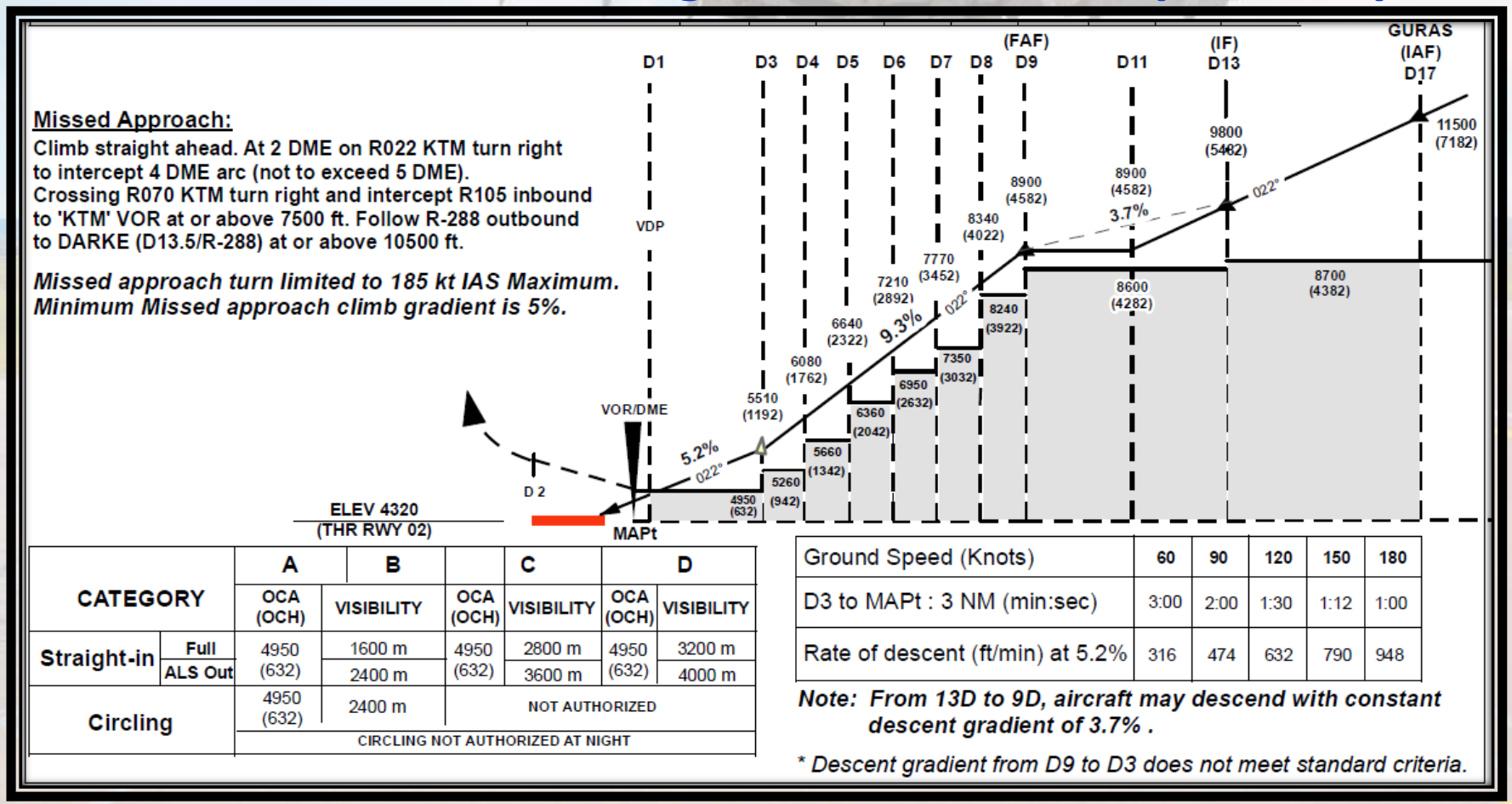




- Proximity of natural terrain around the vicinity restricted the application of precision approach system like ILS, MLS, etc.

Background…

- Feasibility studies in the past revealed that precision approach at TIA is not feasible
- As such, the application of RNP AR APCH considered as one of the most suitable alternatives to the existing conventional step-down procedure.



CATEGORY		A OCA (OCH)	A VISIBILITY	B OCA (OCH)	B VISIBILITY	C OCA (OCH)	C VISIBILITY	D OCA (OCH)	D VISIBILITY
Straight-in	Full	4950 (632)	1600 m	4950 (632)	2800 m	4950 (632)	3200 m		
	ALS Out		2400 m		3600 m		4000 m		
Circling		4950 (632)	2400 m	NOT AUTHORIZED					
CIRCLING NOT AUTHORIZED AT NIGHT									

Ground Speed (Knots)	60	90	120	150	180
D3 to MAPt : 3 NM (min:sec)	3:00	2:00	1:30	1:12	1:00
Rate of descent (ft/min) at 5.2%	316	474	632	790	948

Note: From 13D to 9D, aircraft may descend with constant descent gradient of 3.7% .

** Descent gradient from D9 to D3 does not meet standard criteria.*

Background…

- A workshop on viability of RNP AR APCH for TIA was conducted in Kathmandu with the facilitation of COSCAP and ICAO FPP on 31 March-1 April 2011.

- Attendees- 65 participants representing almost all the 29 air operators flying to/from Kathmandu.

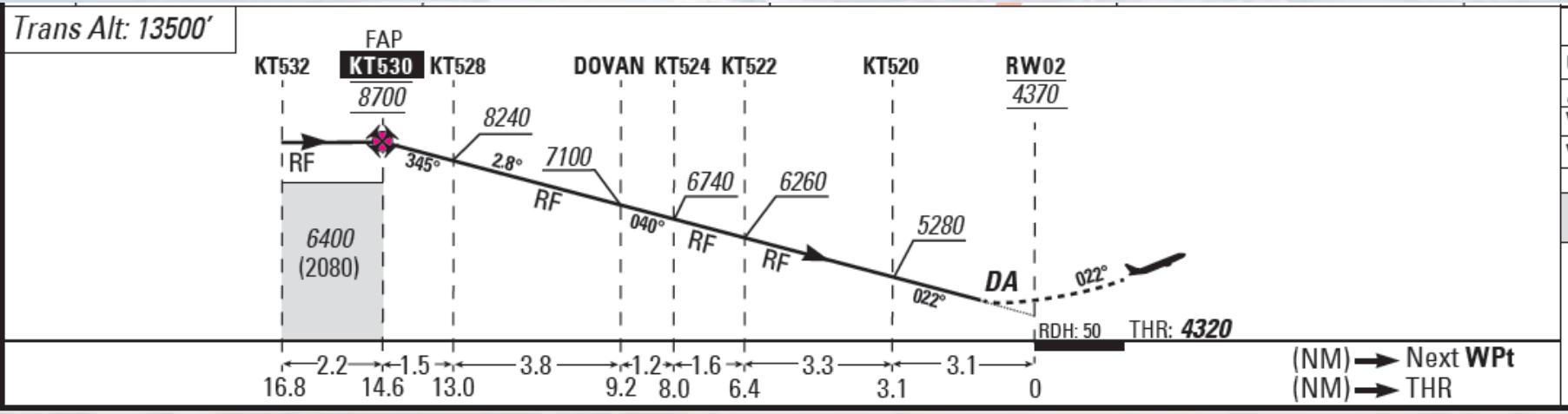
- The survey in the workshop revealed that about:
  - 51% of the operators had RNP AR APCH capability
  - 24% operators could be readily upgraded for it
  - 68% aircraft fleet were found capable of flying RNP AR APCH.

- QUOVADIS, the Airbus subsidiary, presented the viability of RNP AR Approach at TIA.

Background…

- So, to grasp such benefit, CAAN implemented the concept of RNP AR Approach into the TIA operation

- With this, suitable alternative to preclude the existing practice of overflying the controlling terrain became possible.



RNP 0.3				
CAT	A	B	C	D
DA (H)	***4620*** (300)			
VIS (m) ALS	1100			
VIS (m) no ALS	2000			

Missed Approach (see APP2 chart)

*Climb to **10500'** via the RNAV (RNP) missed approach to **DANFE**.*
*At **DANFE** hold or start a new approach.*

2. Implementation of RNP AR

- Initiation of RNP AR formally began in March 2011 with the Workshop on the viability of RNP AR at TIA in which multi-stakeholders participated
- Then, series of planned activities performed from CAAN and QUOVADIS (Airbus) side.
- Finally, RNP AR formally implemented in 28 June 2012 (AIP SUPP S011/12 03 MAY 2012)
- First PBN terminal operation introduced and effectively implemented at TIA and in Nepal.
- One RNP AR APCH with curved final approach path and six associated RNP 1 STARs implemented.
- Qatar Airways as a lead operator started RNP AR Operations on 1 Oct 2012.
- Gradually, other operators also initiated RNP AR implementation.

3. Beginning Issues

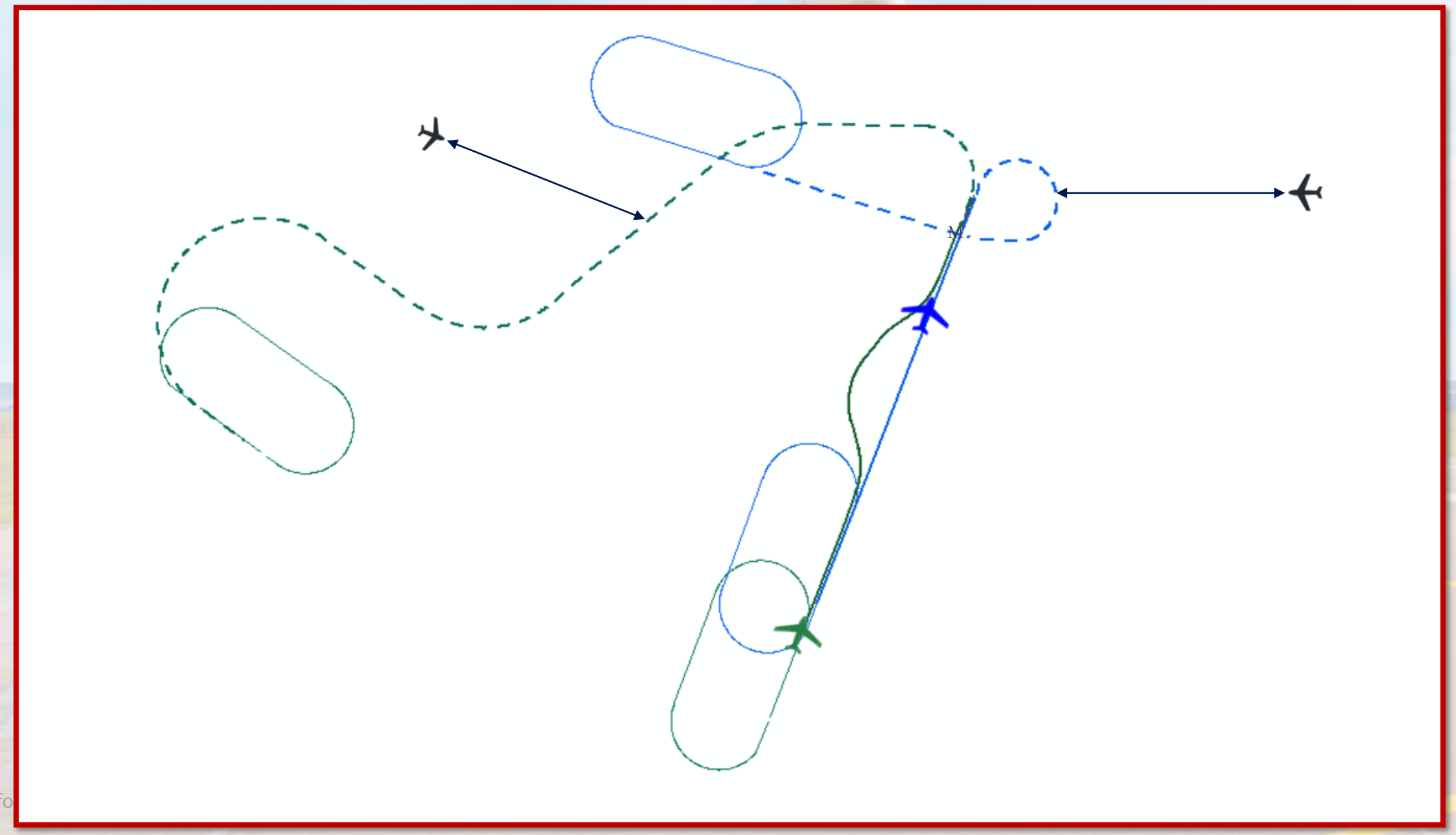
- Following were the issues at the beginning of RNP AR implementation:

1. Lack of regulatory provisions/guidance materials

2. ATC complexities during mix-mode operations
   a. VFR/IFR separations
   b. VOR/RNP AR handling techniques
   c. Use of different phraseologies

3. Different Missed Approach Turns- VOR vs. RNP AR and associated complications
   a. ATCs' and Pilots' concerns

Beginning Issues…



Beginning Issues…

- Aircraft Capability issues- dual system requirement
  a. Dual GNSS sensors
  b. Dual APs
  c. Dual FMSs
  d. Dual air data systems

- Operators' concerns- Retrofitting requirements and large cost involvement

- Procedure Design issues, basically the deviations in design criteria

4. Procedure Design Issues

1. **Deviation from Doc 8168 and Doc 9905 provisions**
   a. **Bank angle:**
      Bank angles > 15˚ up to 24.4˚ used in MAPCH

   b. **FROP distance:**
      FROP only 40 sec prior to OCA/OCH point than the required 50 sec

   b. **VPA:**
      VPA 2.8˚ which is less than required 3˚

2. **Reasons for deviations in Bank angle and FROP distance:**
   a. **To avoid terrain penetration**
   b. **To make the procedure possible**

Procedure Design Issues…

3. Reasons for deviations in VPA:
   a. To accommodate the majority of fleet
   b. To ease energy management
   c. To allow optimum gradient even during high OAT conditions

4. Challenges ahead:
   a. Accept deviations
   b. Gain confidence for:
      - RNP AR design approval
      - RNP AR operational approval

5. Primary reasons for accepting such deviations are:
   a. the aircraft onboard capability and
   b. the safety activities to mitigate the associated risks

5. Activities to Resolve Prevailing Issues

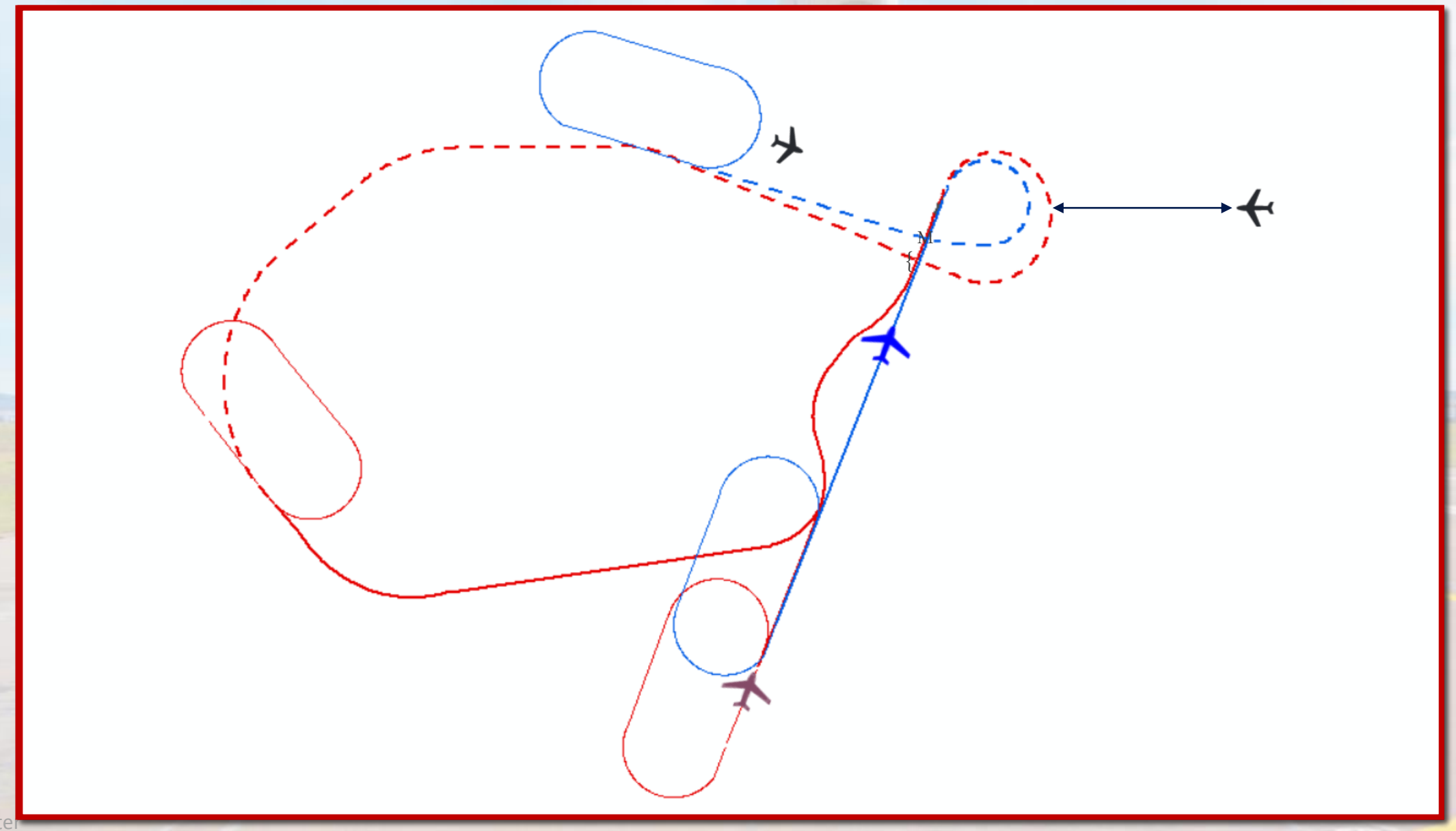
- Operational approval procedure developed for the RNP AR APCH, including other PBN NAVSPECs
- ATC procedure for handling RNP AR traffic developed
- VFR holding at 30DME west developed, protecting the RNP AR MAPCH track
- ATCs and operators including pilots were involved during the design phases
- ATC briefing and theoretical training conducted
- ATC simulator training conducted

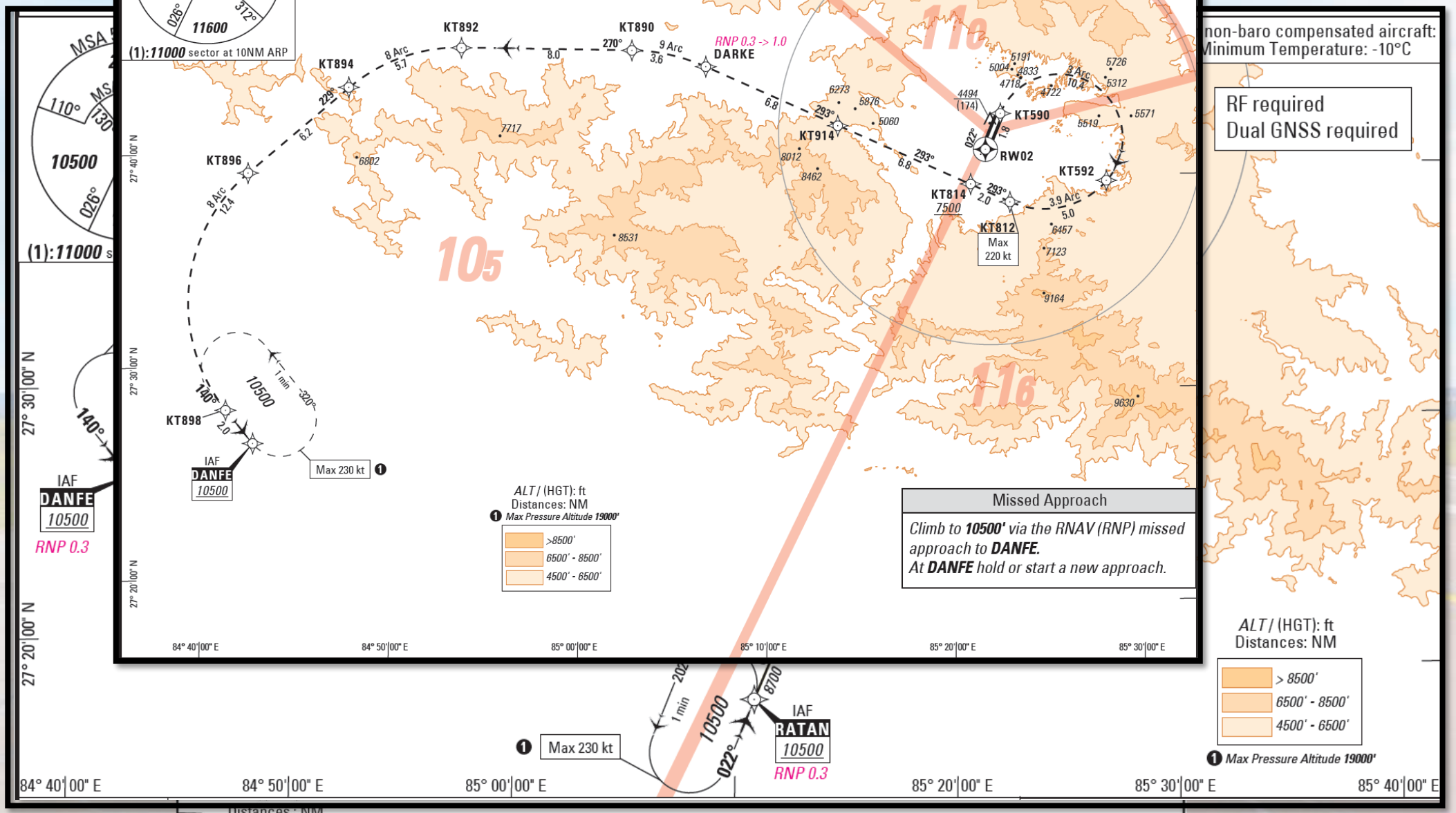
Activities to Resolve Prevailing Issues …

- Despite the above activities, dissatisfactions from both ATCs and VFR pilots due to long holding delays, and

- Subsequent demands for modification of missed approach turn similar to that of VOR APCH

  - Finally, the missed approach turn modified and implemented as right turn in 2017.




MSA 50 NM ARP
28200
MSA 25 NM ARP
21200
(1)
110°
130°
255°
282°
10500
12400
026°
312°
11600
(1):11000 sector at 10NM ARP
For non-baro compensated aircraft:
Minimum Temperature: -10°C
RF required
Dual GNSS required
25 NM ARP
10 NM ARP
KT892
KT890
KT894
DARKE
RNP 0.3 -> 1.0
KT896
KT914
KT590
RW02
KT592
KT814
7500
KT812
Max
220 kt
KT898
IAF
DANFE
10500
RNP 0.3
Max 230 kt
ALT / (HGT): ft
Distances: NM
Max Pressure Altitude 19000'
>8500'
6500' - 8500'
4500' - 6500'
Missed Approach
Climb to 10500' via the RNAV (RNP) missed approach to DANFE.
At DANFE hold or start a new approach.
IAF
RATAN
10500
RNP 0.3
Max 230 kt
> 8500'
6500' - 8500'
4500' - 6500'
Max Pressure Altitude 19000'
27° 40' 00" N
27° 30' 00" N
27° 20' 00" N
84° 40' 00" E
84° 50' 00" E
85° 00' 00" E
85° 10' 00" E
85° 20' 00" E
85° 30' 00" E
Distances : NM
084° 40'
085° 00'
085° 20'

6. Safety Activities

- Safety Activities- mandatory for the acceptance of deviations in design criteria

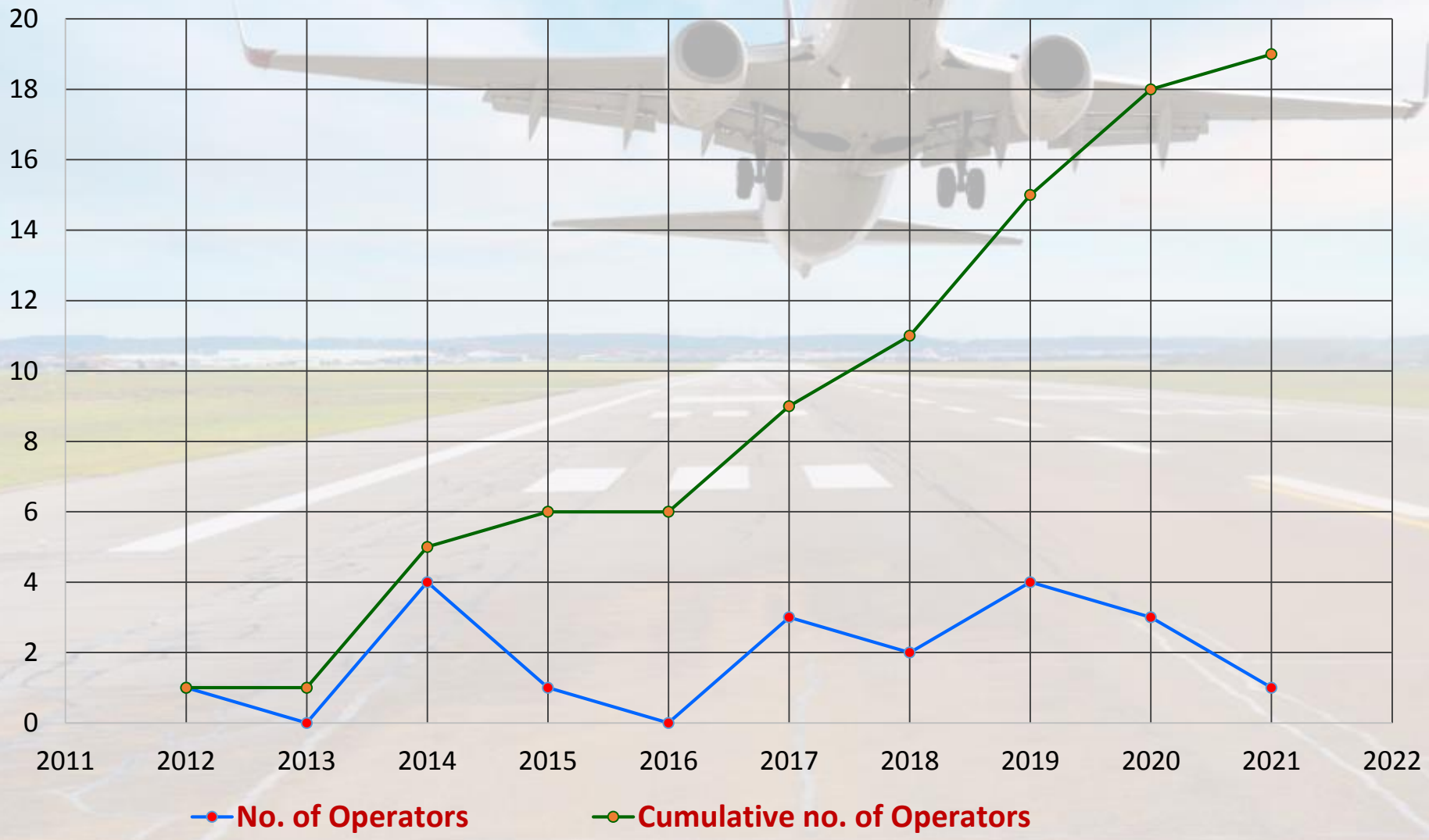
- Safety activities- necessary to gain confidence for the operational approval

- Safety activities conducted to overcome the challenges due to deviations in design criteria
  - ATS operational safety ensured through theoretical training and simulator training
  - SIM trial and Demo flights before procedure approval
  - Flight operational safety ensured through FOSA
  - Interim authorizations for RNP AR, then full authorization

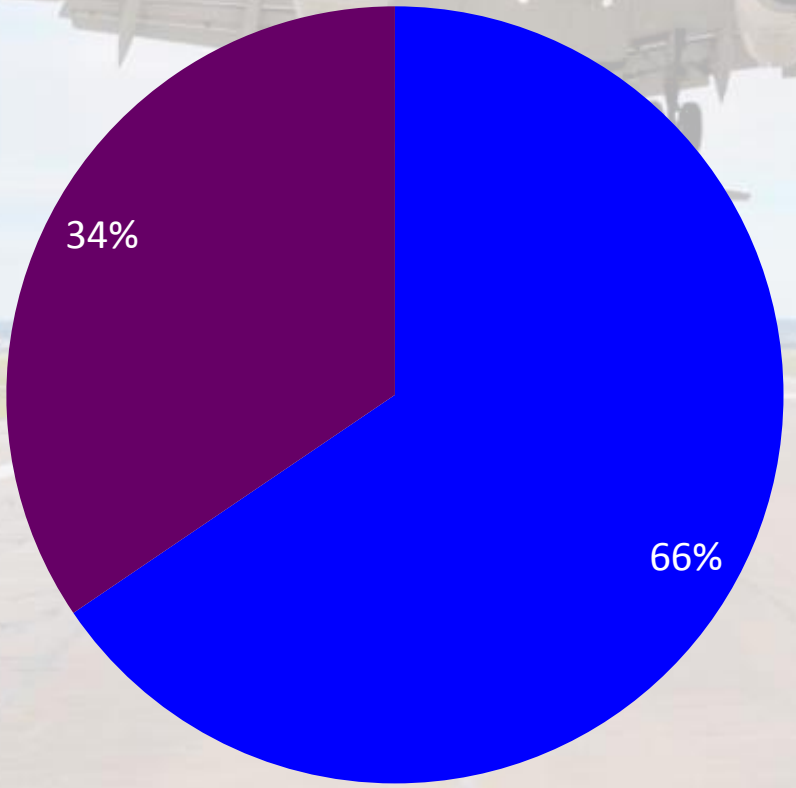
7. Operators' Tendency for RNP AR

- **Operators' willingness for RNP AR increasing gradually:**
  1. **Number of RNP AR operators at the beginning in 2012: 1**
  2. **Increasing interest and formal application for RNP AR operations**
  3. **Number of scheduled international operators approved for RNP AR (by Sep 2021): 19**
  4. **Majority of international operators (more than 65%) are conducting RNP AR**
  5. **Some more are in pipeline**

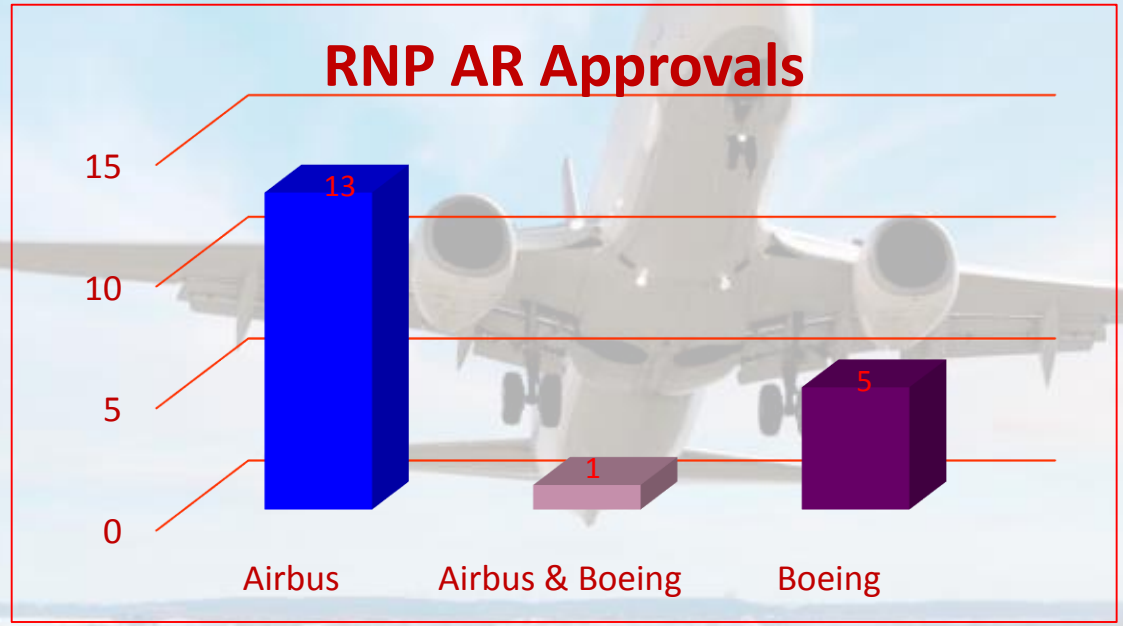
Operators Tendency for RNP AR

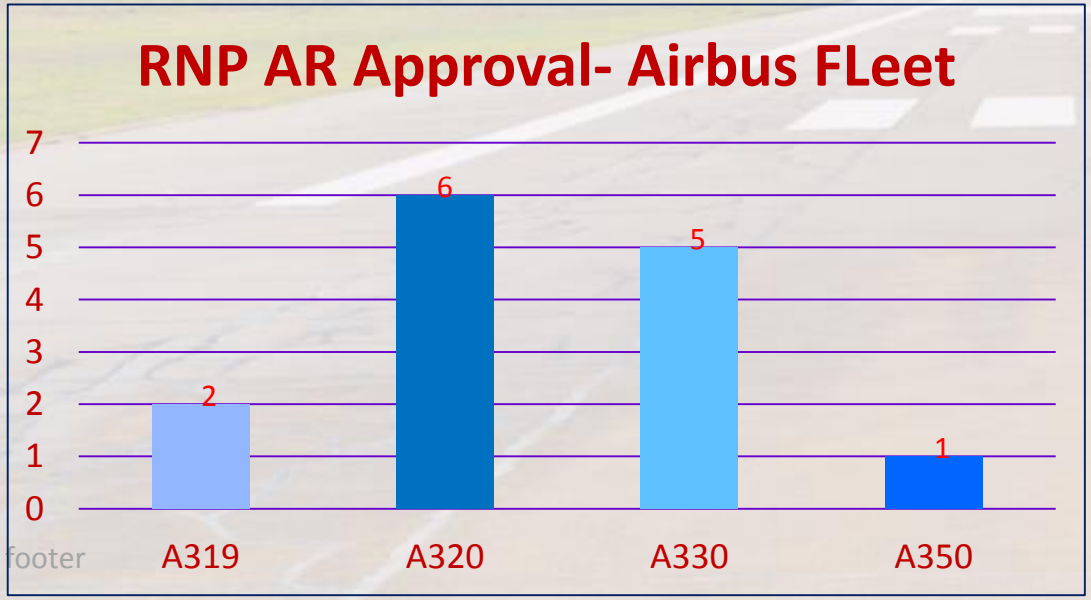


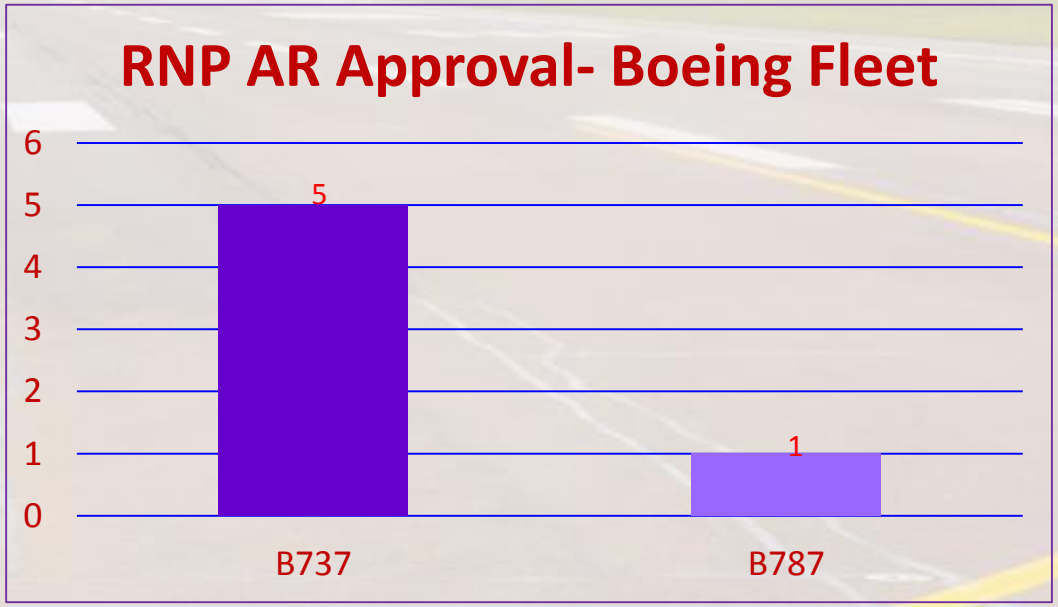
RNP AR Authorization Status, September 2021



8. RNP AR Operating Fleets



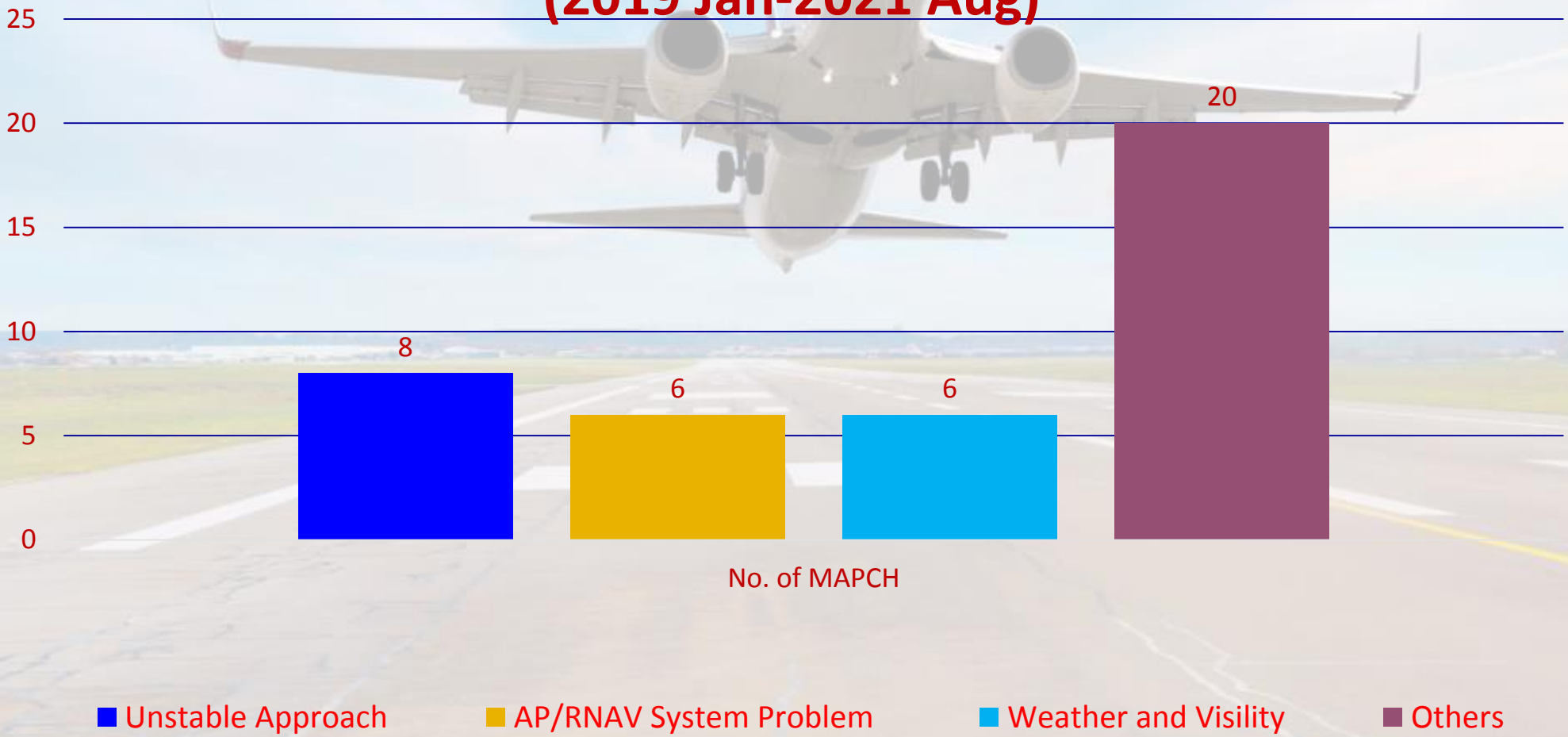




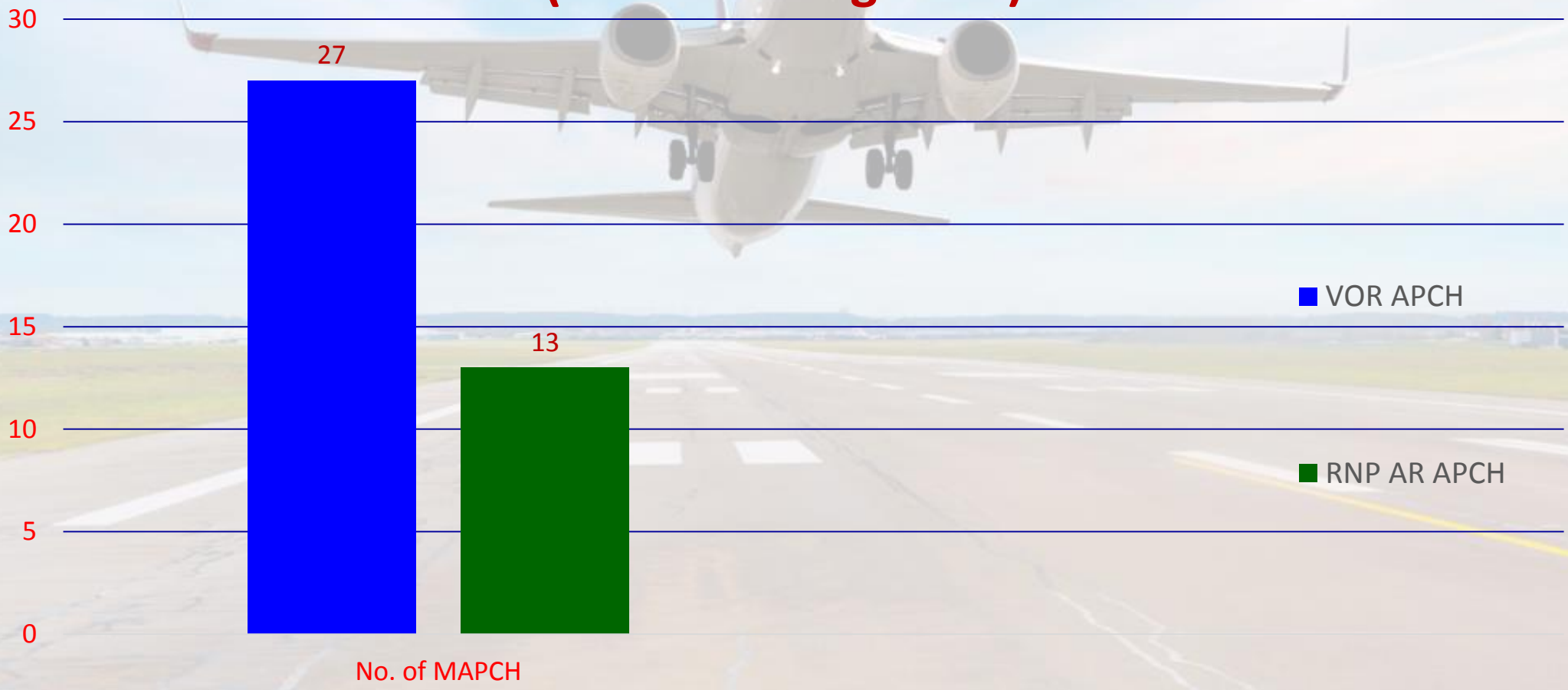
9. Major Benefits of RNP AR at TIA

1. Flexibility in flight procedure design
2. OCH reduced from 632ft to 300ft for CAT C operation, and consequently visibility minima reduced from 2800m to 1100m for that Category
3. Stabilized approaches with constant descent profile
4. Avoidance of long holding delays and less diversions
5. Enhancement in flight reliability, accessibility and timeliness
6. Cost of operation reduced
7. CFIT related risks significantly reduced

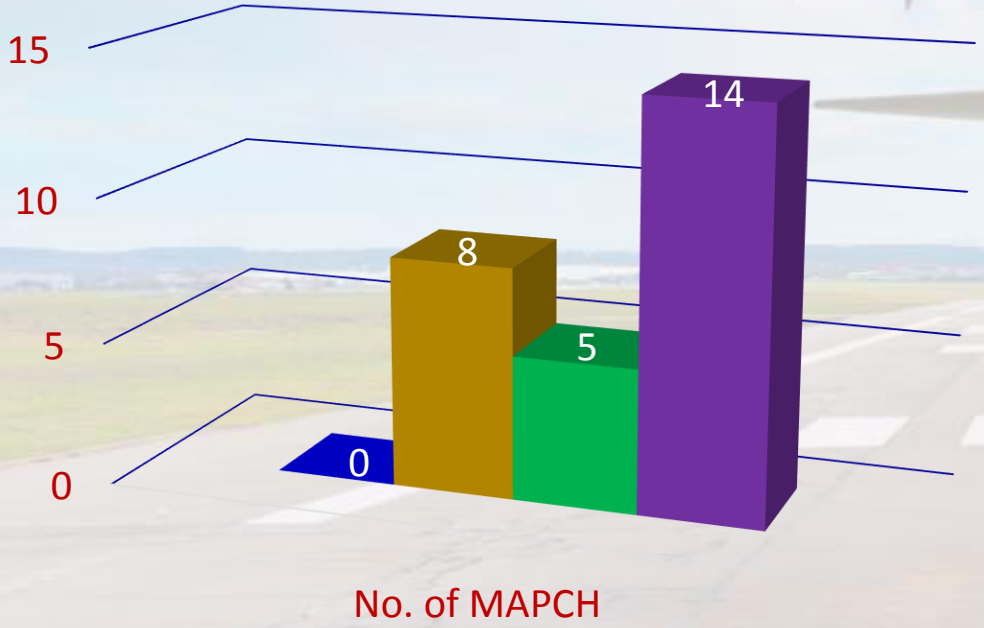
Missed Approaches at TIA (Reason-wise)
(2019 Jan-2021 Aug)



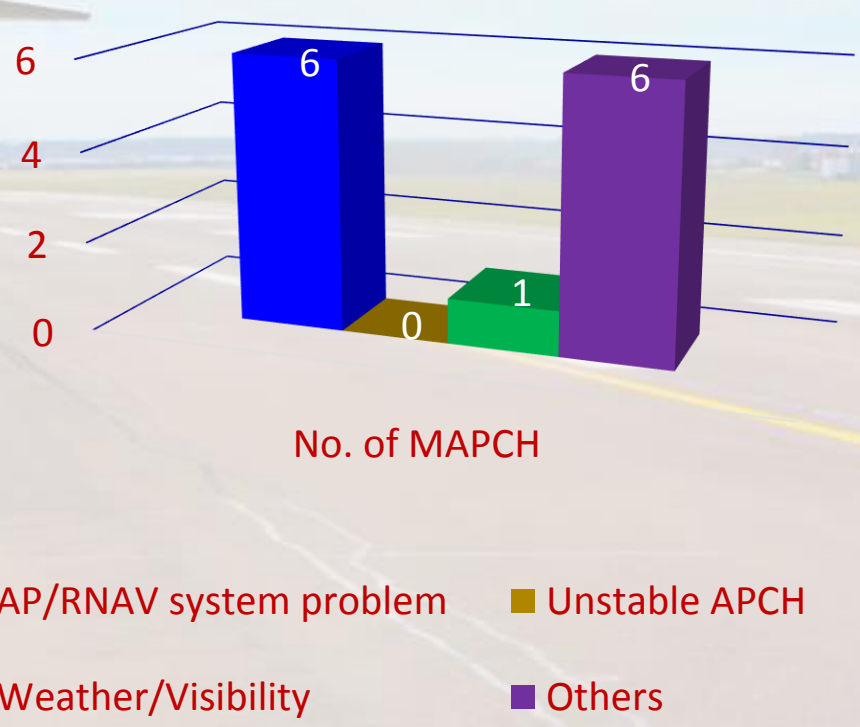
Missed Approaches at TIA (Conventional Vs. RNP AR) (Jan 2019-Aug 2021)



VOR Missed Approaches (Reason-wise) (Jan 2019-Aug 2021)



RNP AR Missed Approaches (Reason-wise) (Jan 2019-Aug 2021)



10. Future planning

1. Implement new RNP AR STARs and Approaches at TIA under NAVBLUE support (nearing design approval)

2. Implement new RNP AR SIDs at TIA under NAVBLUE support (nearing design approval)

   - Use of Doc 9905 (RNP AR APCH criteria) and FAA Order 8260 58B for the design of RNP AR DP
     - ICAO RNP AR DP design criteria awaited

   - Deviations (from RNP AR APCH) employed in the RNP AR DP designs:
     - Bank angle
     - FROP distance
     - Turn initiation criteria for turning departure (turn before reaching 120m from DER elevation)

Future planning…

- Simulator trials conducted to address the deviations as a part of design safety activities and to support design approval
- FOSA to commence to address all the deviations before operational approval
- RNP AR APCH approval mandated for RNP AR DP.

3. Feasibility study of RNP AR implementation in selective instrument runways (future plan)

11. Conclusion

Following are the realizations from the implementation of RNP AR at TIA:

1. RNP AR is one of the best solutions for terrain constrained environment
2. Deviations, if can be addressed appropriately, can be the solution
3. Deviations can be accepted provided operational safety is demonstrated and ensured through simulation trial and FOSA
4. Stakeholders' engagement and support is the key to success
5. One's own benefits and achievements can be the motivation for others


Thank
You!