IFP DESIGN IN CHALLENGING ENVIRONMENTS

SHARING IDEAS & EXPERIENCE

ICAO APAC FPP
Procedure Design Seminar
17-19 September 2019

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Pakistan Civil Aviation Authority

Sequence

- IFP Design Criteria, Challenges and solutions
- Stories of IFP design with challenges in Pakistan
- Typical examples on way forward

IFP Design Criteria

- ICAO Doc 8168 “PANS-OPS” Volume II “Construction of Visual & Instrument Flight Procedures”
  - Part I – General Criteria
  - Part II – Conventional Procedures
  - Part III – PBN Procedures
  - Part IV – Helicopters
- ICAO Doc 9905 “RNP AR Procedure Design Manual”
- State Regulations (may vary from ICAO criteria)
- Objective – achieving a reasonable degree of standardization and uniformity in procedures & associated areas

IFP Design Criteria

- Obstacle Clearance, primary safety consideration in IFP design
- Requirement may also include airspace management, environmental issues, ATC procedures etc.
- Protection areas primarily meant for obstacle clearances
- Silence of PANS-OPS criteria for airspace regulations
- Use of standard conditions for aircraft characteristics, deviation permissible when specific airspace requirements apply
- Any deviation from existing standards, the reasons for such a deviation and details of the mitigations applied to assure continued safe operations needs to be documented

IFP Design Activity

- Complex field of activity in the aviation
- Significant Challenges
  - Terrain / topography
  - Airspace constraints
  - Growing congestion
  - Environmental constraints

Possible Solutions

- Complex designs
- Deviation from criteria
- Refined criteria using technological developments
- Navigational aids and siting

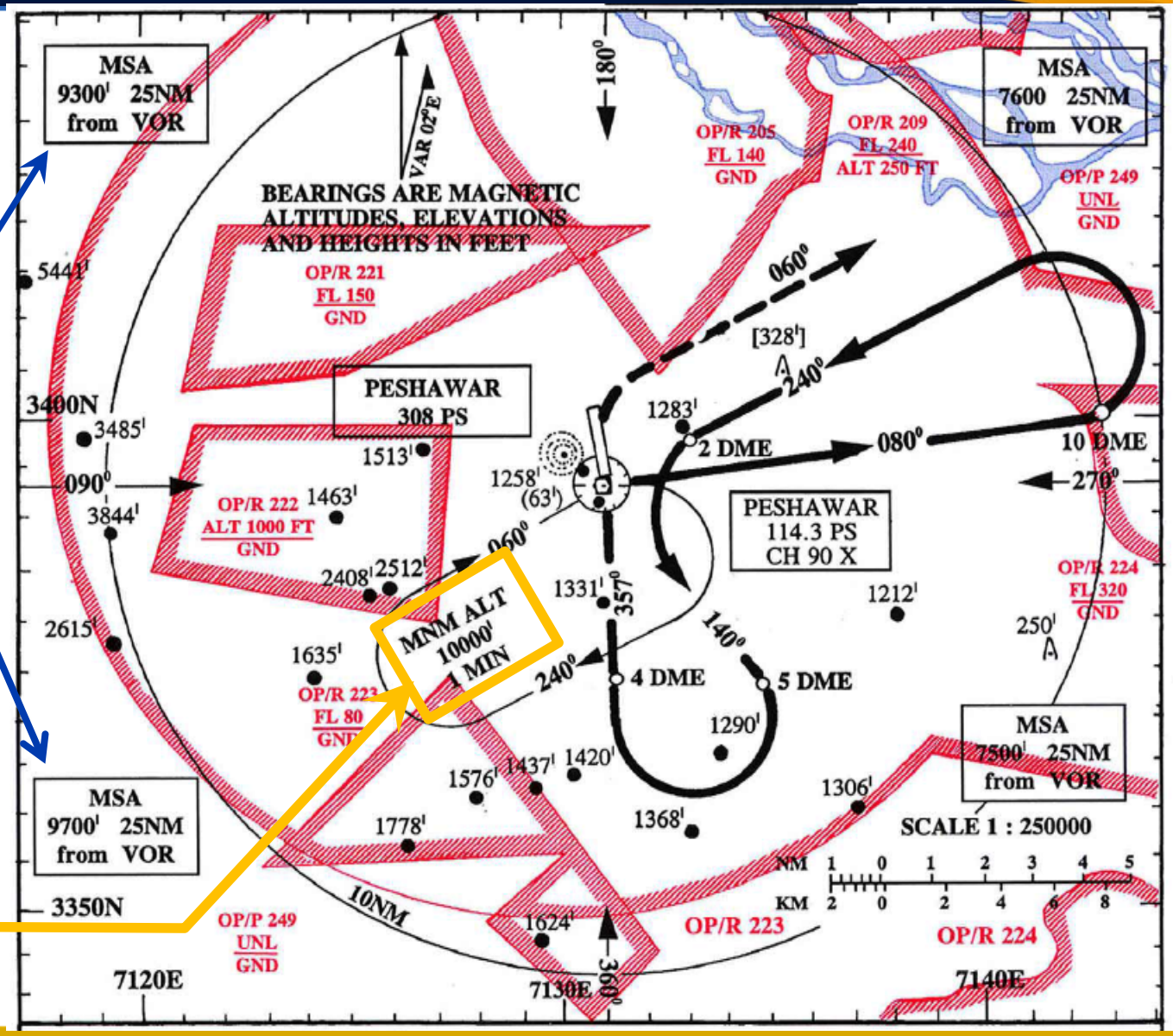
Complex Design

Aerodrome Elevation – 1211 ft
Initial Approach Alt – 10,000 ft

MSA
9300 /9700

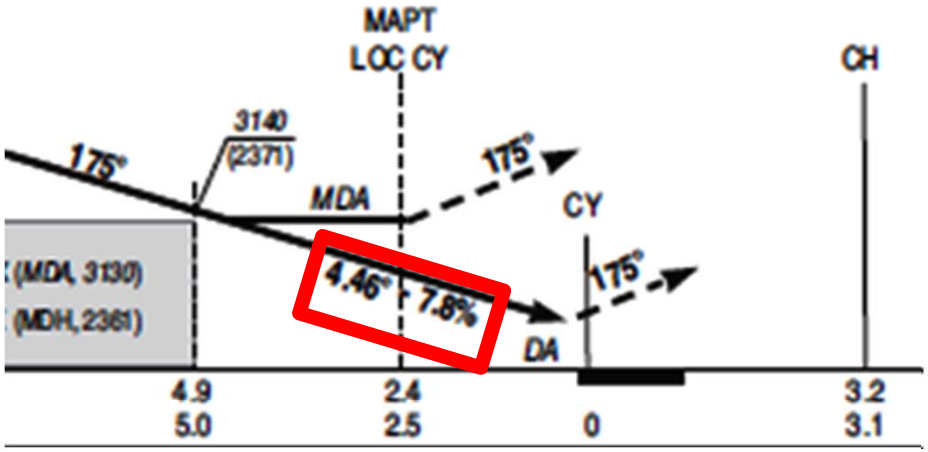
Sufficient track miles to loose altitude

MHA 10000

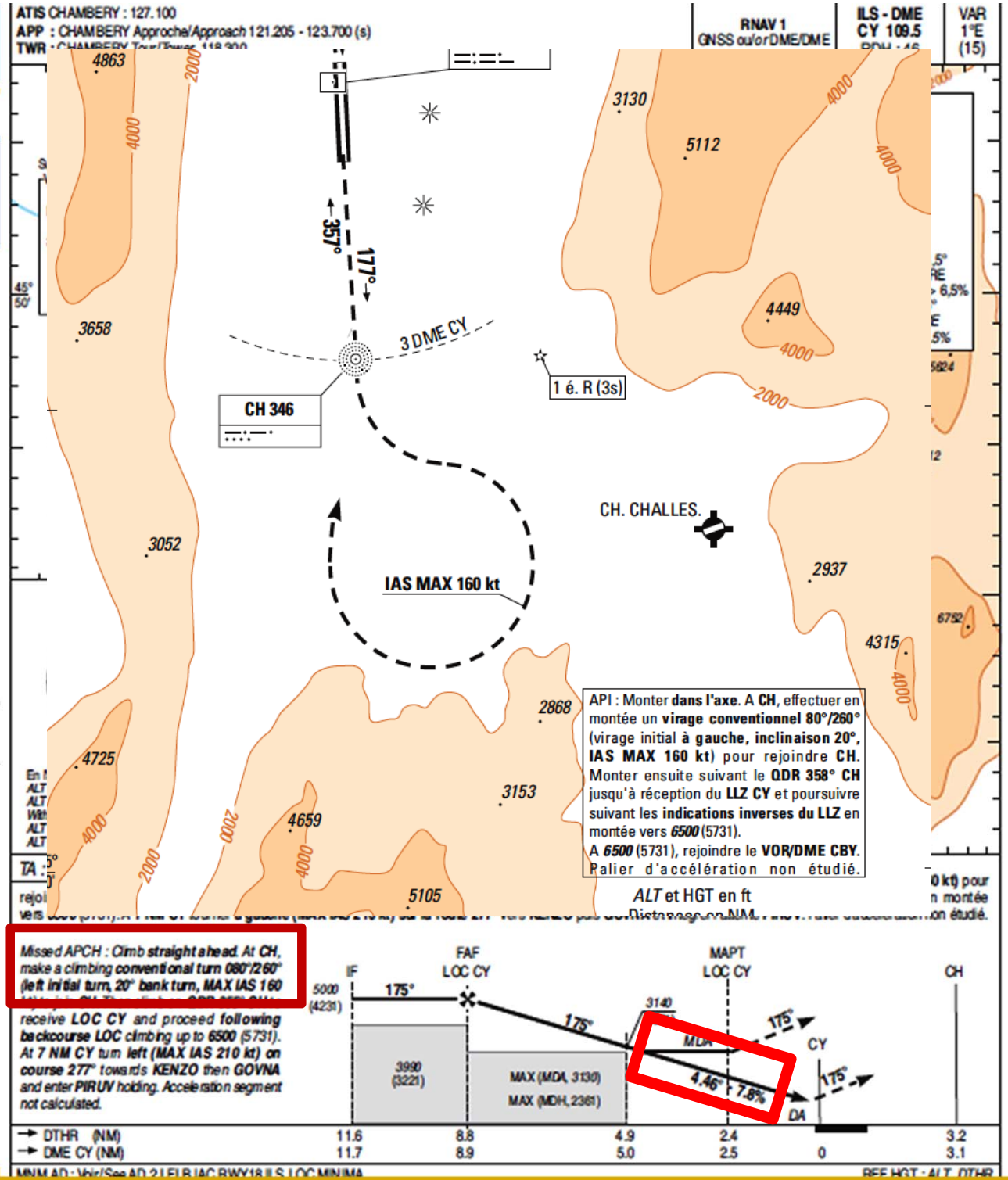


Deviations from criteria

Aerodrome Elevation: 768 ft
Terrain exceeding 4000 all around



Missed APCH: Climb straight ahead. At CH, make a climbing Conventional turn 80/260 (left initial turn, 20 bank turn, Max IAS 160KT) to join CH.

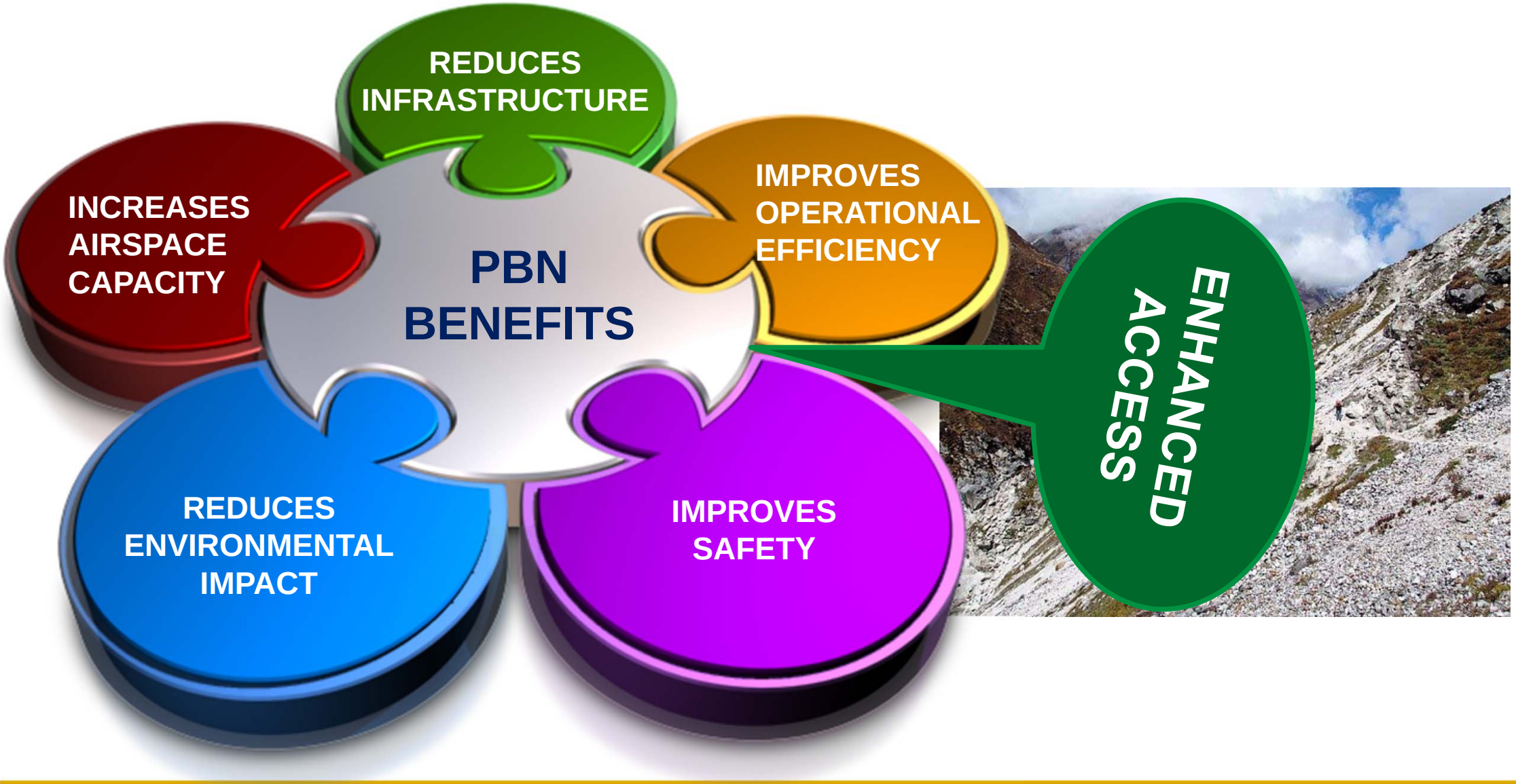


Criteria / Technological Development

- **PANS-OPS Conventional Criteria**
  - ❖ NDB
  - ❖ VOR
  - ❖ ILS
- **PANS-OPS PBN Criteria**
  - ❖ RNP APCH (Radius to Fix Legs)
  - ❖ RNP/RNAV 1 ARR/DEP
  - ❖ Advanced RNP (Scalable RNP)
- **PBN Doc 9905 RNP AR Criteria**
  - ❖ RNP AR Criteria
  - ❖ RNP AR DEP
  - ❖ RNAV/RNP Visual

Criteria were found to be insufficient / lacking in the necessary support guidance for approving operations where demanding RNP solutions were needed

WHY PBN


REDUCES INFRASTRUCTURE
INCREASES AIRSPACE CAPACITY
IMPROVES OPERATIONAL EFFICIENCY
PBN BENEFITS
ENHANCED ACCESS
REDUCES ENVIRONMENTAL IMPACT
IMPROVES SAFETY

RNP AR CRITERIA (Doc 9905)

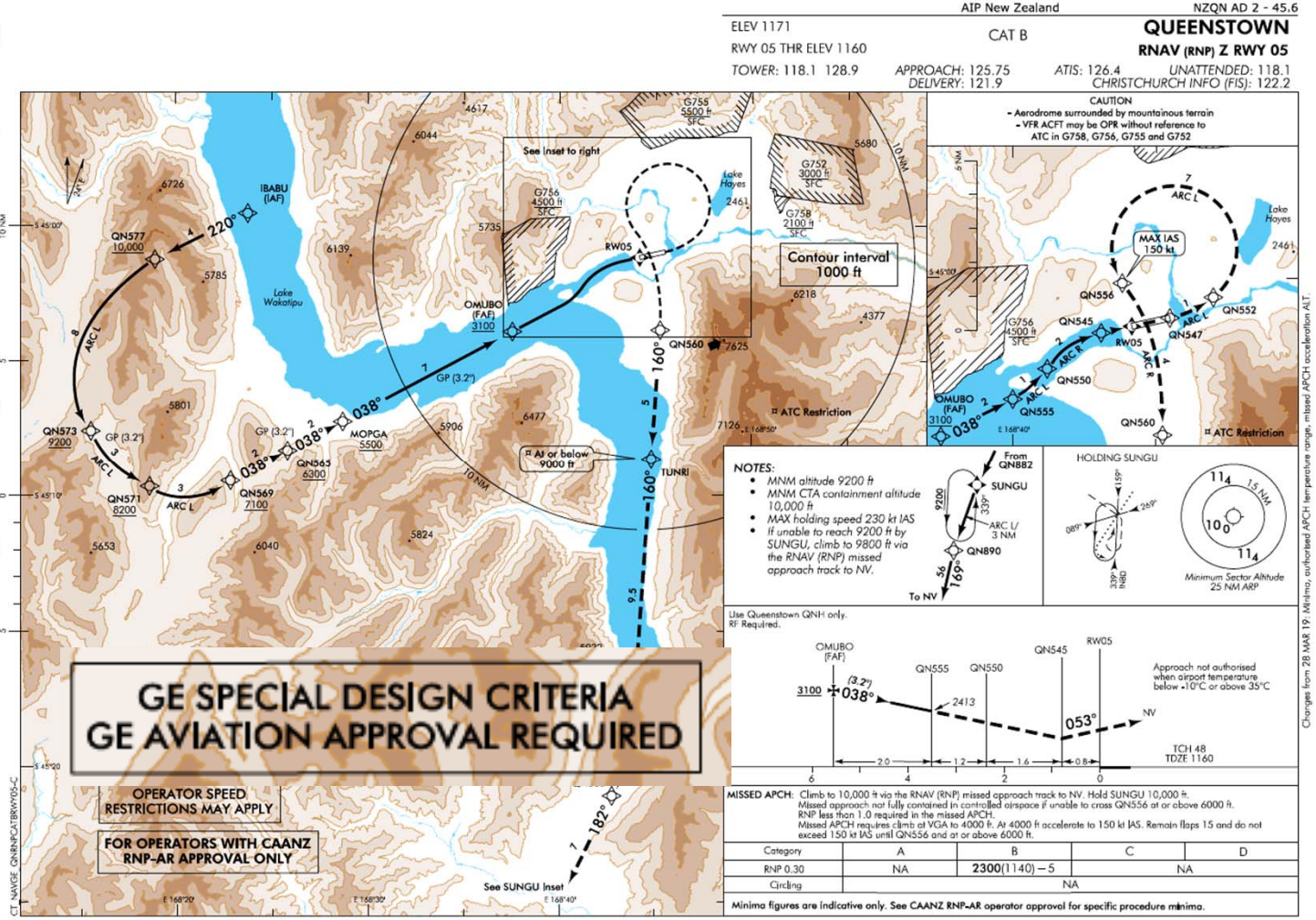
- Extends beyond procedure design in that an authorization process for aircraft operators is necessary to ensure that other critical dependencies and associated airworthiness and operational procedure approvals are complete prior to implementation.
- Applicable to a range of aircraft types and cannot; therefore, take into account the full capability of some aircraft types.
- Consequently, procedures designed in accordance with this manual will provide an acceptable operational solution in many but not all circumstances.

RNP AR CRITERIA

- Where an operationally acceptable solution is not available through the application of these criteria, development of detailed procedures may be needed to satisfy local conditions.
- Alternative design solutions may be derived which specify aircraft type or specific performance parameters, special operating conditions or limitations, crew training, operational evaluation or other requirements that can be demonstrated to provide an equivalent level of safety.
- Such solutions are not the subject of this manual and require a case-by-case flight operations safety assessment (FOSA) and operational approval.

RNP AR Limitations

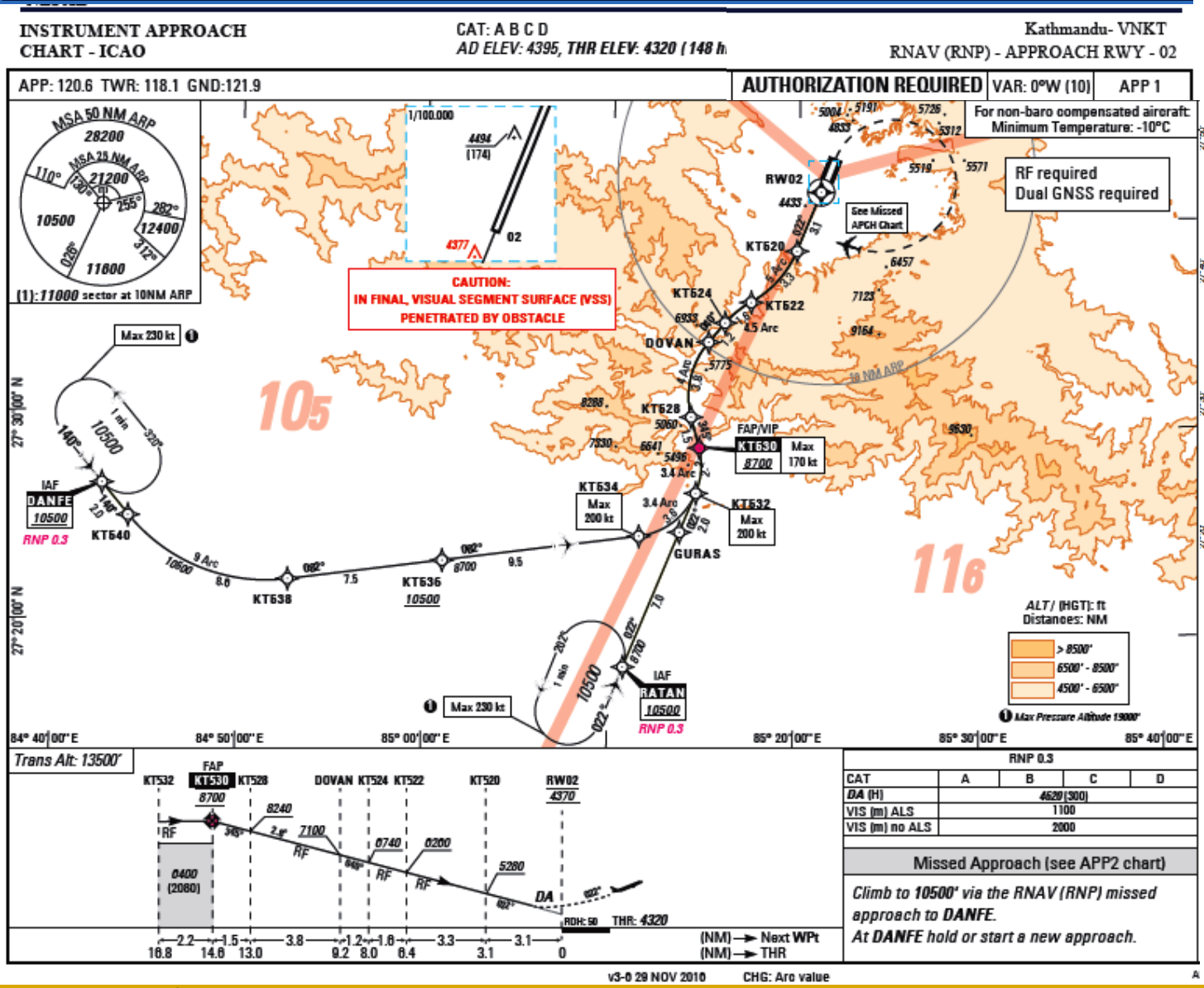
- Implementation of RNP AR – may be beyond Doc 9905 criteria.
- RNP AR Departures – not covered currently under ICAO Doc 9905 criteria

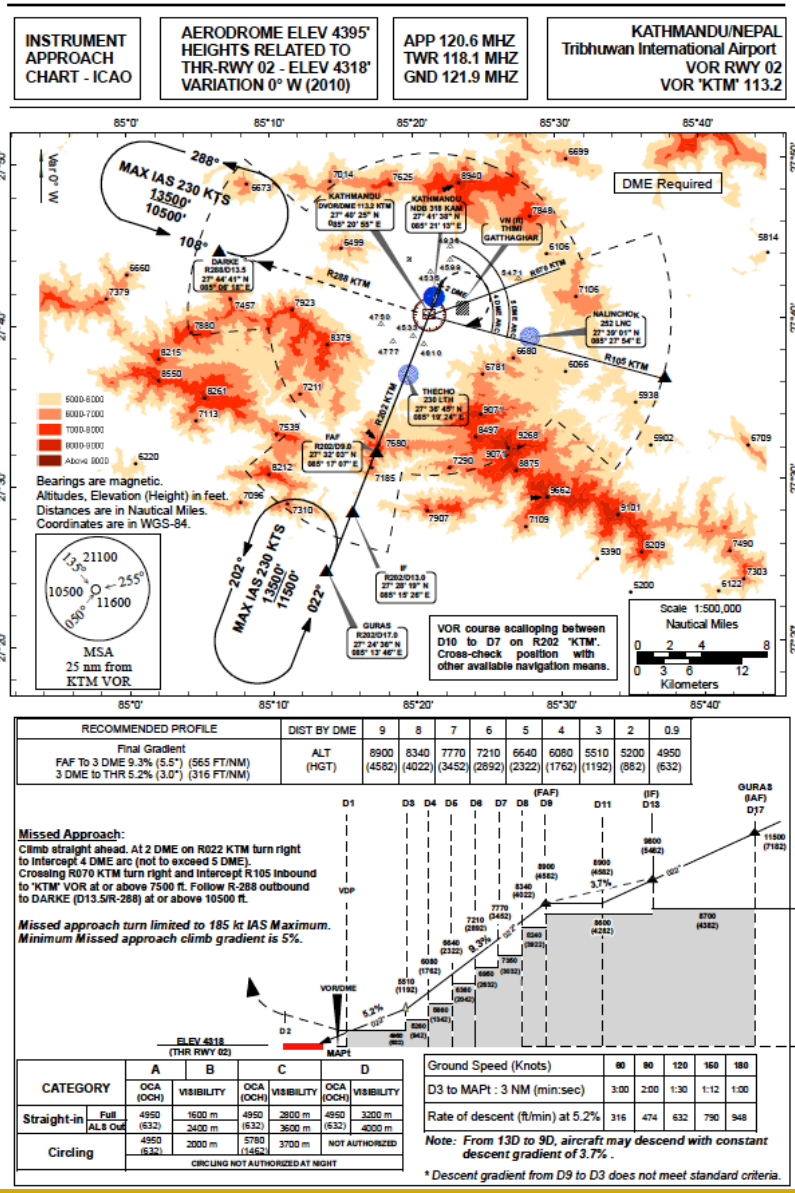


CONTINUOUS IMPROVEMENT

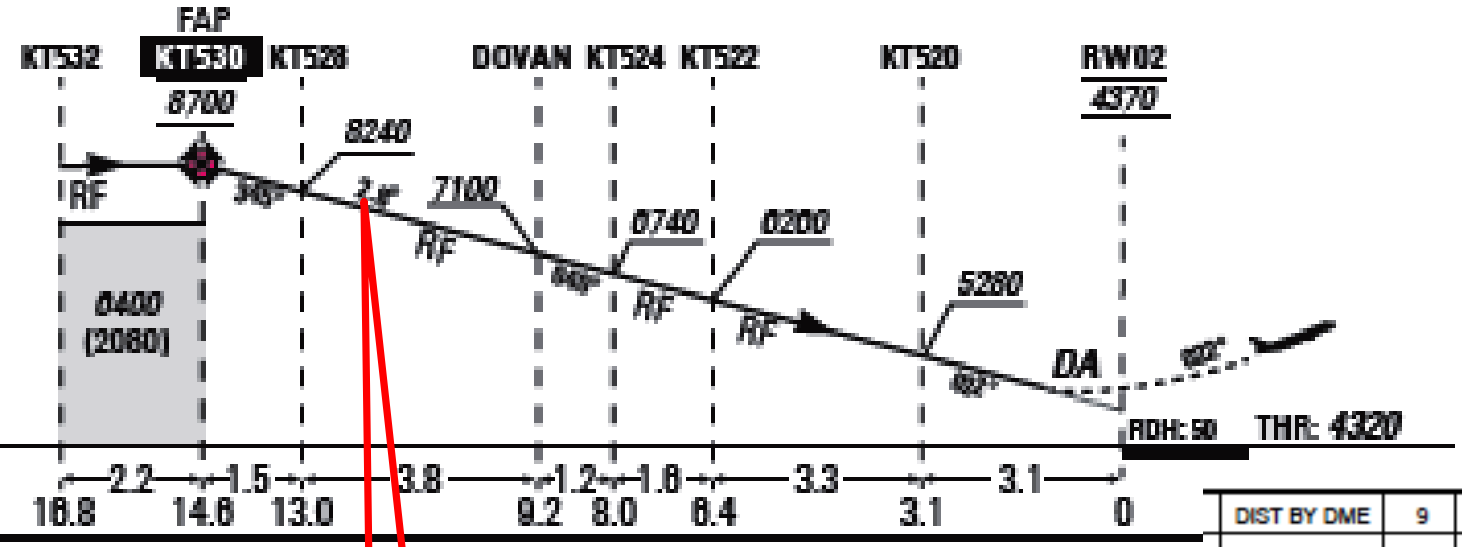
- **Role Of IFP Design Organization:**
  - **Monitor ongoing development**
  - **Explore possibility for better options**
    - ✓ **Enhanced safety**
    - ✓ **Optimized Profiles**
    - ✓ **Lower Minima**

VNKT Improvement



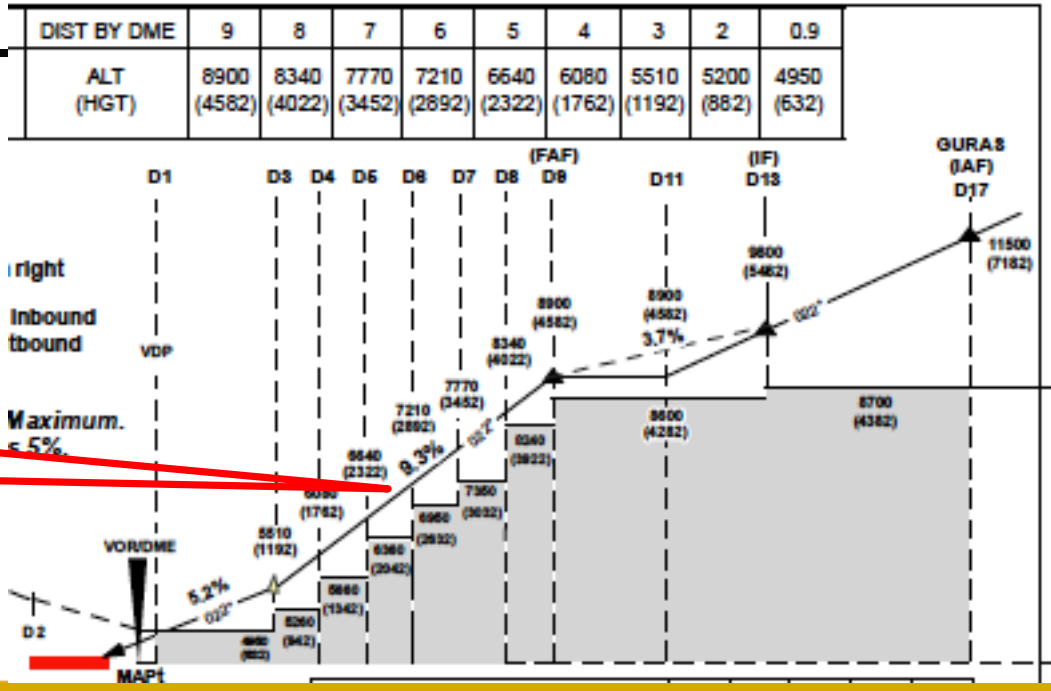


VNKT Improvement



2.8°

9.3% UPTO
3 DME



Navigational Aids

- Important role specially in conventional solutions
- Siting is also important factor
- Provision of additional facilities may also help in finding solution

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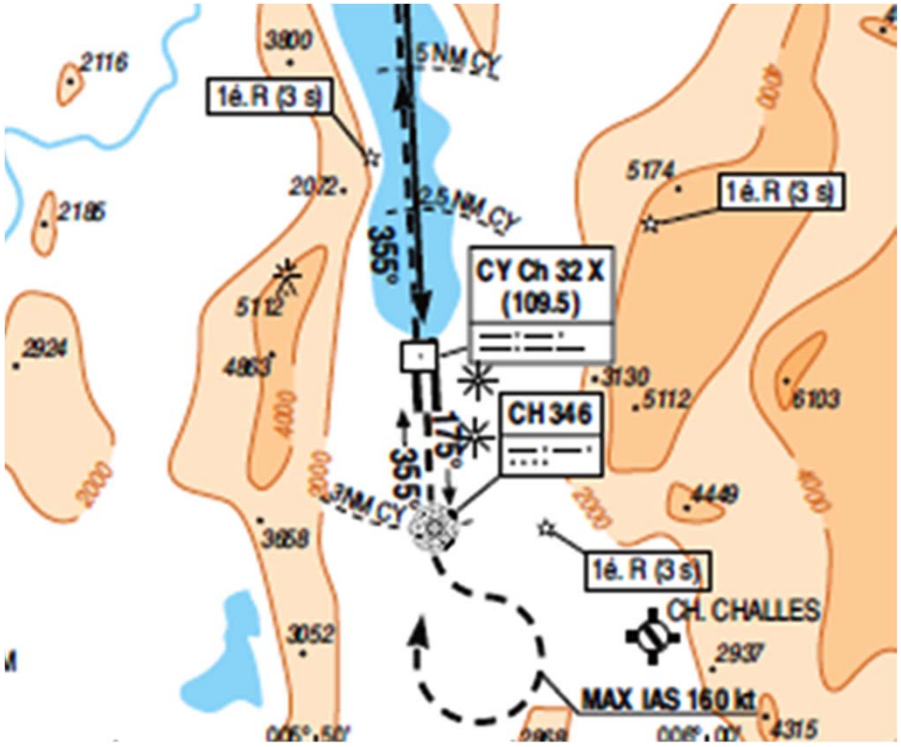


Terrain / Topography

- Typically different from other challenges, practically cannot be changed
- Posses serious threat to safety : Controlled Flight Into Terrain
- Restrict access to aerodromes specially in Instrument Meteorological Conditions – All Weather Operations

Airspace Management

- Close by airfields
- Segregated airspaces
- Other requirements

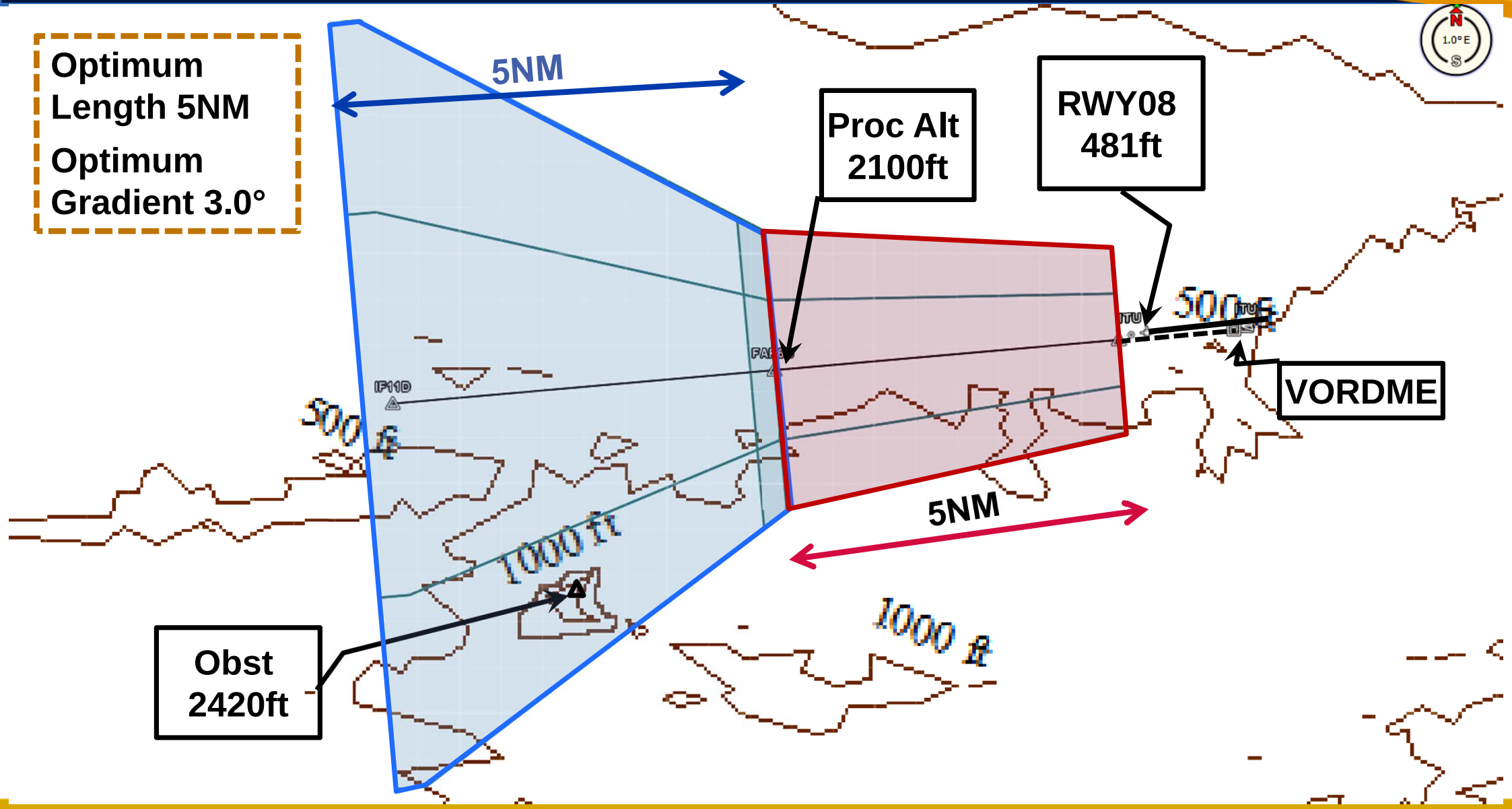
IFP Designer Knowledge

- **Besides design criteria requires knowledge of**
  - **Aerodromes**
  - **Navigation**
  - **Geodesy**
  - **Database coding**
  - **Aircraft performance**
  - **Charting & Publication**

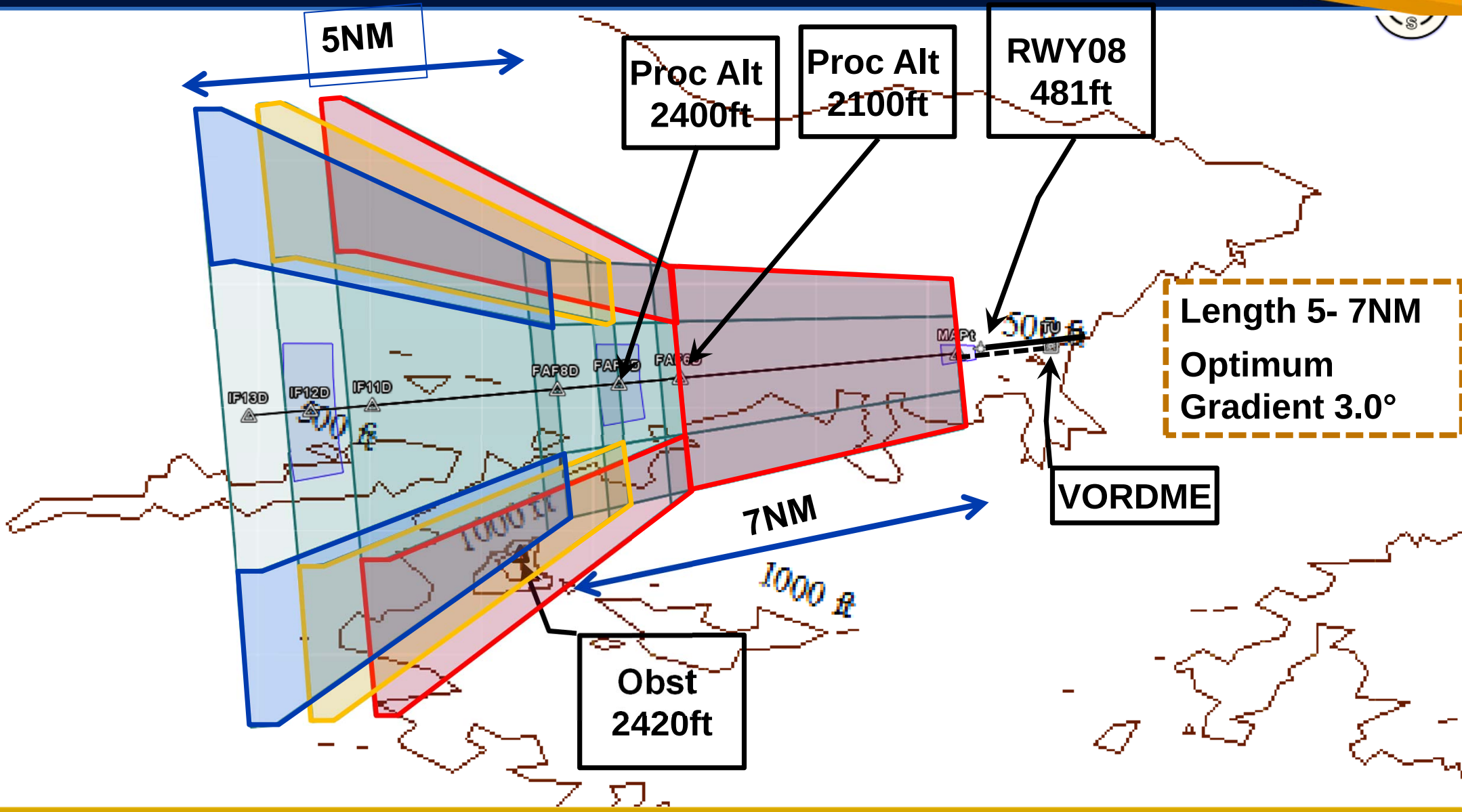
SKA in IFP

- **What an individual requires to perform an enabling objective derived from performance criteria.**
  - **Skill is the ability to perform an activity that contributes to the effective completion of a task.**
  - **Knowledge is specific information required for the trainee to develop the skills and attitudes for the effective accomplishment of tasks.**
  - **Attitude is the mental state of a person that influences behaviour, choices and expressed opinions.**
- **SKA provide competence to address issues (Thinking out of box solution to address challenges)**

Example – Use of Criteria

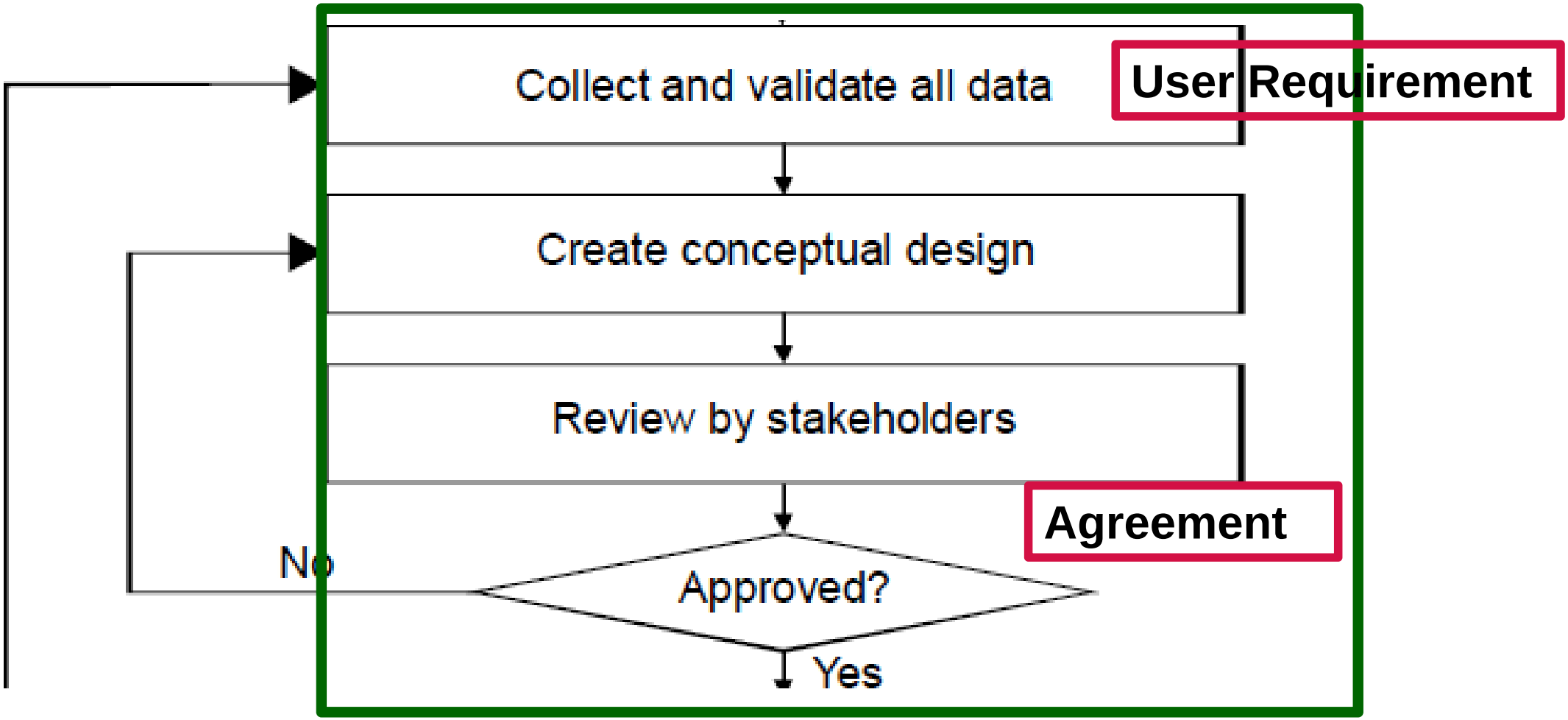


Example – Use of Criteria



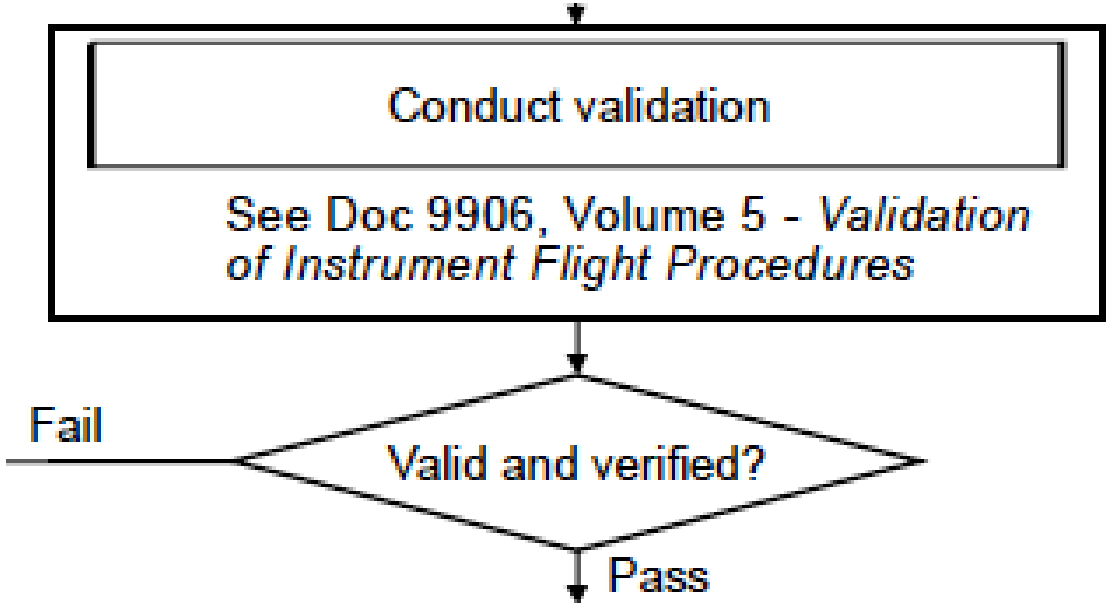
WORKING METHODOLOGY ADOPTED

- **Ascertain user requirement – needs of operators / ATS**



WORKING METHODOLOGY ADOPTED

- **Ground & Flight validation**



- **Seek support from the operators**
  - **SIM sessions**
  - **Operational trials**

IFP Stories from Pakistan

Jinnah Int'l Airport (JIAP) Karachi

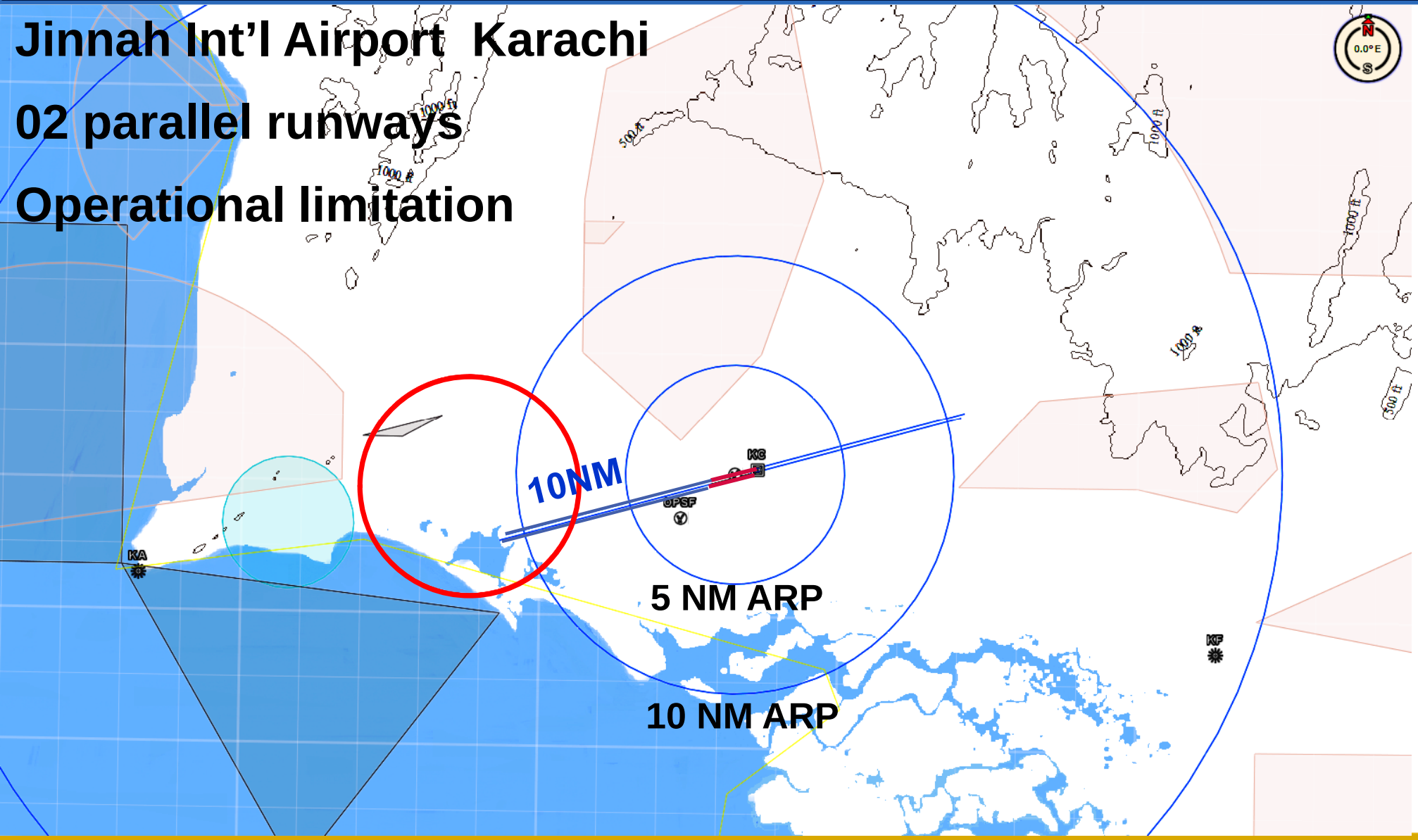
- Int'l Airport at Karachi, the biggest city of Pakistan
- Close by military aerodrome restricting instrument approach operations RWY07L/R
- Circle to land was also a concern, general practice vectoring for visual approach
- Challenge to have instrument approach on RWY07L/R

JIAP Karachi Environment

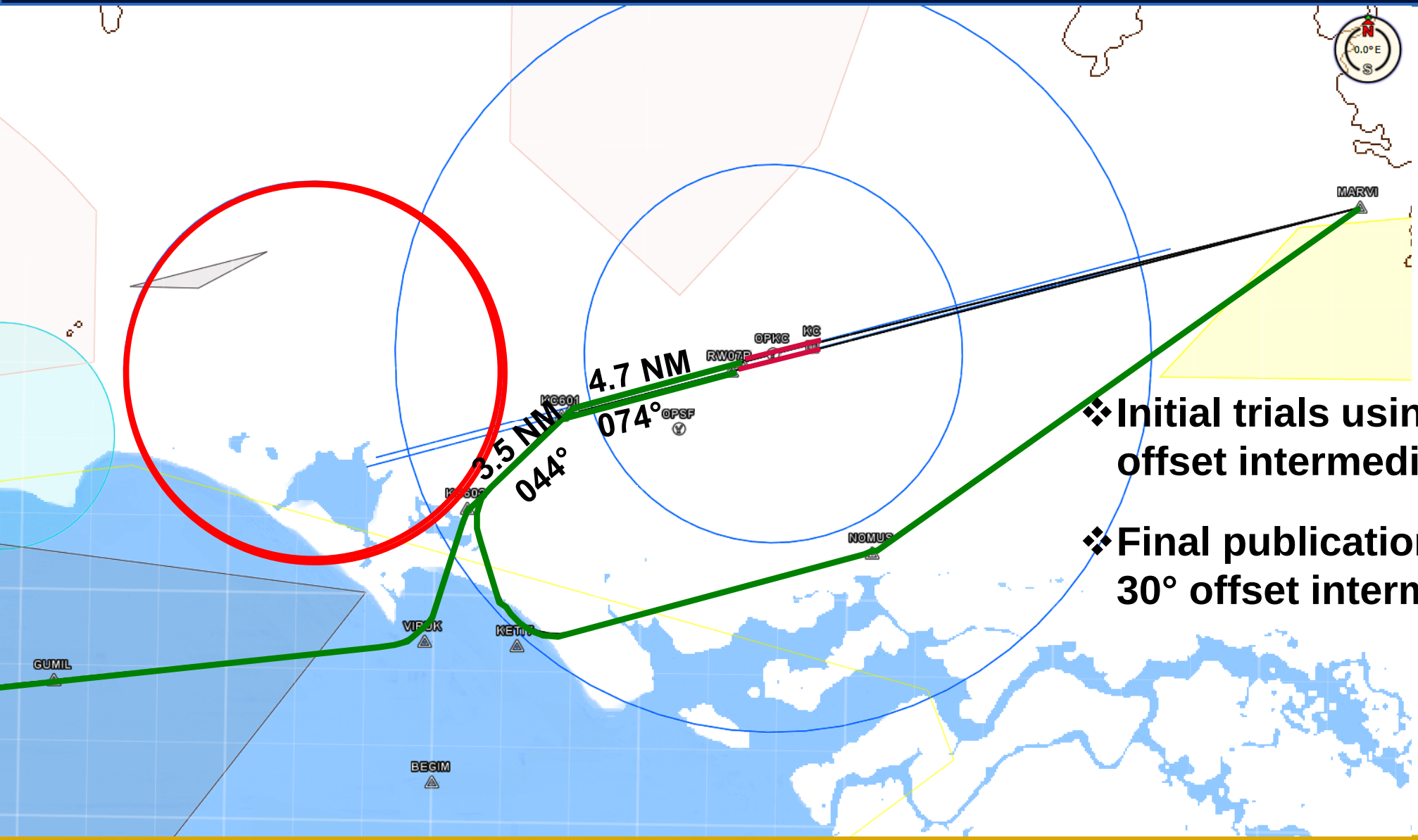
Jinnah Int'l Airport Karachi

02 parallel runways

Operational limitation

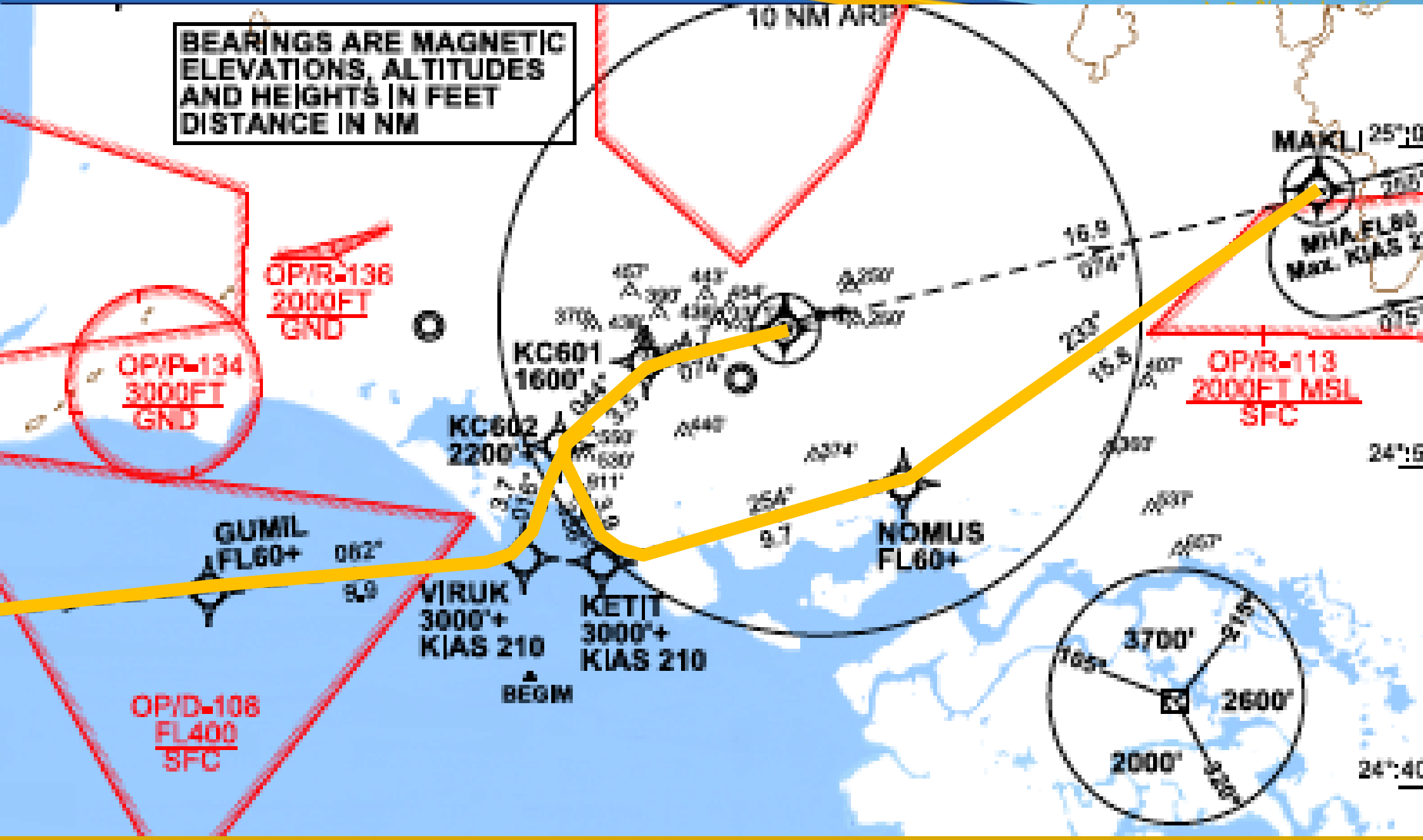


JIAP Karachi PBN Solution



- Initial trials using 45° offset intermediate
- Final publication using 30° offset intermediate

JIAP Karachi PBN Solution

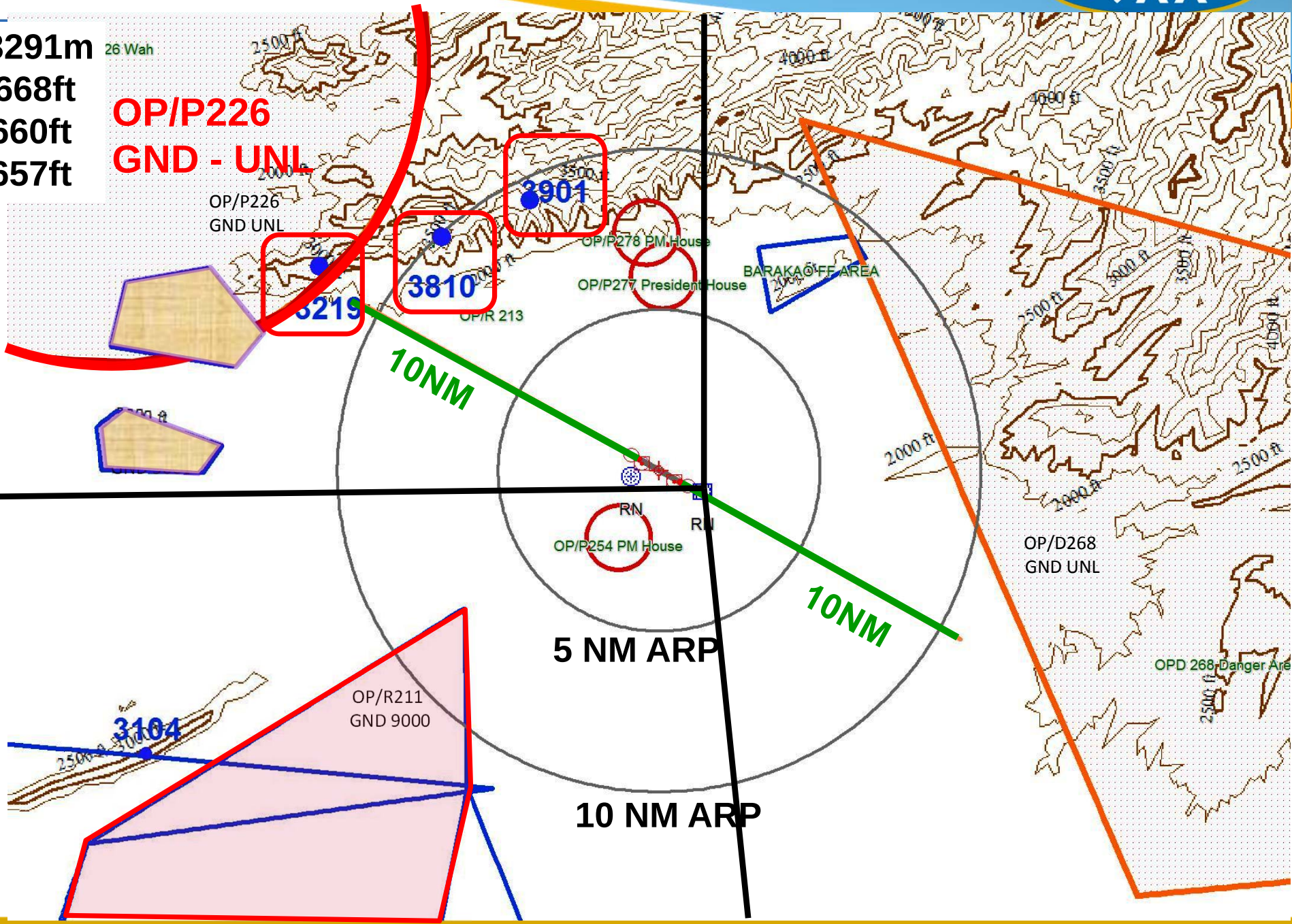


Benazir Bhutto Int'l Airport Islamabad

- Joint user aerodrome at Capital city of Islamabad
- Close by segregated airspace and terrain constraints restricting instrument approach operations RWY12
- Circle to land was also a concern, general practice vectoring for visual approach
- Challenge to have instrument approach on RWY12

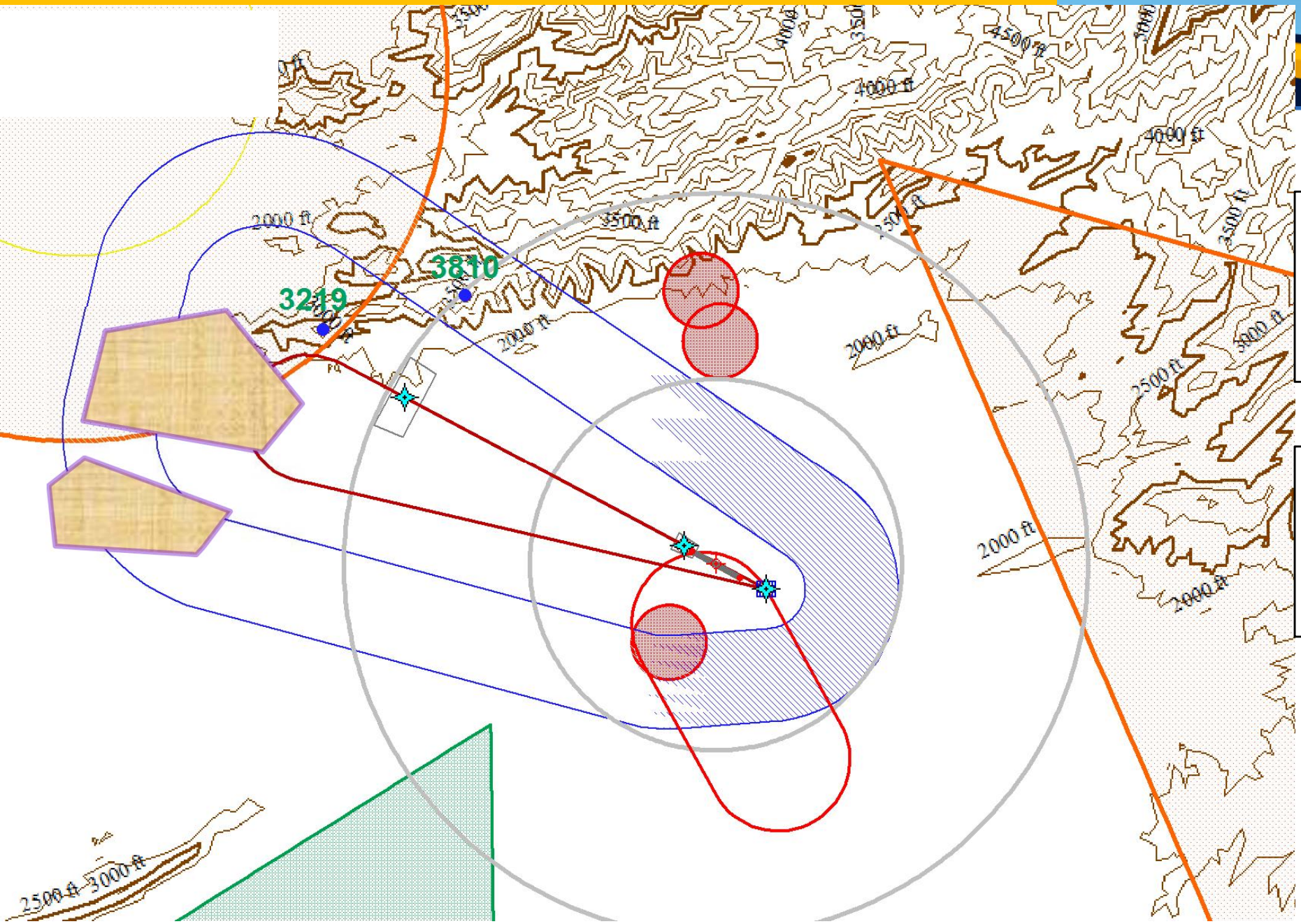
BBIAP Environment

RWY 12/30 – 3291m
Aerodrome 1668ft
THR12 Elev 1660ft
THR30 Elev 1657ft



Contour Interval 500ft

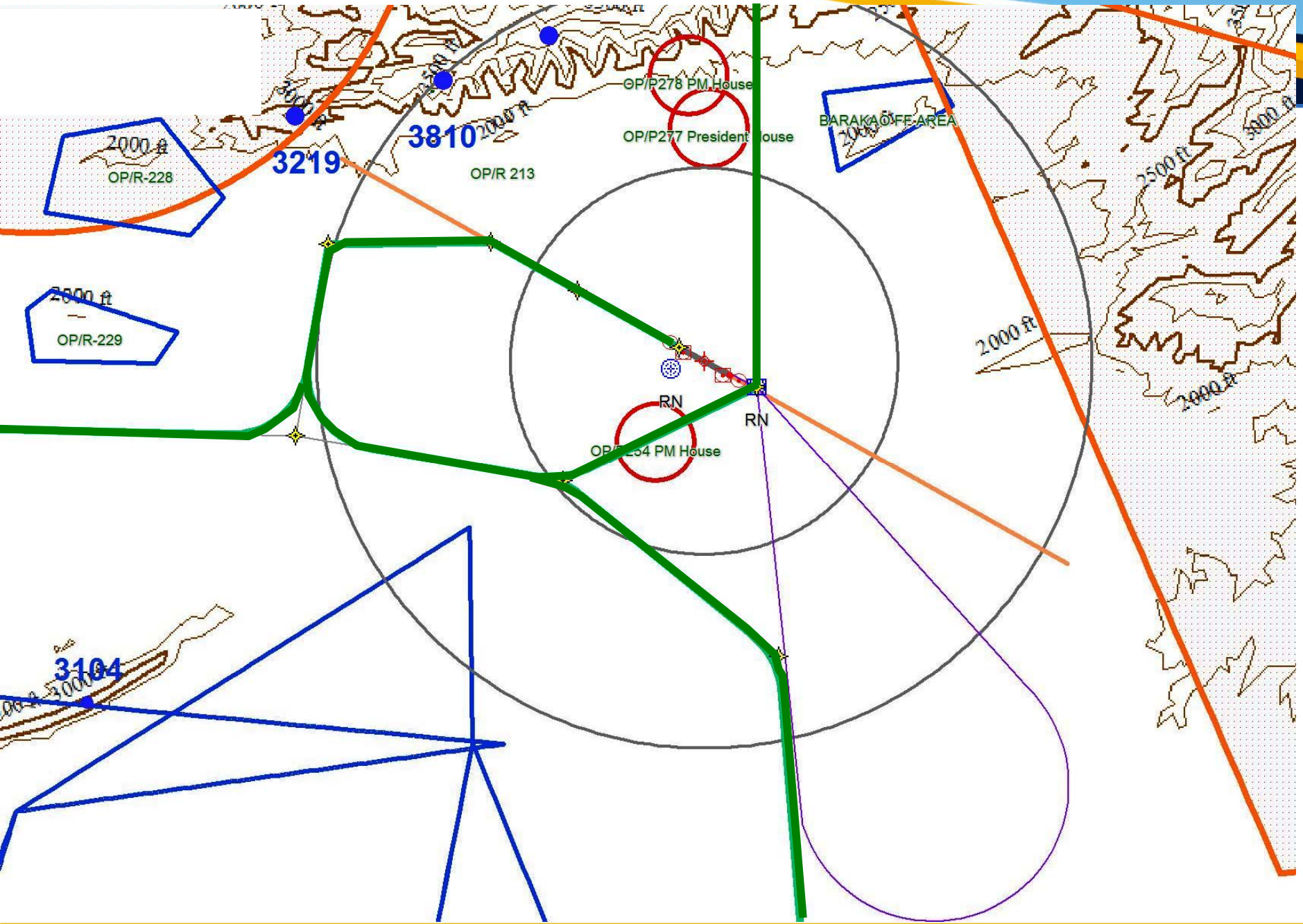
BBIAP Conventional Solution



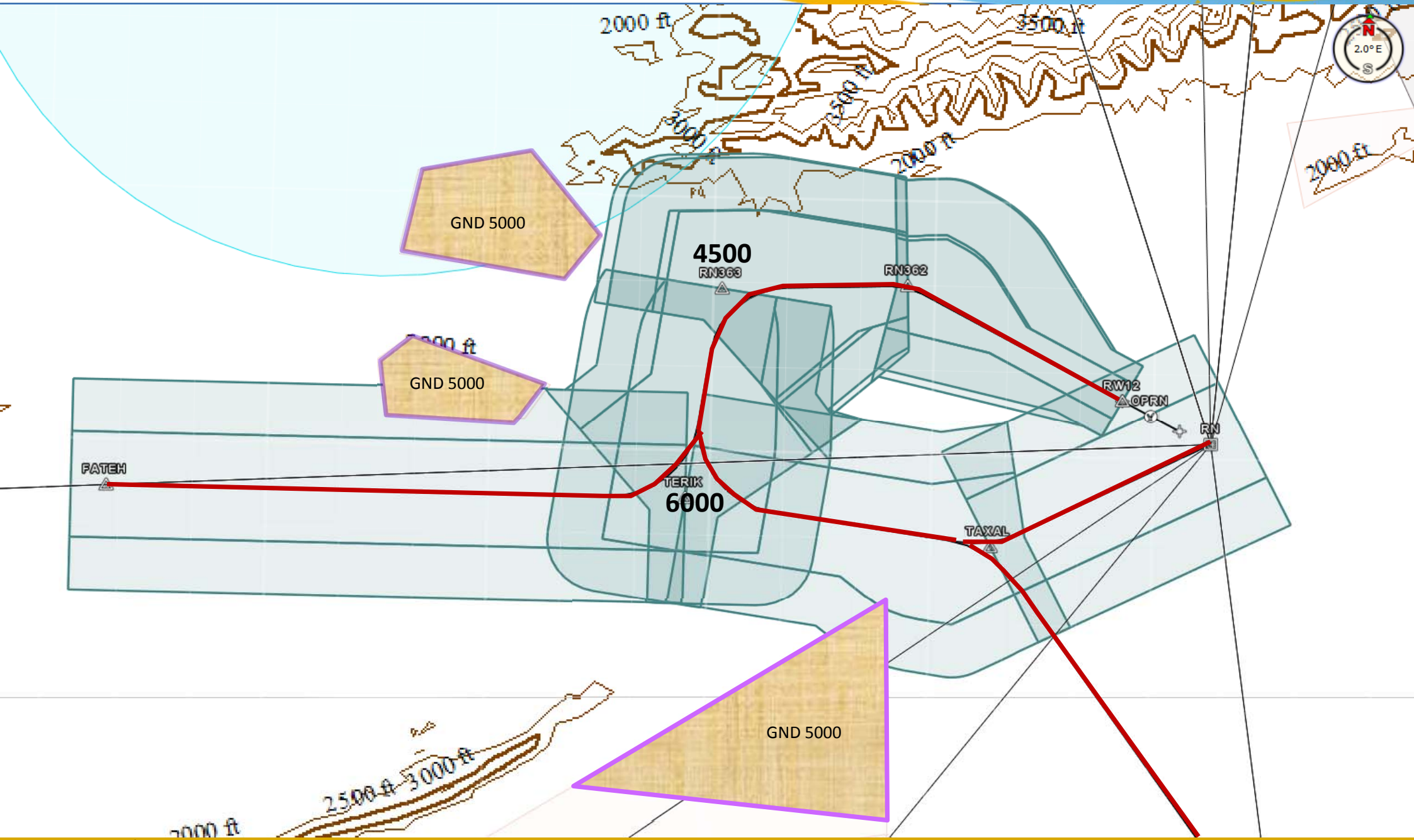
Procedure Altitude 4600 ft

No option to avoid Areas

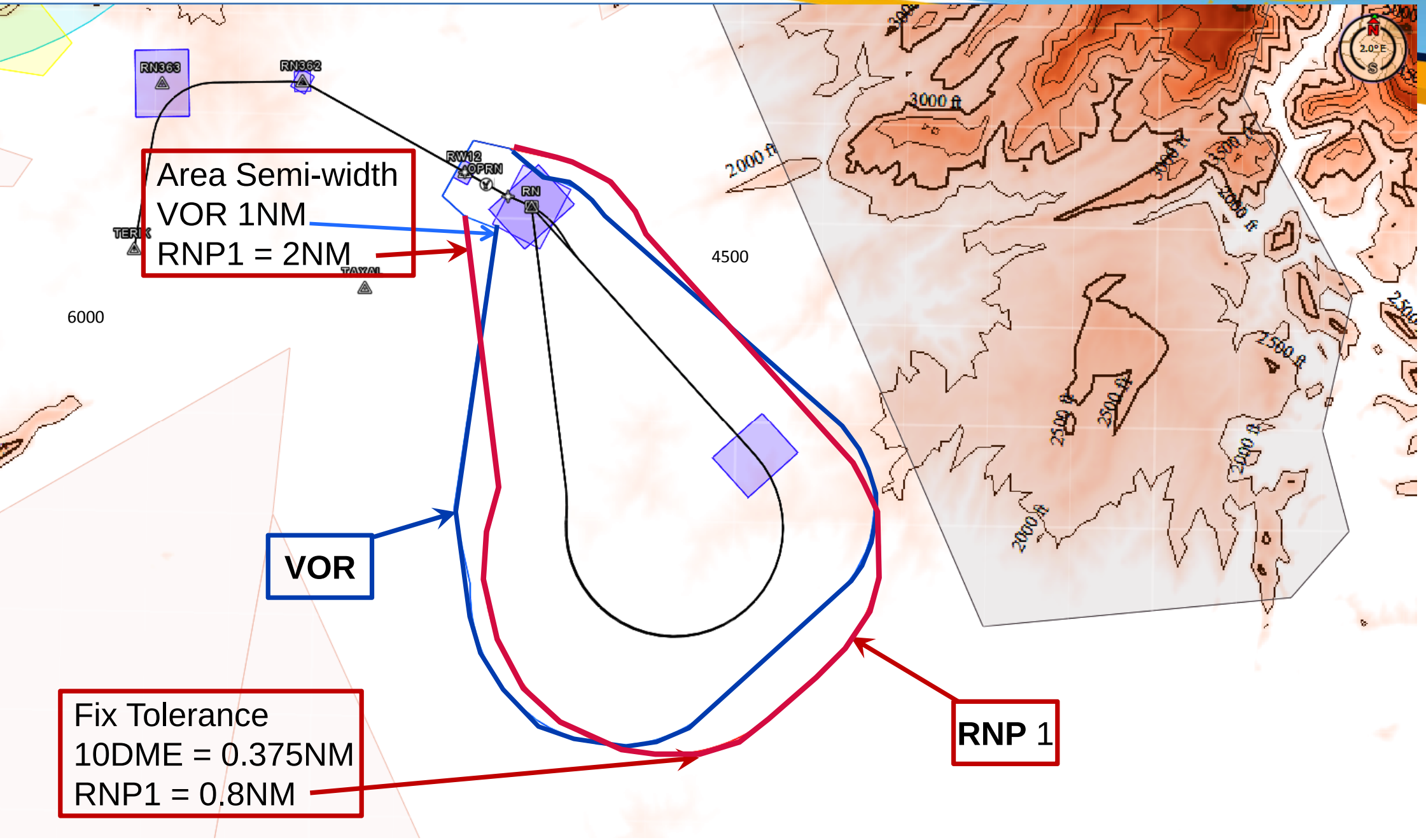
BBIAP PBN Solution



BBIAP PBN Solution



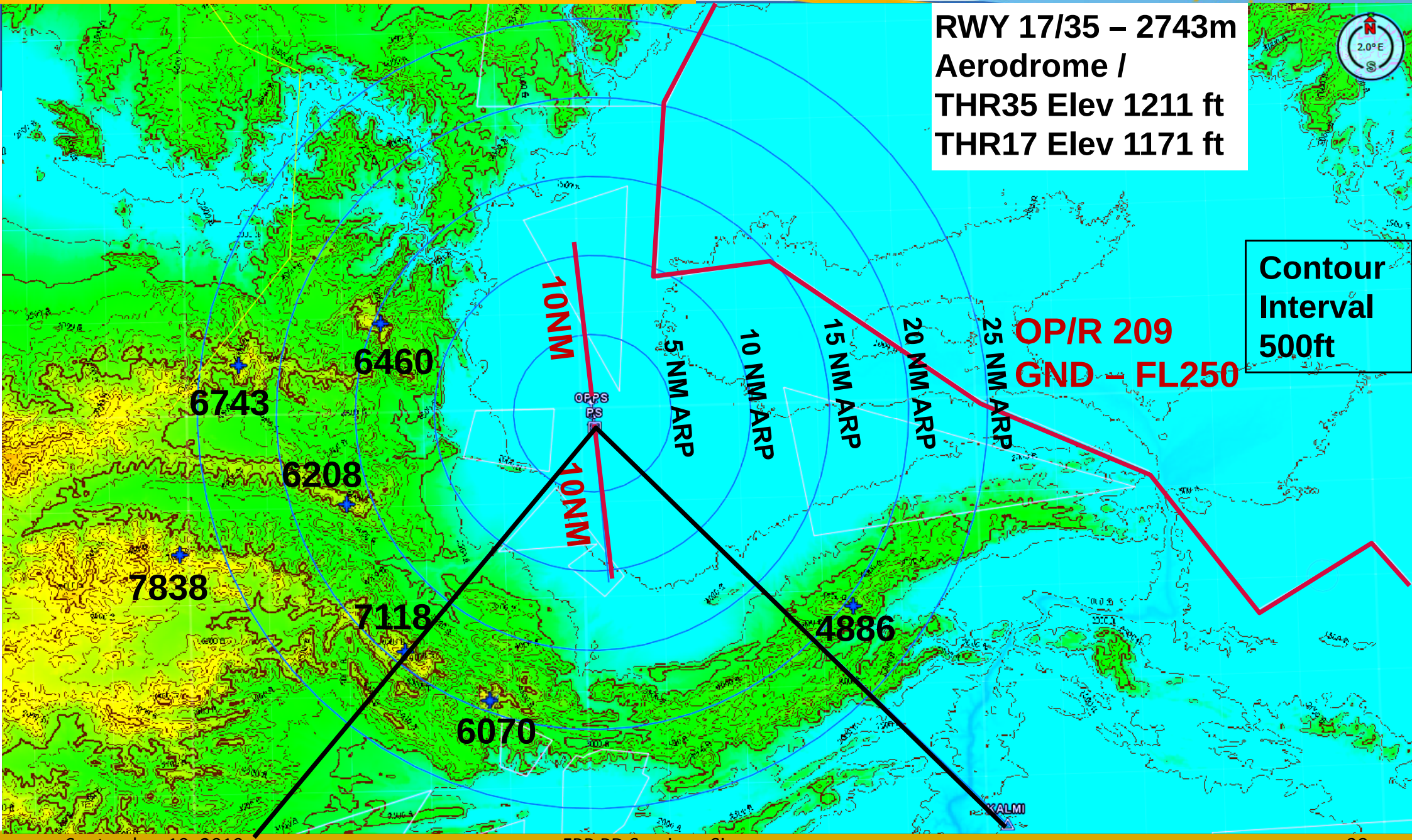
BBIAP MA Solution Conv vs PBN



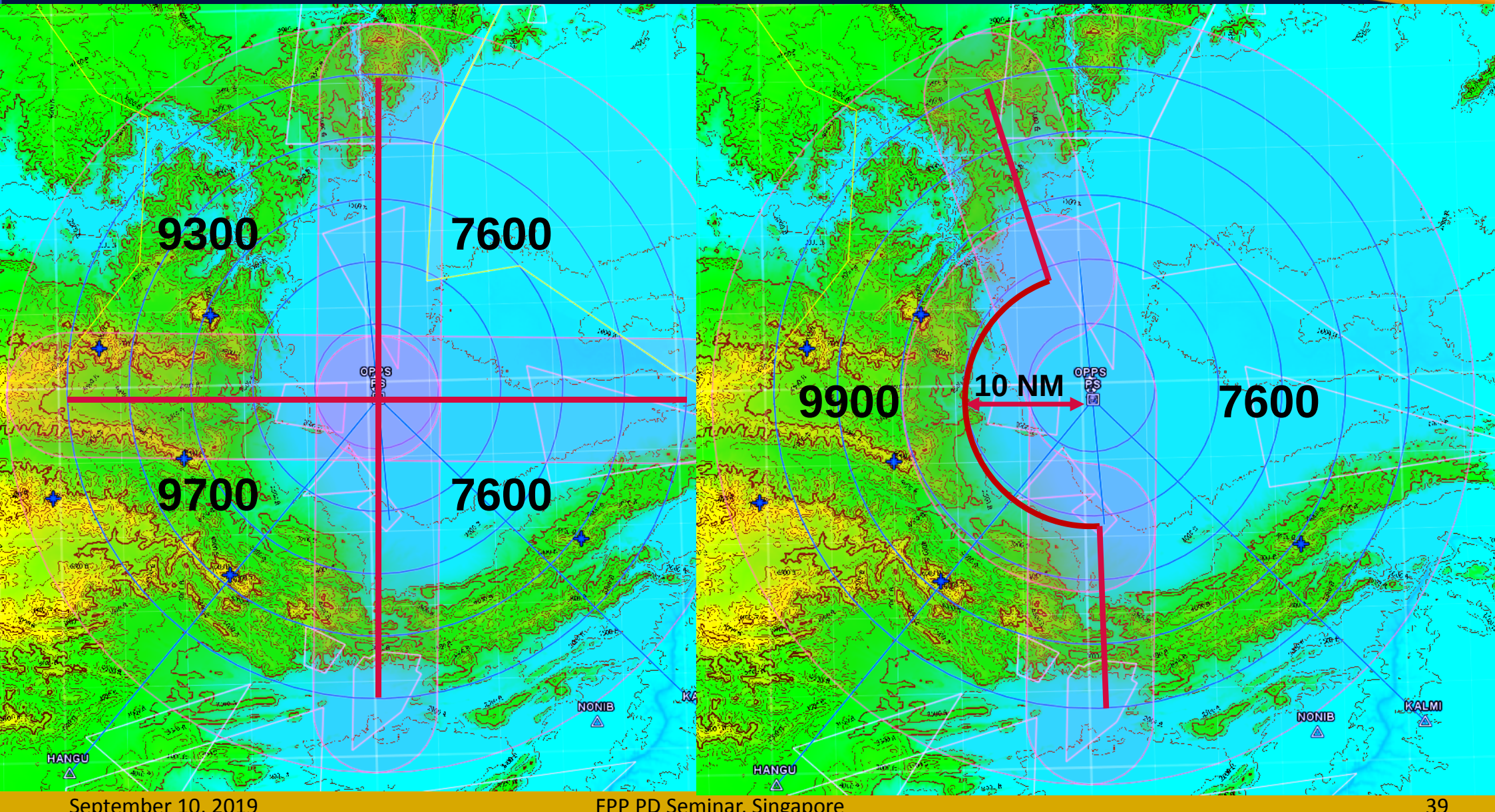
Bacha Khan Int'l Airport Peshawar

- Joint user aerodrome at Peshawar
- Terrain constraints beyond 10NM resulting in Complexity in IFP design
- Requirement to have optimized profiles in instrument approach operations

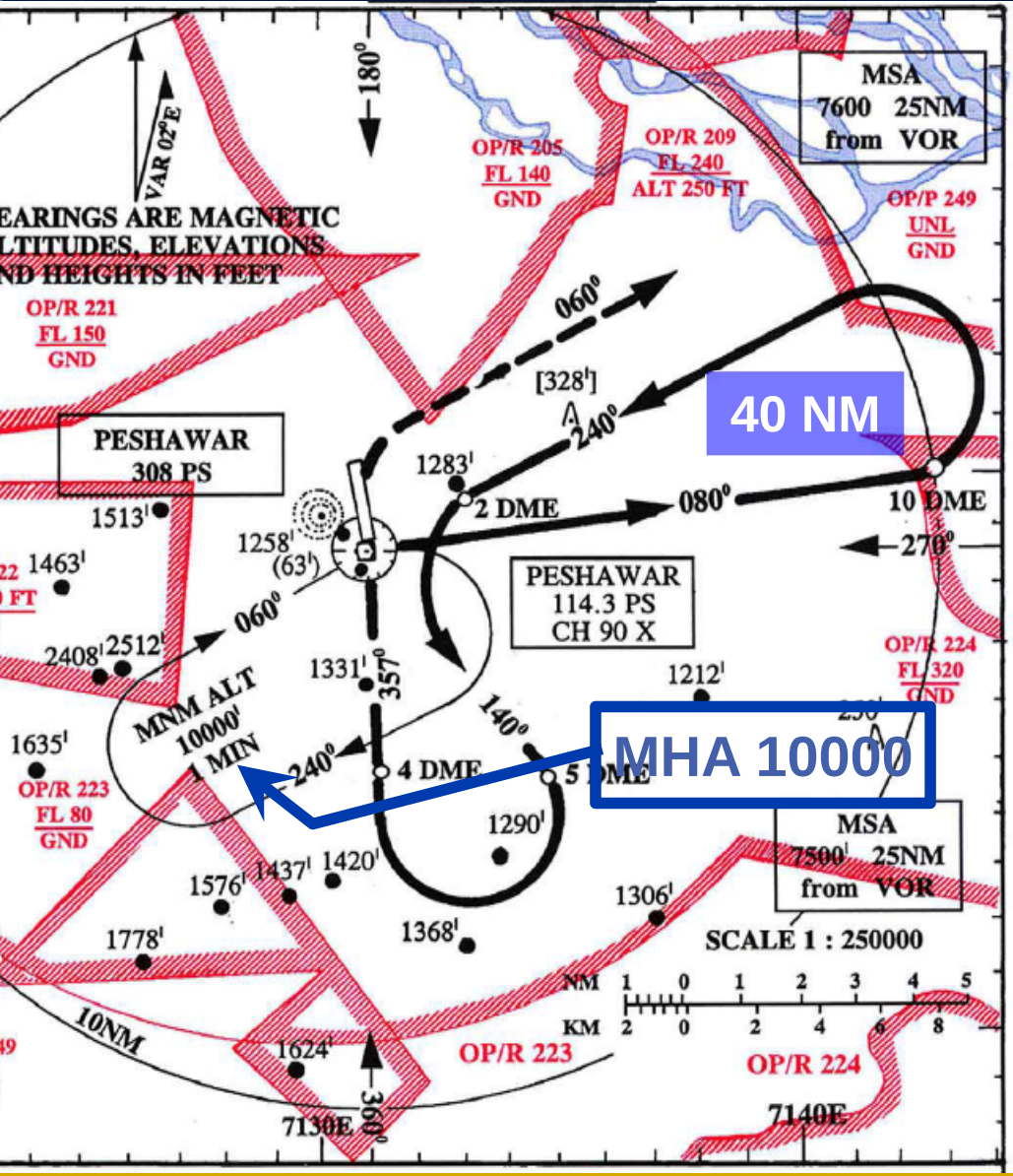
BKIAP Environment

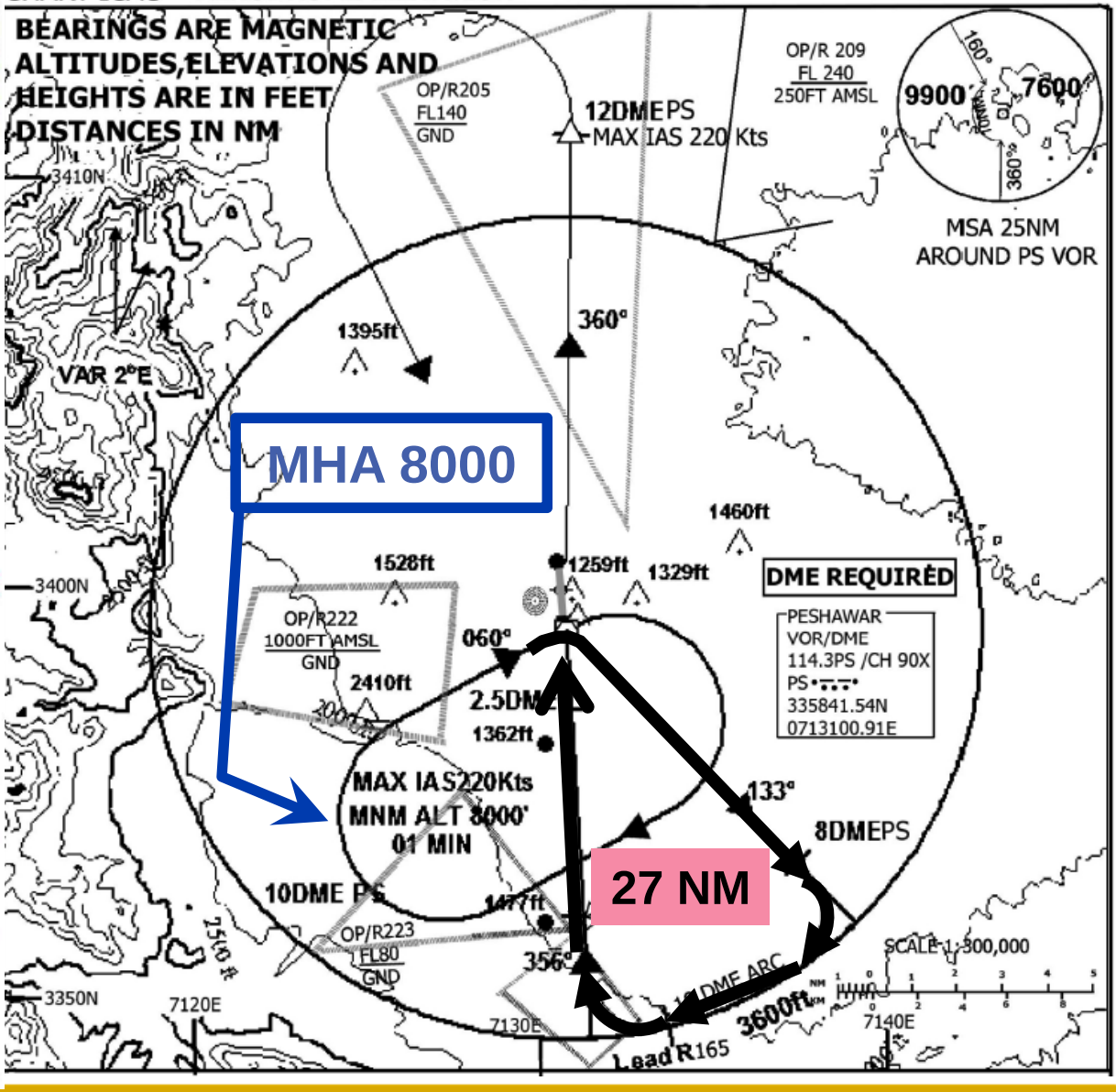


MSA improvement

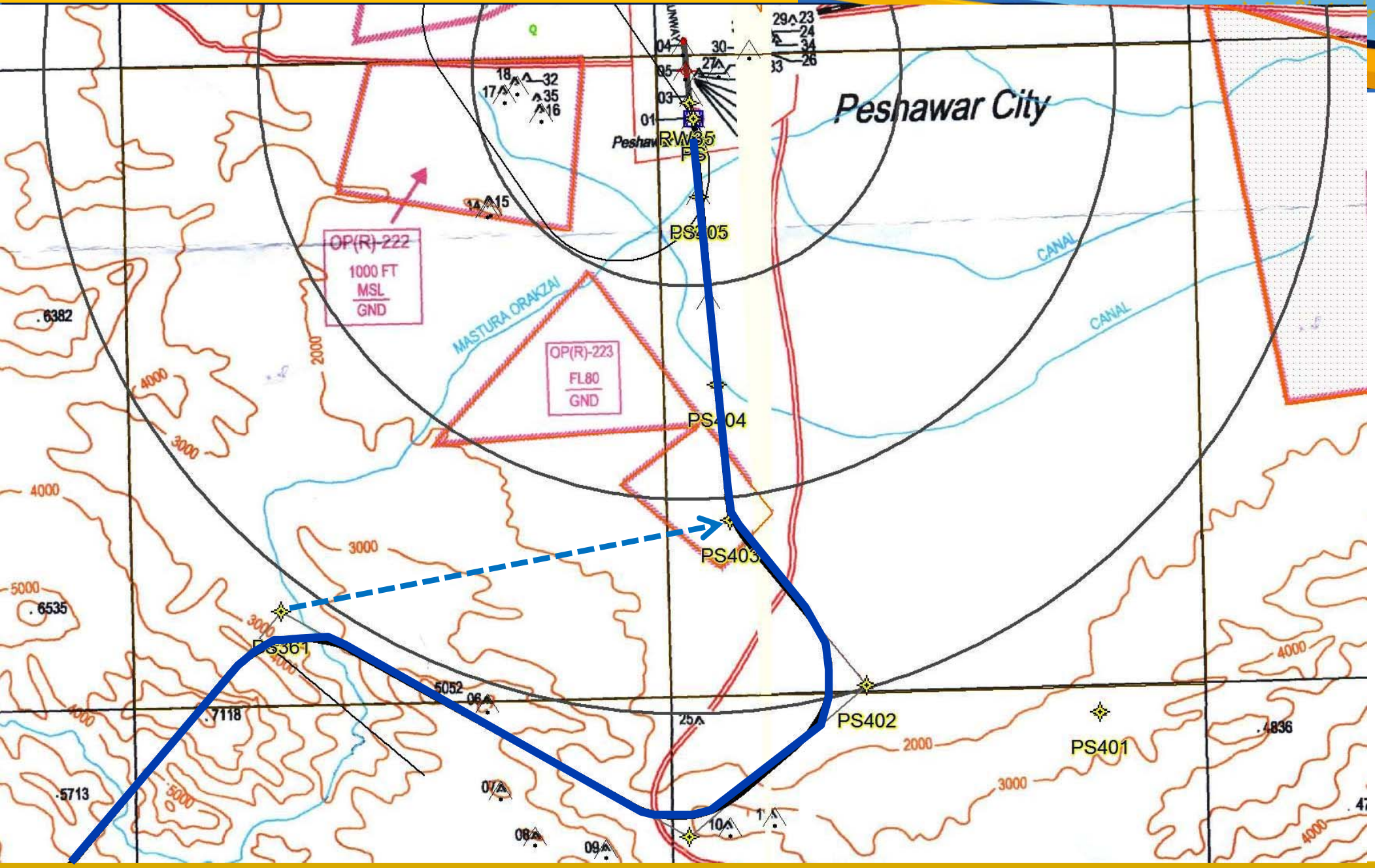


Conventional Improvement

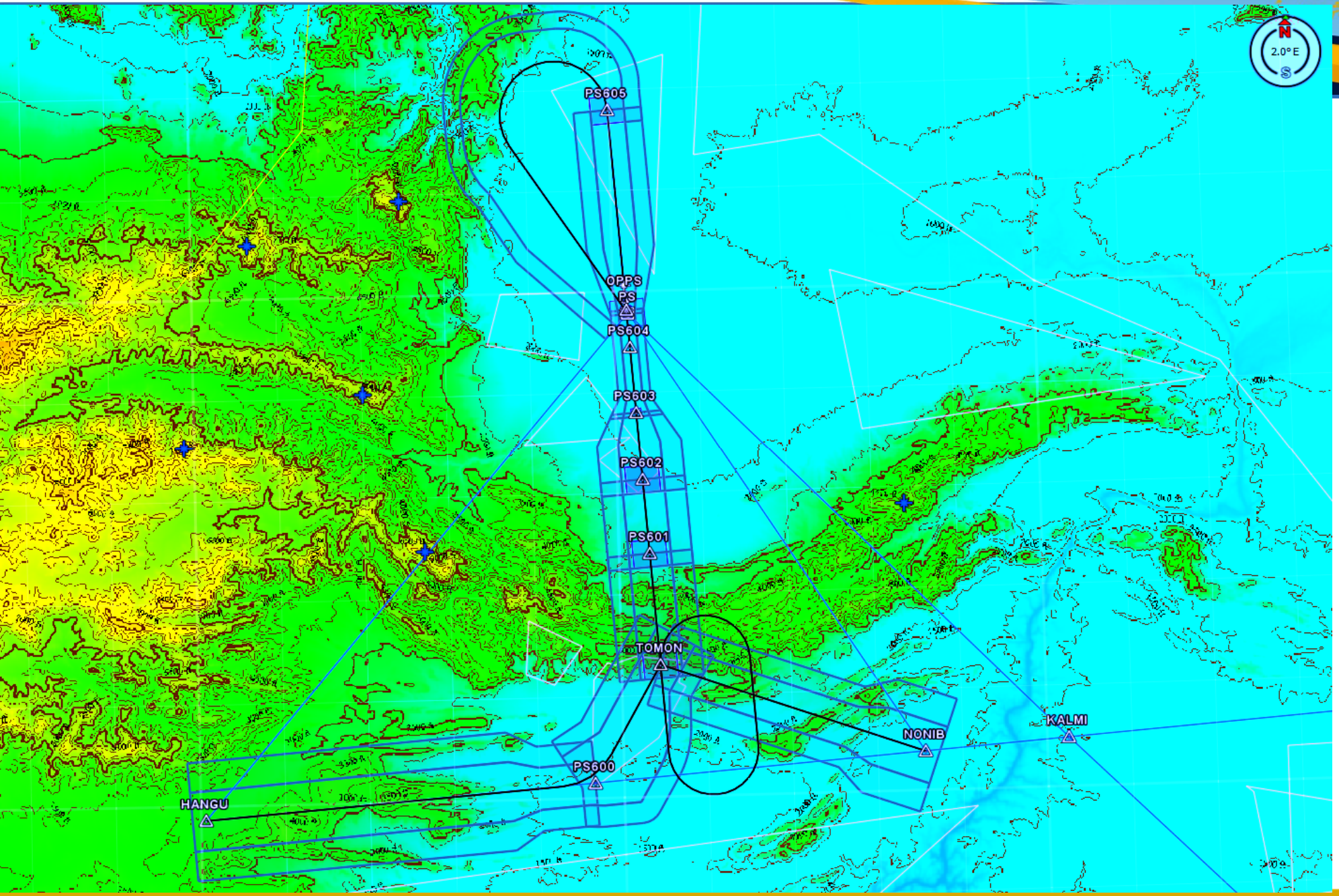




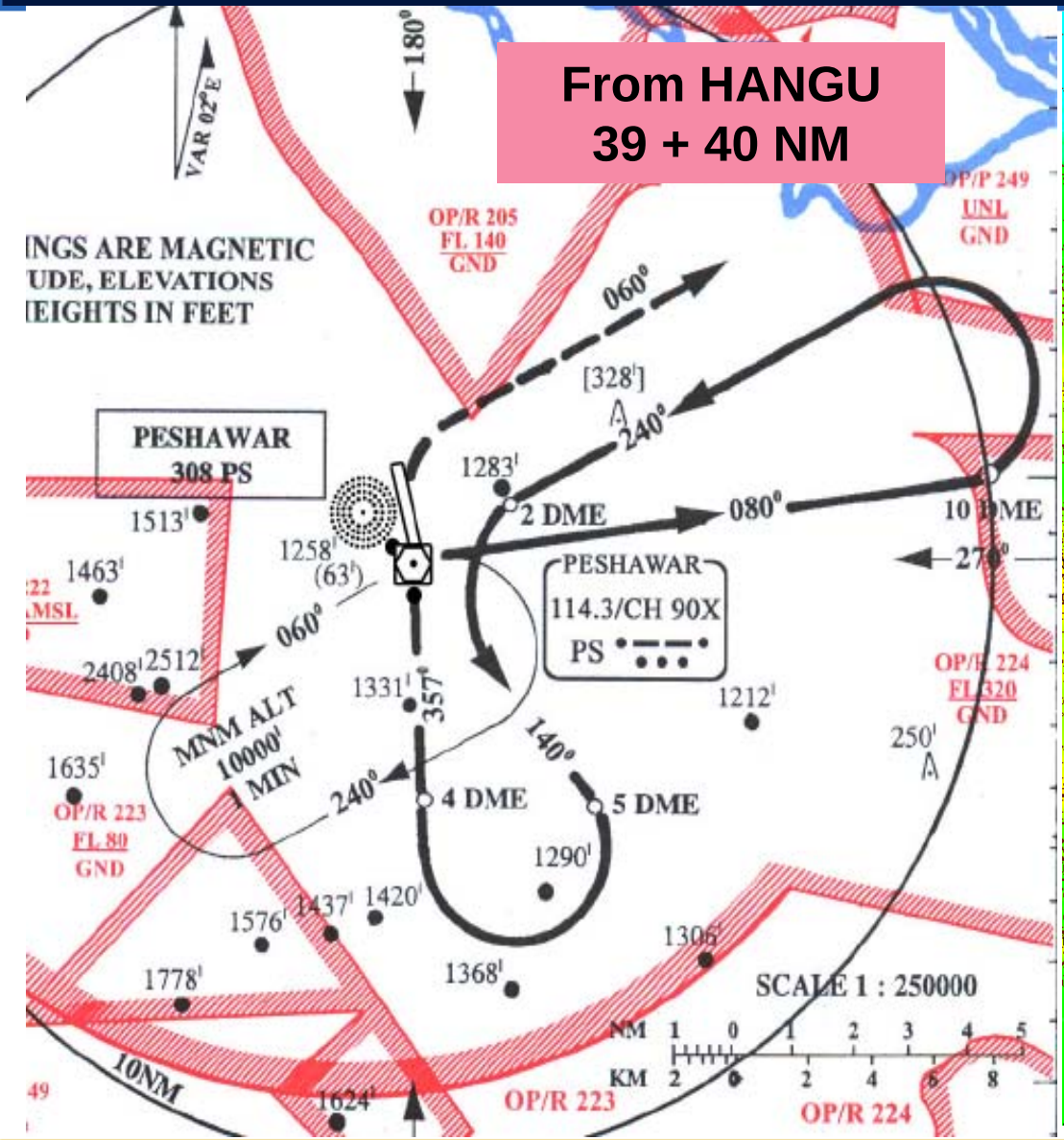
BKIAP RNAV Concept

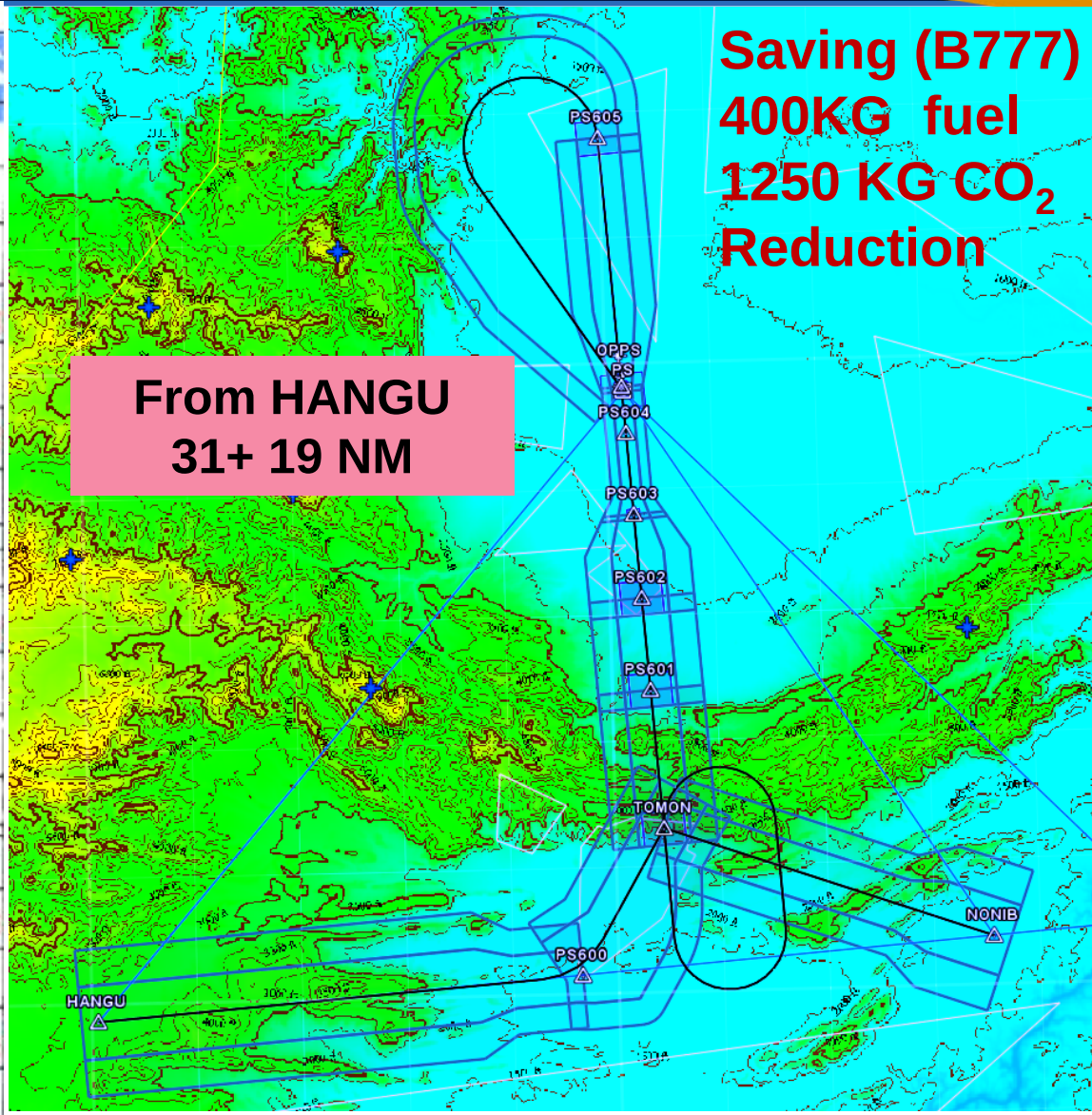


BKIAP RNAV improvement



BKIAP Peshawar - Improvement



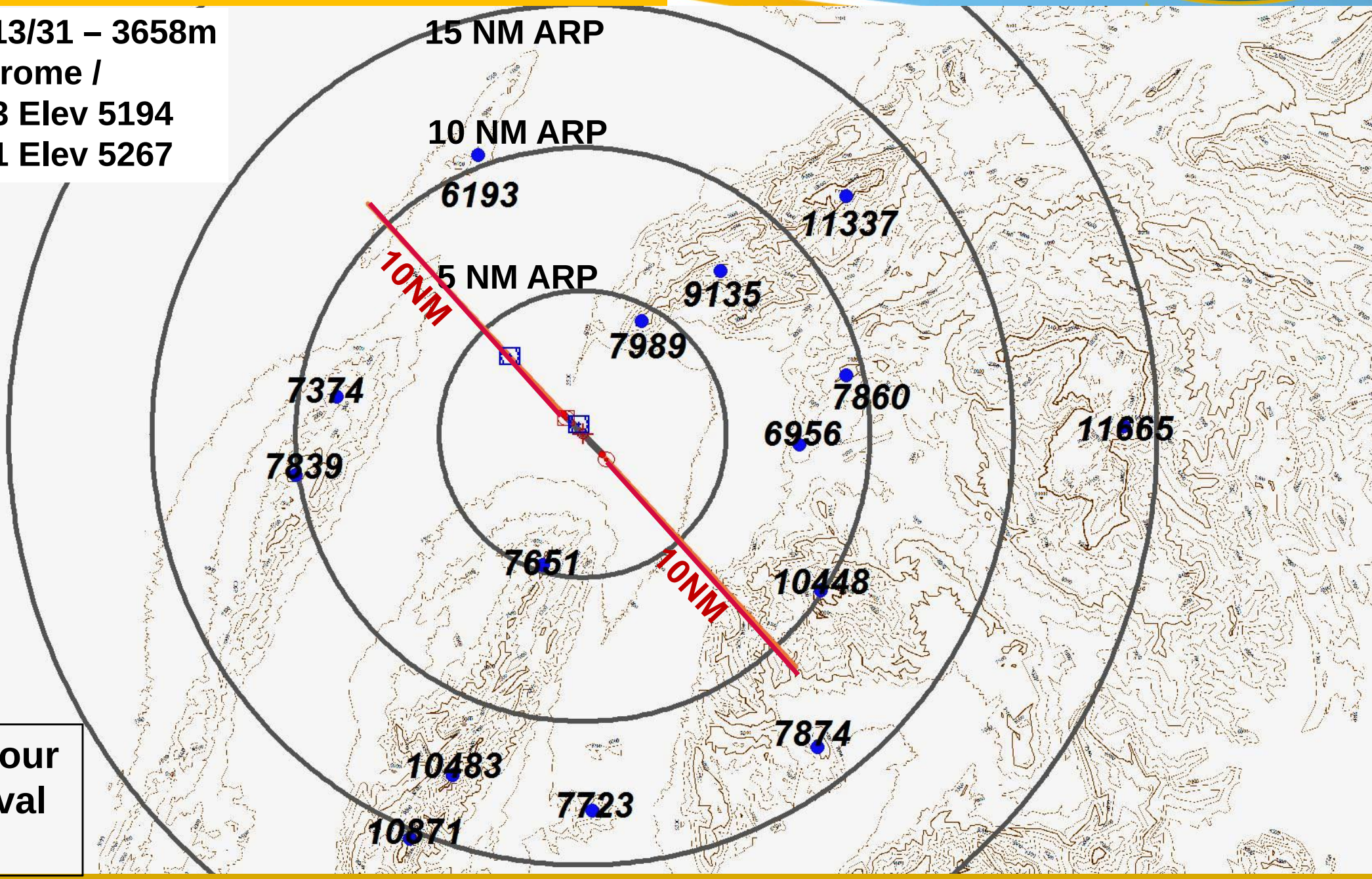


Quetta Int'l Airport

- Joint user aerodrome in Baluchistan province
- Rich terrain environment restricting instrument approach operations for RWY31 as well as significant penalty for RWY13 due to Missed Approach limitations
- Requirement to have all weather operations at the airport

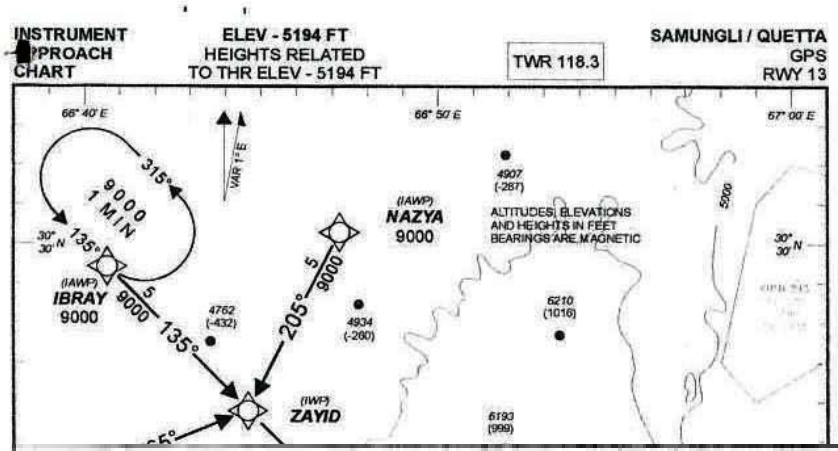
Quetta Environment

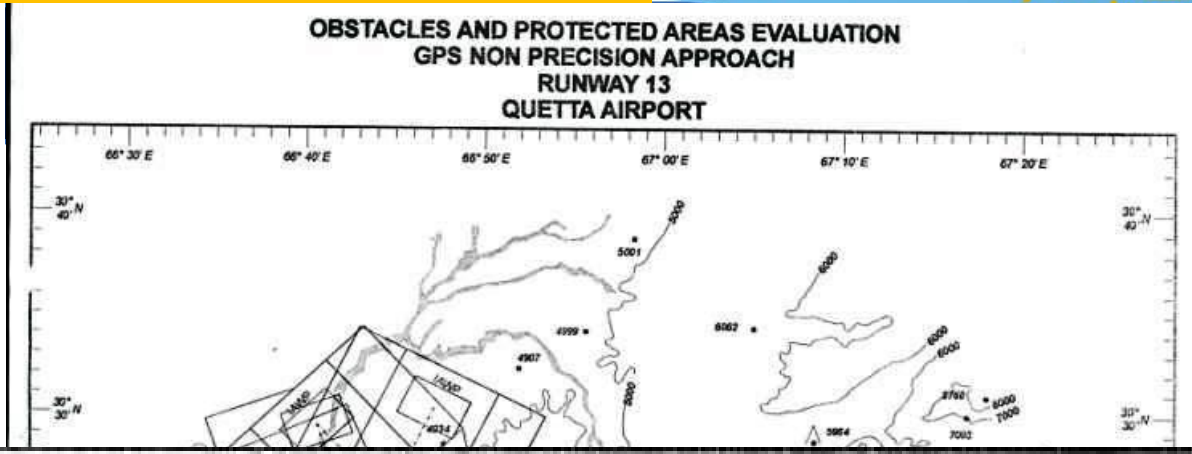
RWY 13/31 – 3658m
Aerodrome /
THR13 Elev 5194
THR31 Elev 5267

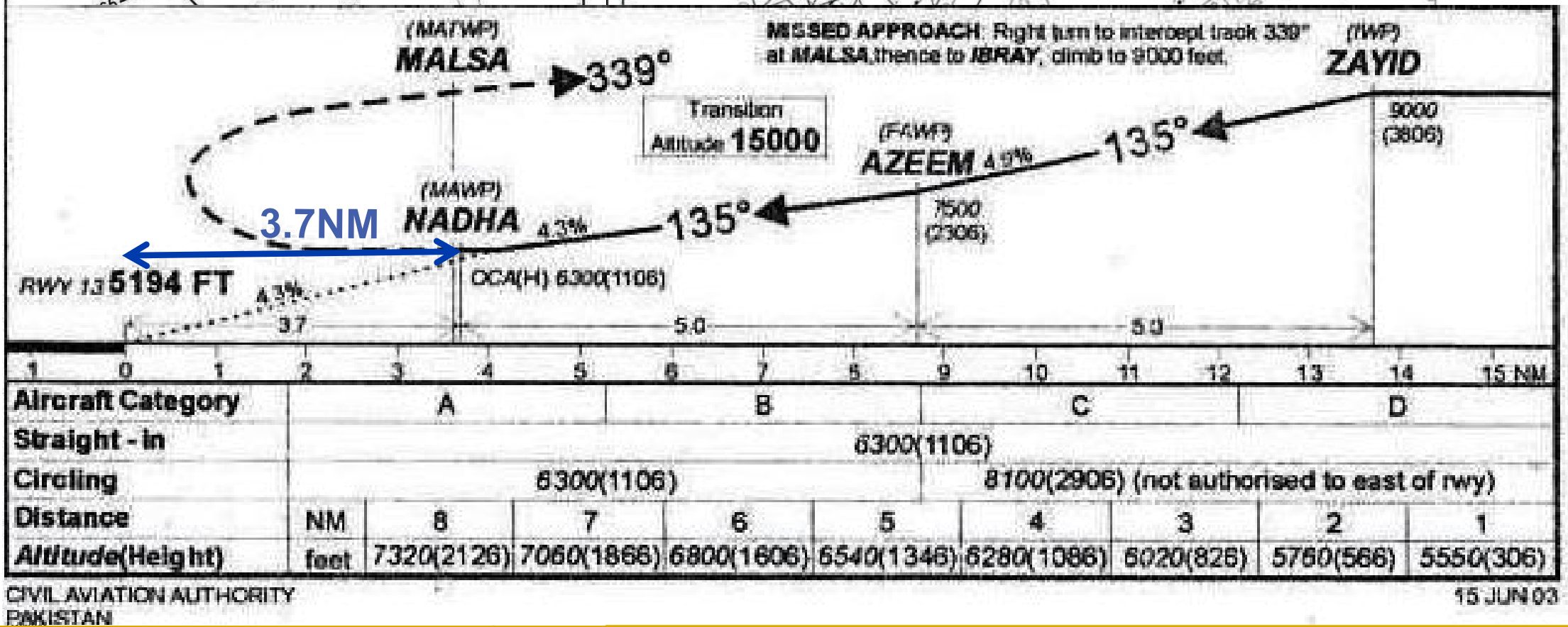


Contour Interval 500ft

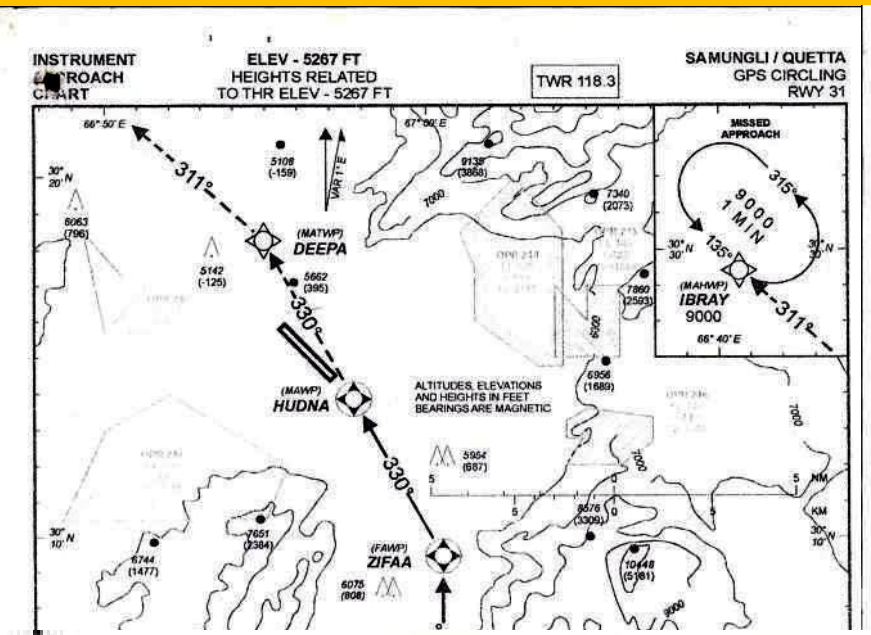
Quetta GPS RWY13 (2003)

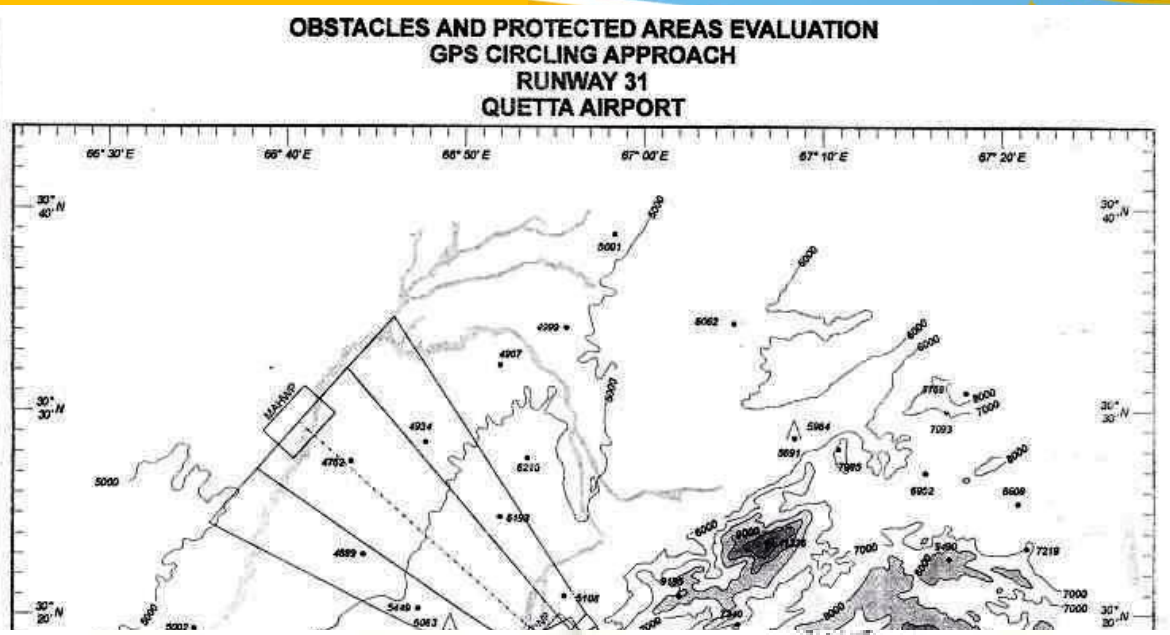


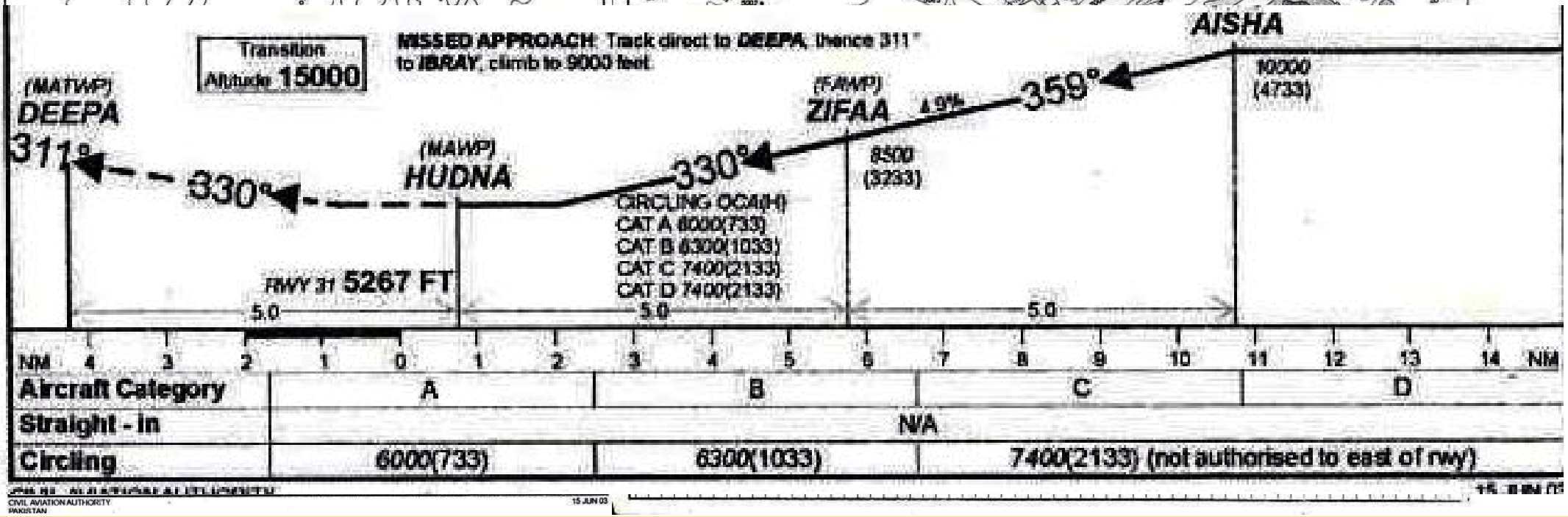




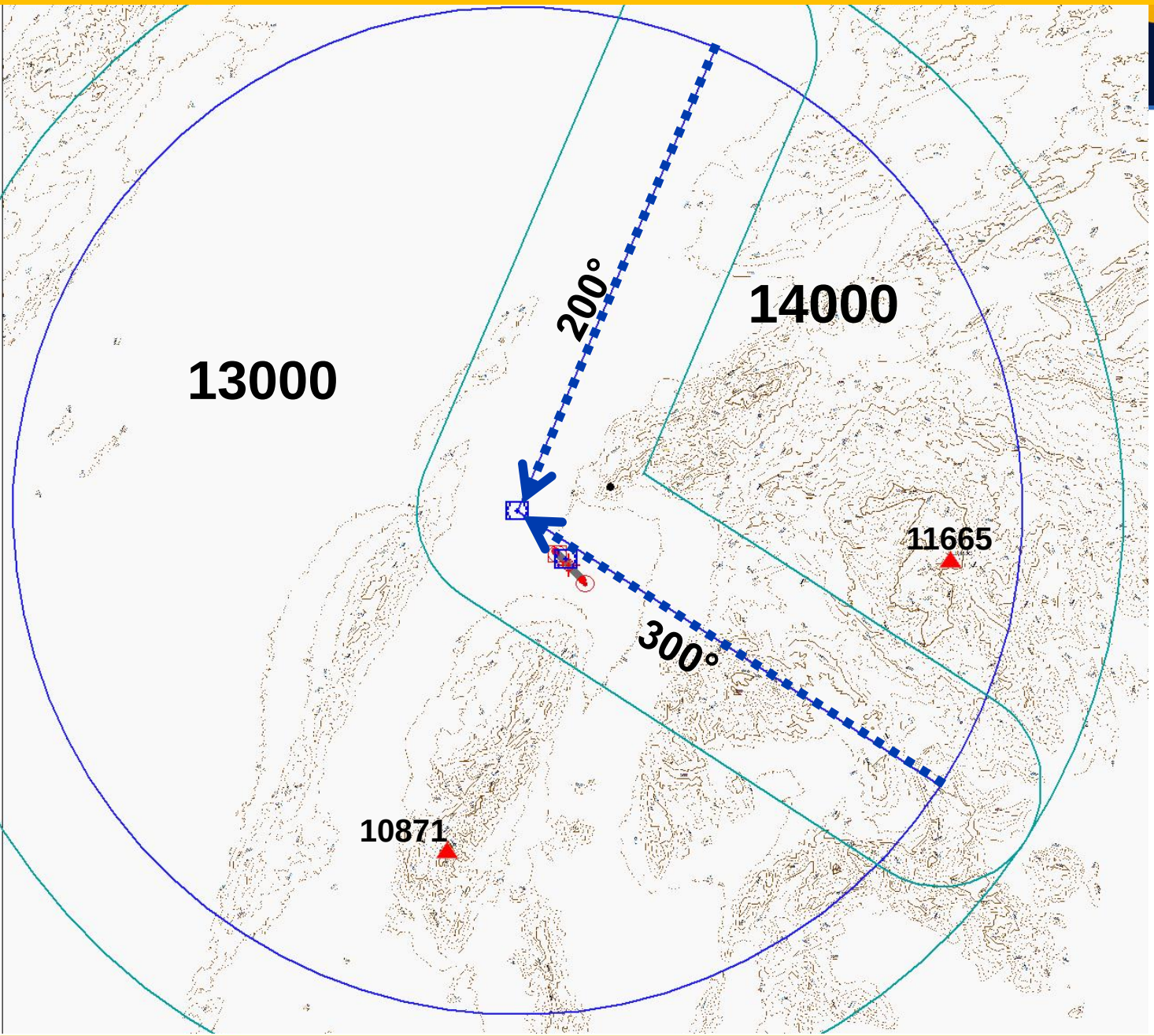
Quetta GPS RWY31 (2003)







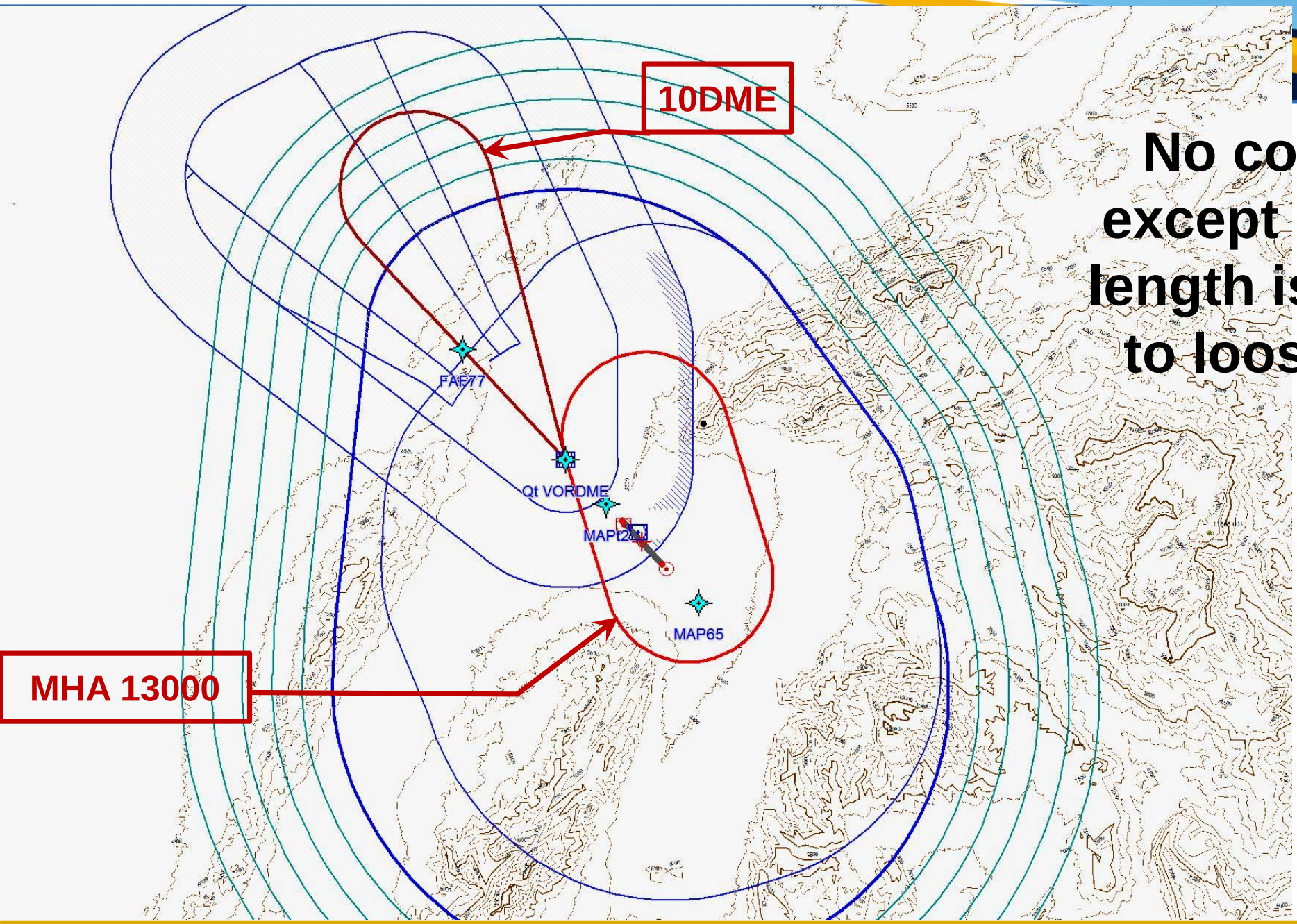
Quetta Conventional 2007



MSA

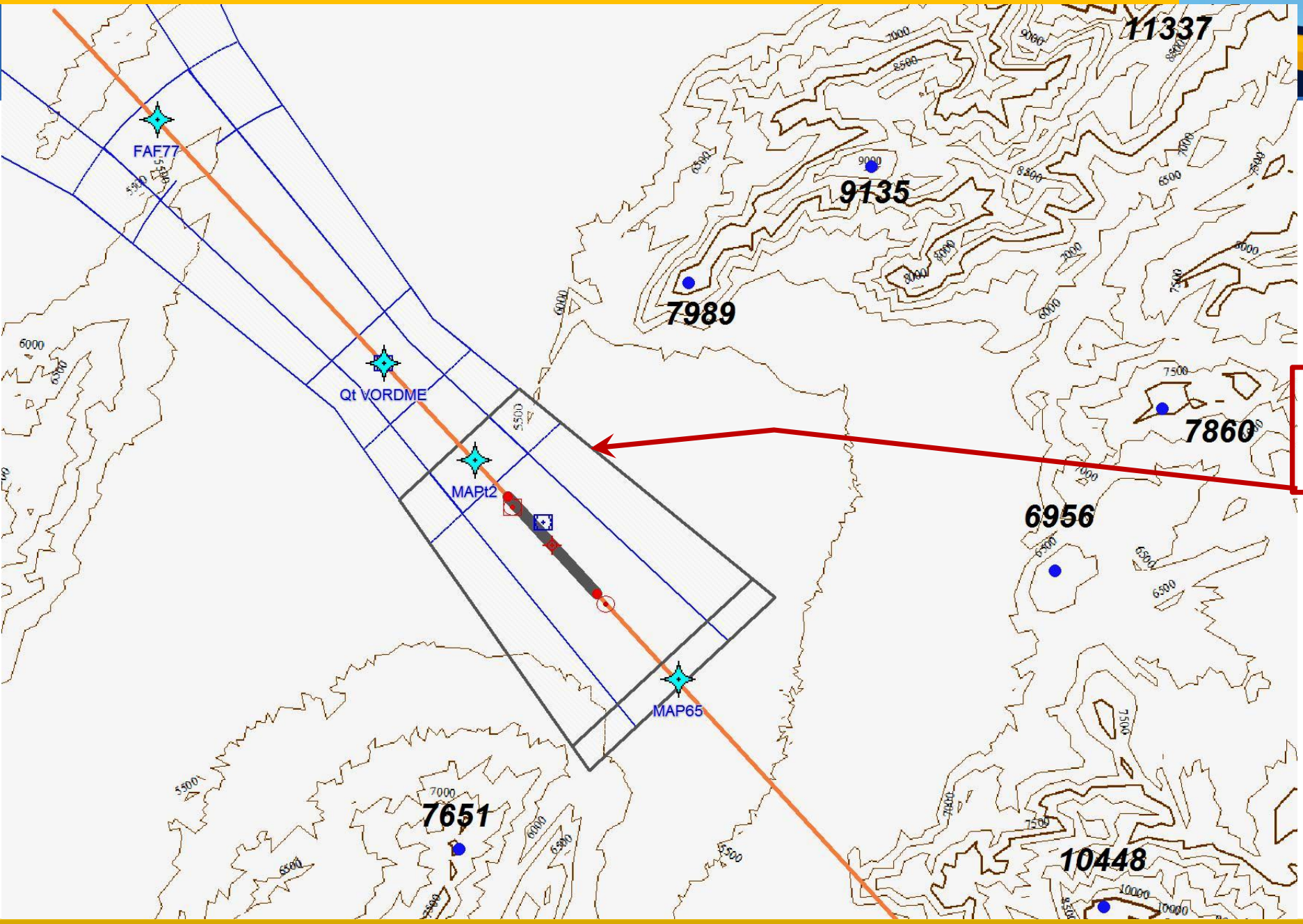
Could be lowered towards west but of no use as no route to/from west

Quetta Reversal



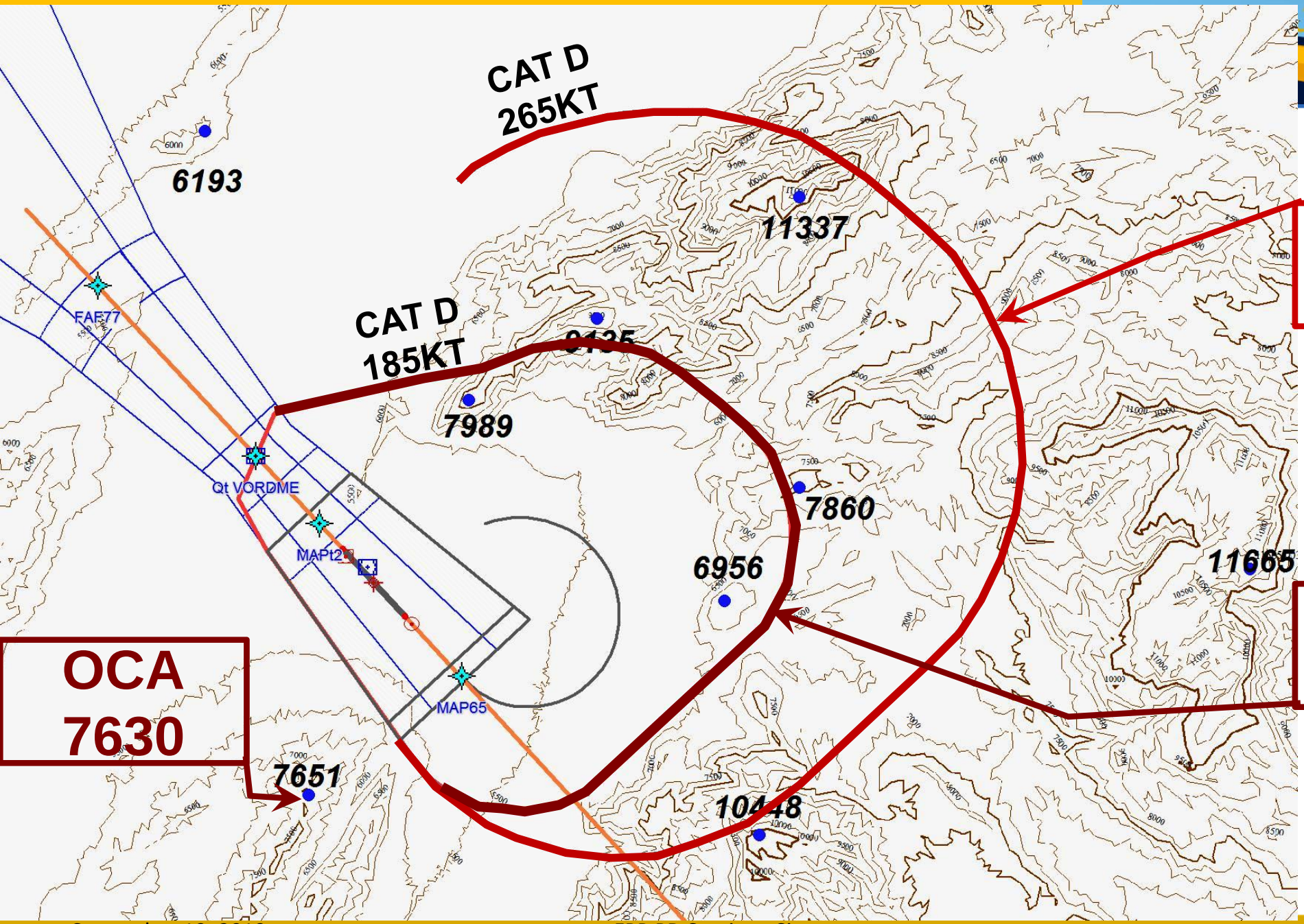
No constraint except sufficient length is required to loose height

Final & Initial Missed Approach



OCA 5740

Missed Approach Final Phase



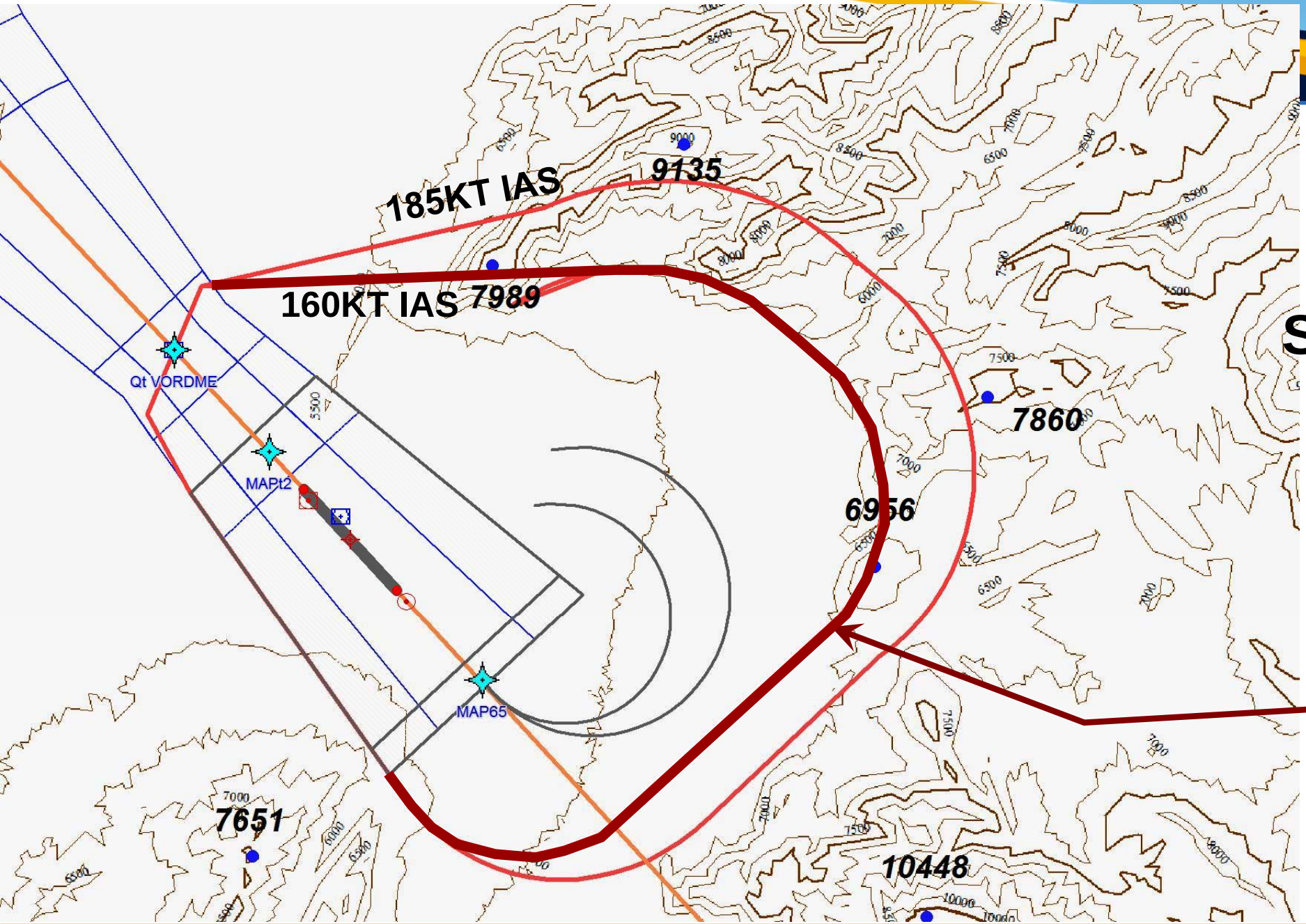
OCA 9100

Reduce speed

OCA 7170

OCA 7630

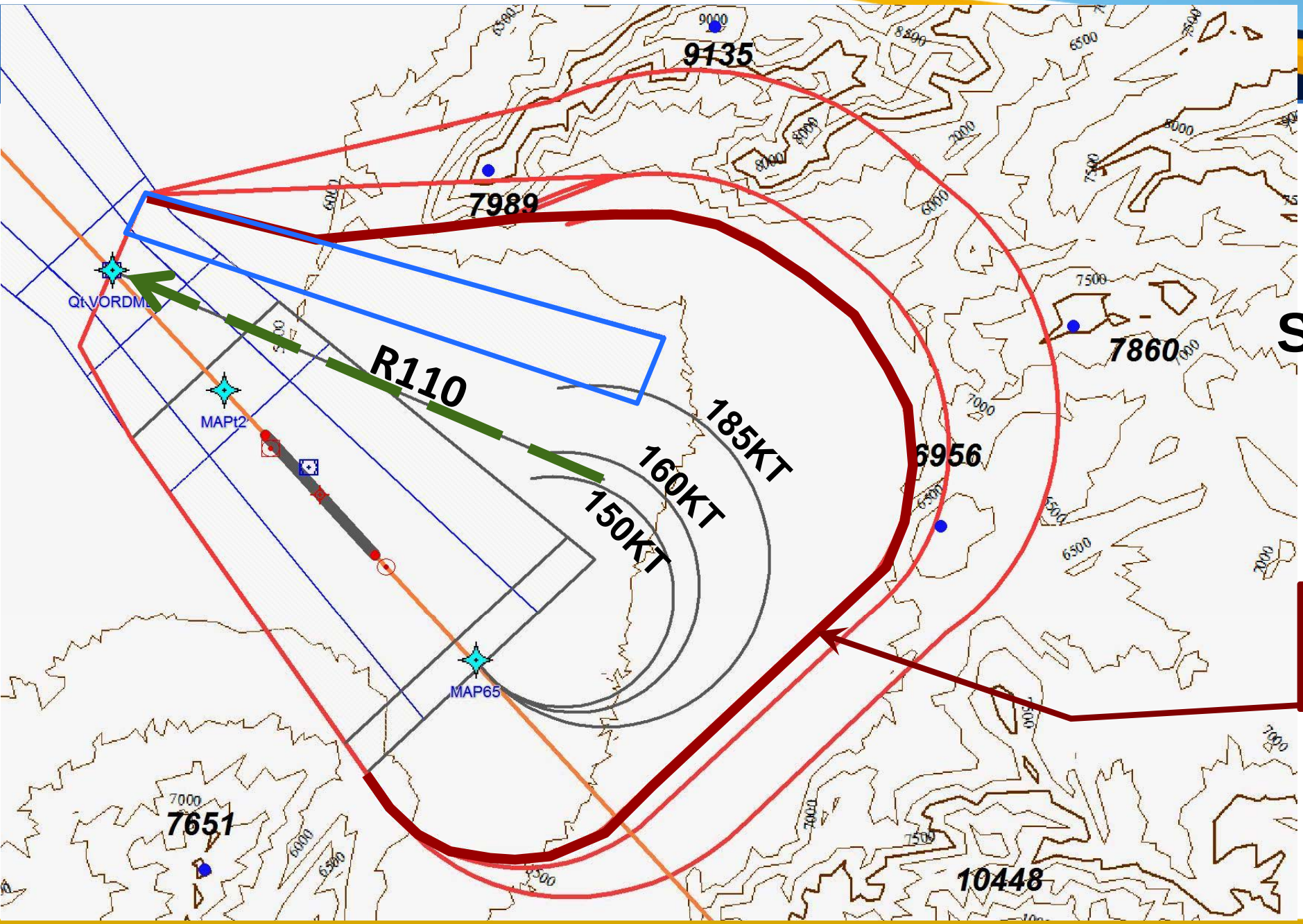
Missed Approach Final Phase



Segregate CAT C

OCA 6620

Missed Approach Final Phase



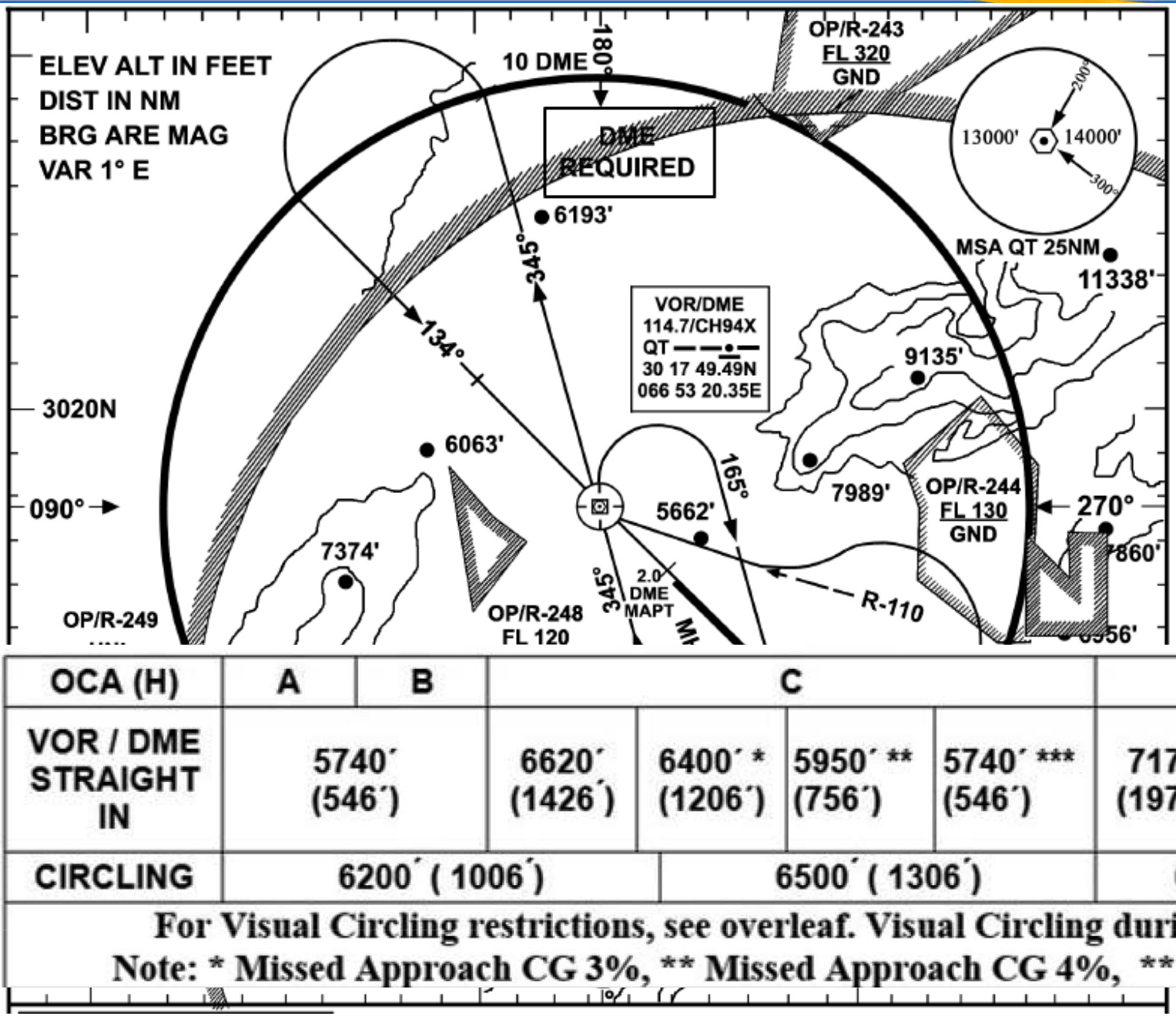
Segregate CAT A/B

OCA 5740

What else can be done

- **Facilitate Better Performance**
  - **2.5%**
  - **3.0 %**
  - **4.0 %**
  - **5.0 %**

QT VOR RWY13

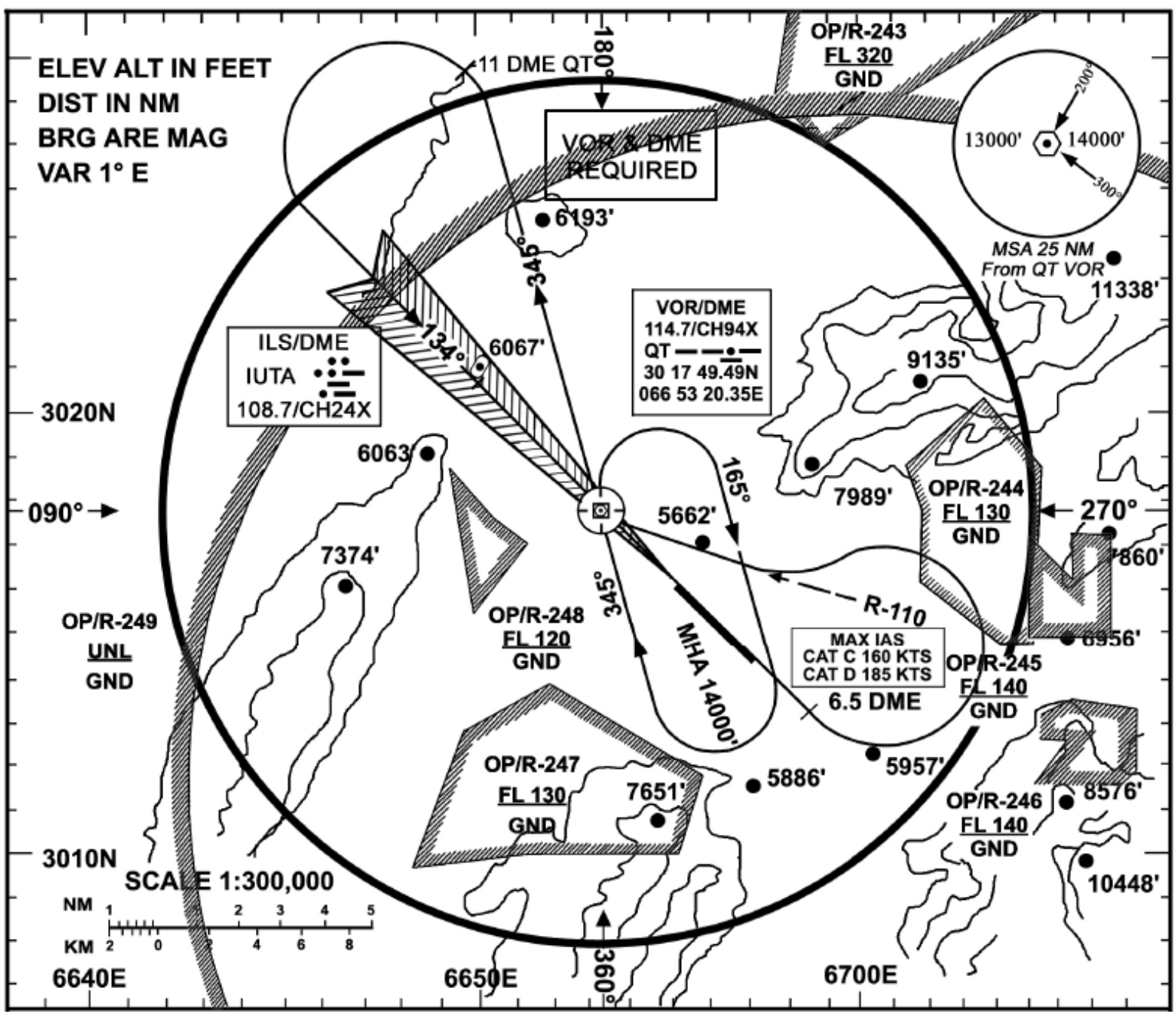


OCA (H)	A	B	C				D			
VOR / DME STRAIGHT IN	5740´ (546´)		6620´ (1426´)	6400´ * (1206´)	5950´ ** (756´)	5740´ *** (546´)	7170´ (1976´)	6900´ * (1706´)	6380´ ** (1186´)	5930´ *** (736´)
CIRCLING	6200´ (1006´)			6500´ (1306´)			6800´ (1606´) Max IAS 195Kts			

For Visual Circling restrictions, see overleaf. Visual Circling during night not authorized.

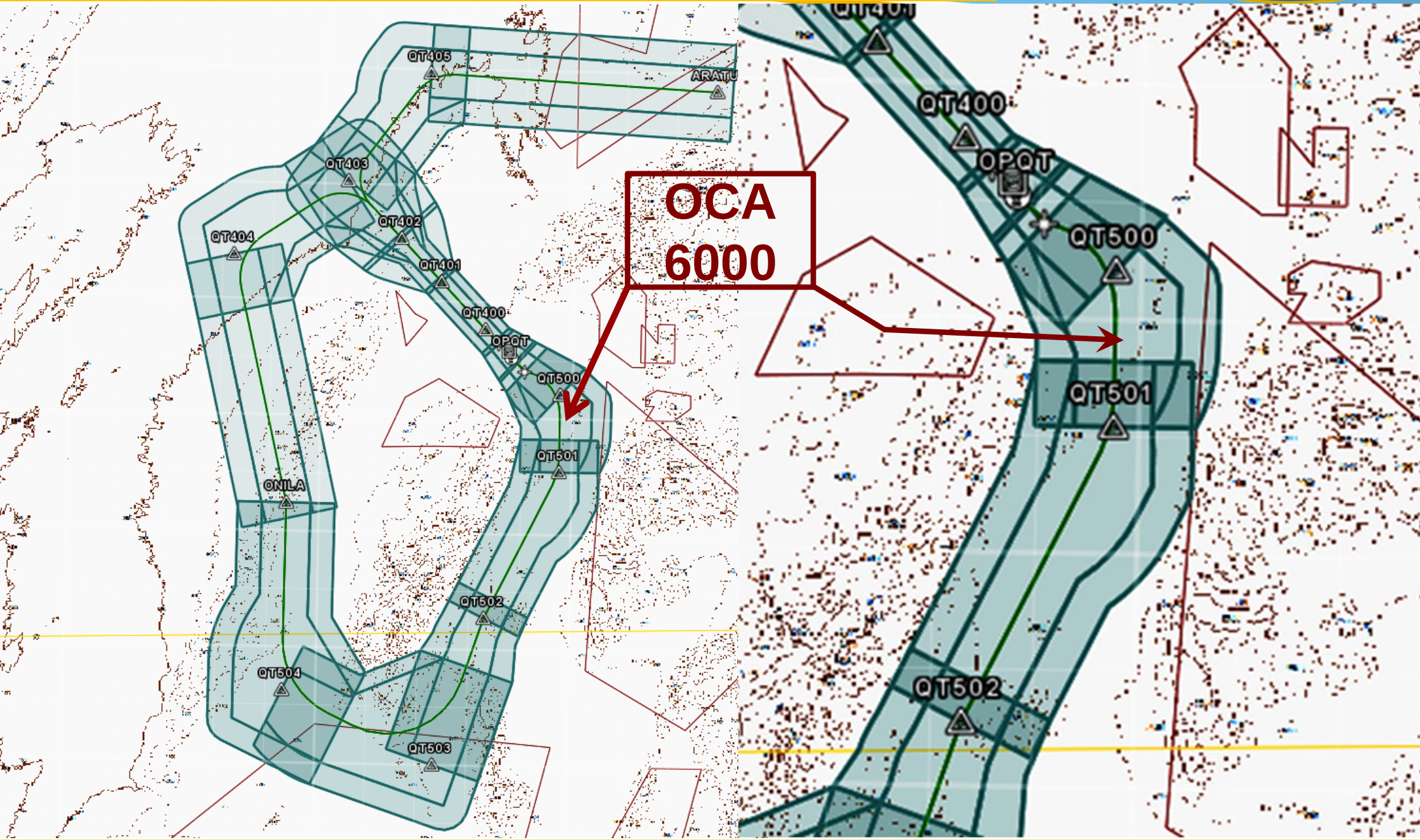
Note: * Missed Approach CG 3%, ** Missed Approach CG 4%, ***Missed Approach CG 5%

QT ILS RWY13 (2009)

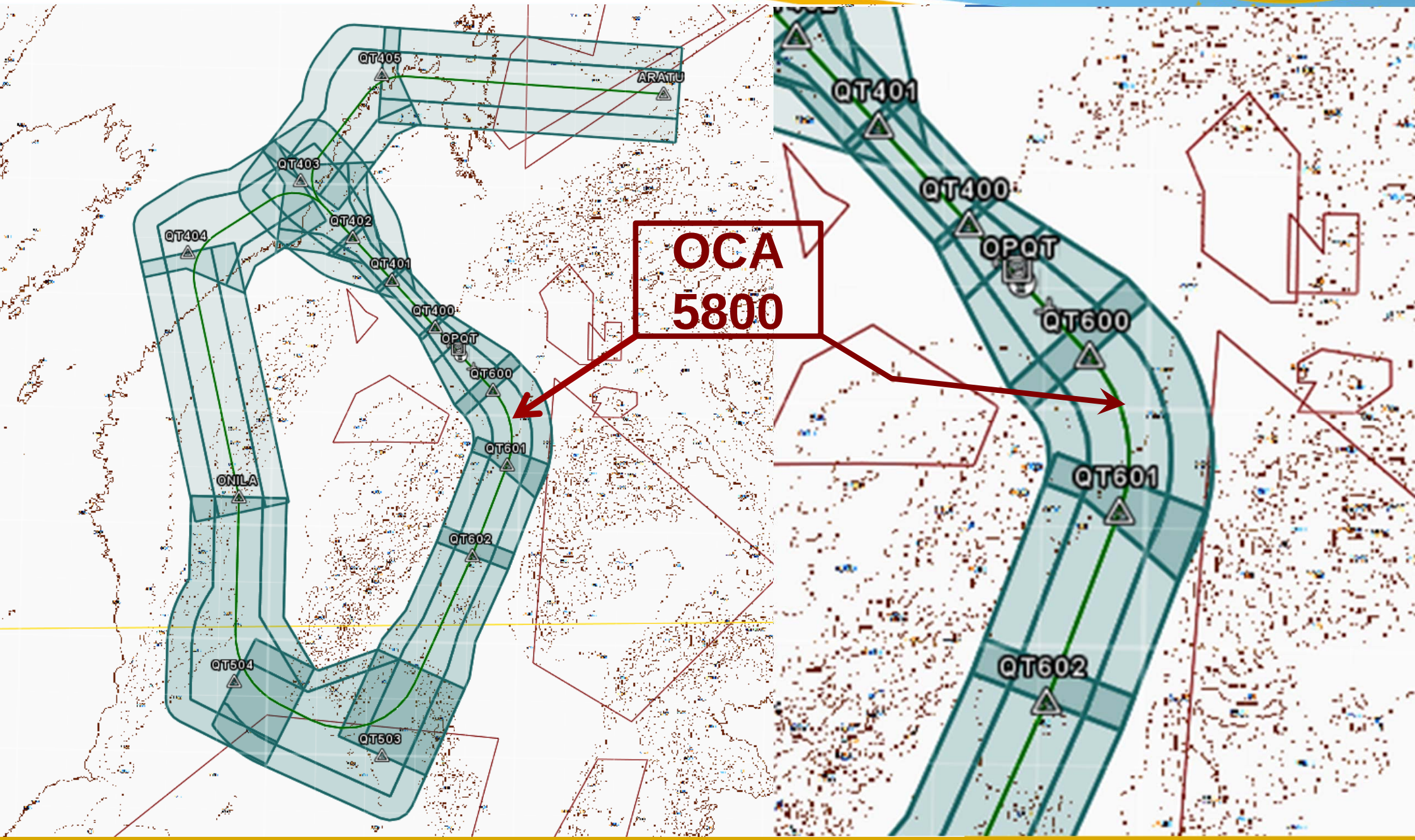


Similar Philosphy for ILS RWY13

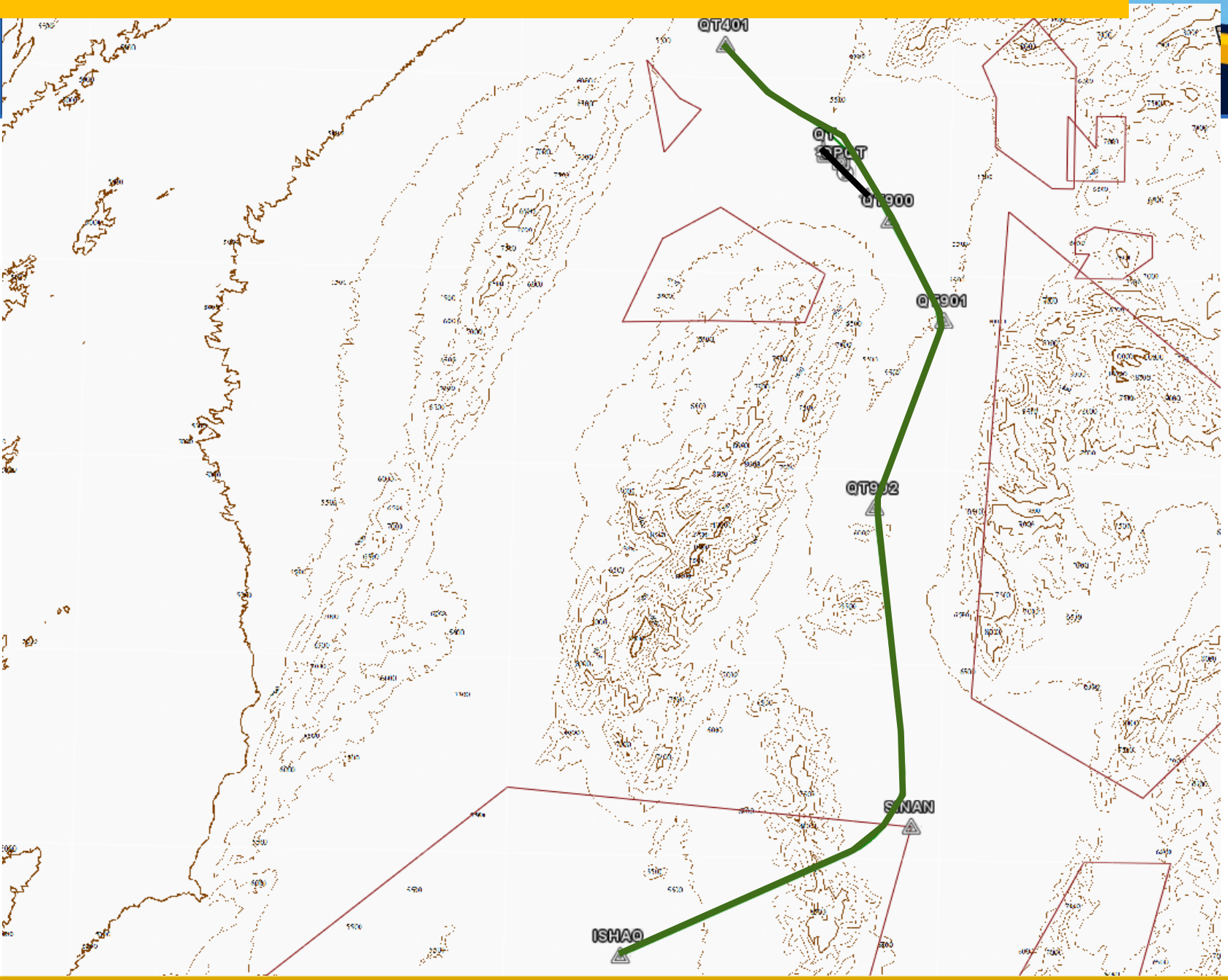
QT RNP RWY13 (MA TF Legs)



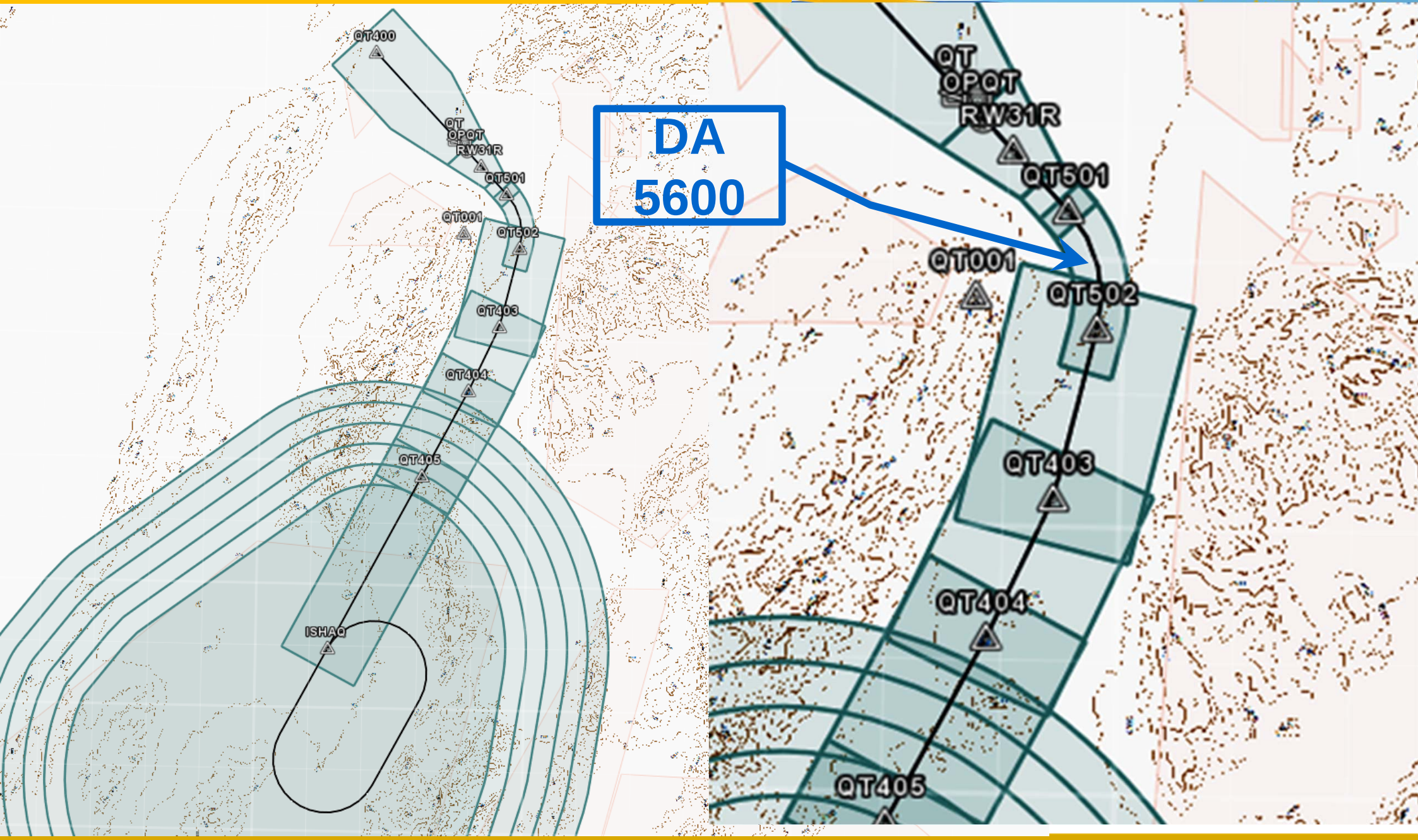
QT RNP RWY13 (MA – RF leg)



QT RWY31 RNAV Visual Concept



QT RWY31 RNP AR

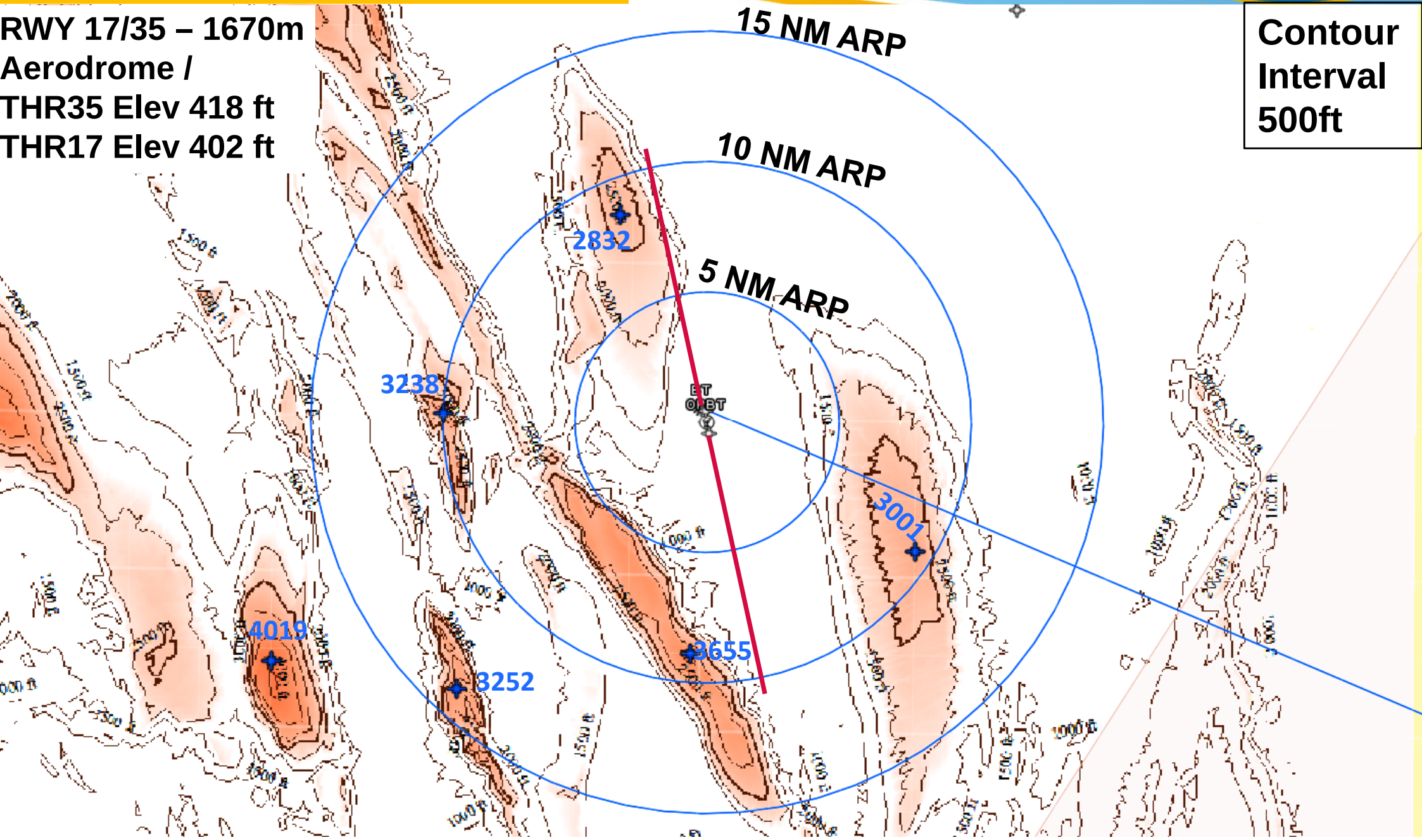


Bhit Private Aerodrome

- Private aerodrome to provide Logistic Support for nearby gas field
- Requirement to have IFR operation due weather and support night operation for any contingency

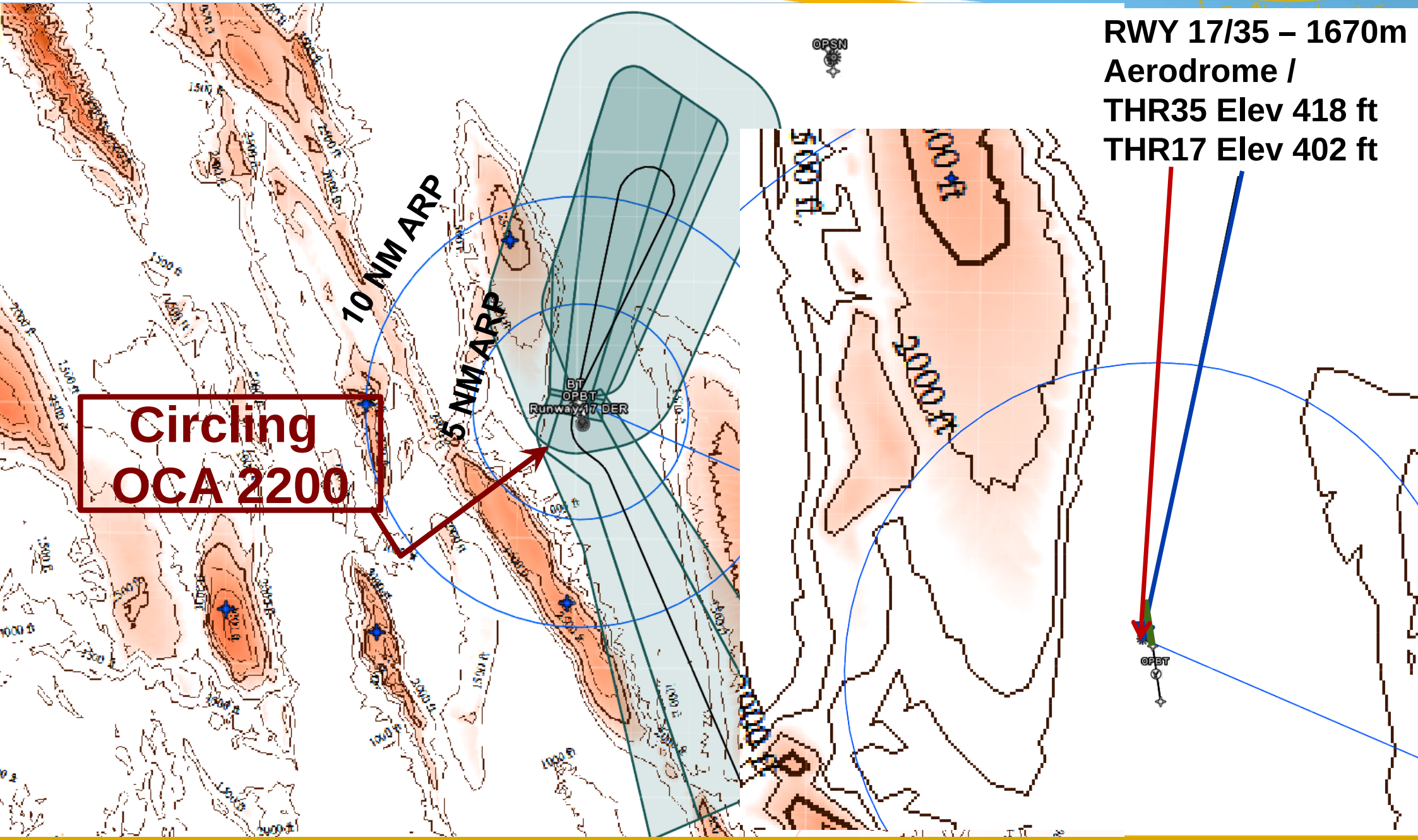
Bhit Environment

RWY 17/35 – 1670m
Aerodrome /
THR35 Elev 418 ft
THR17 Elev 402 ft

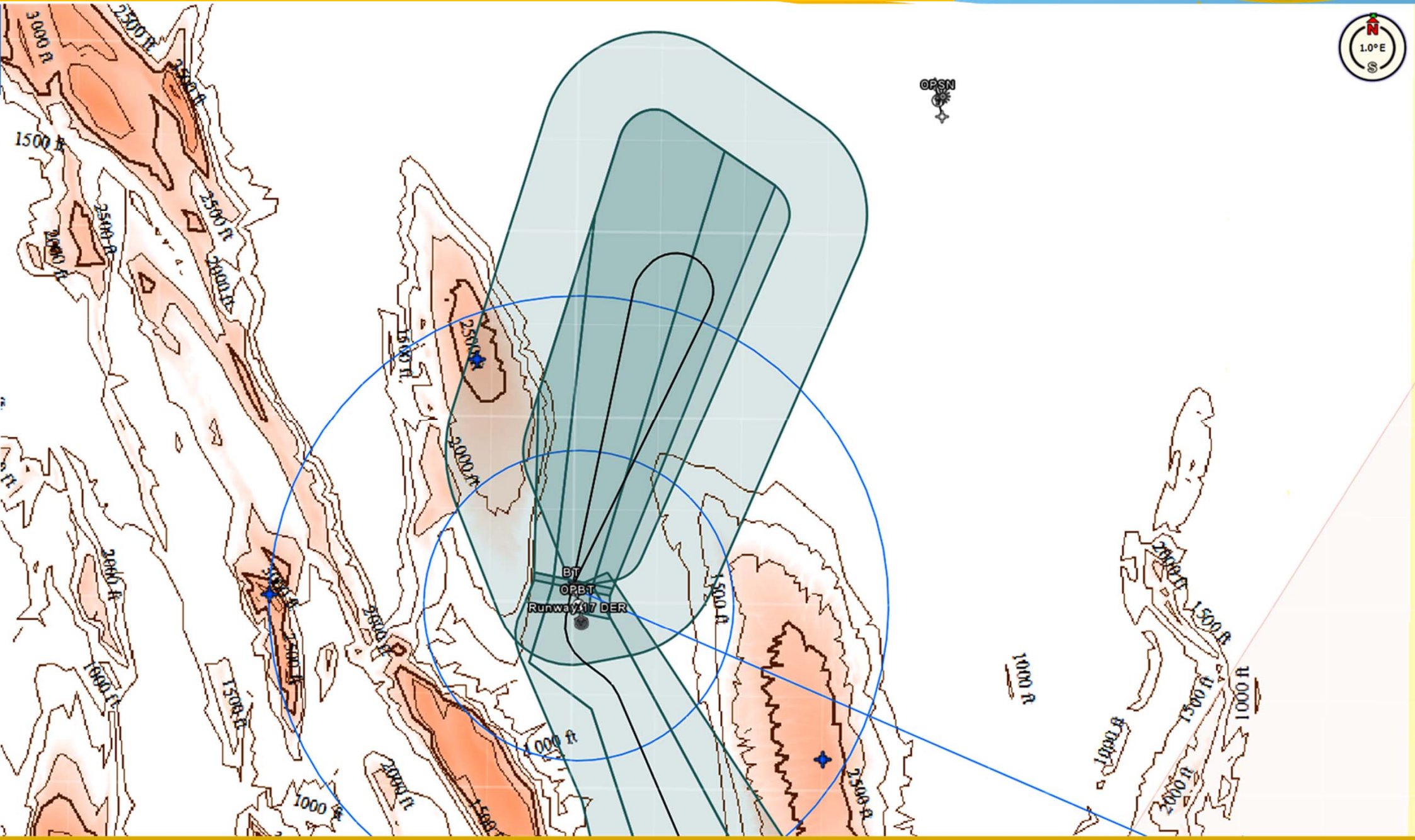


Contour Interval 500ft

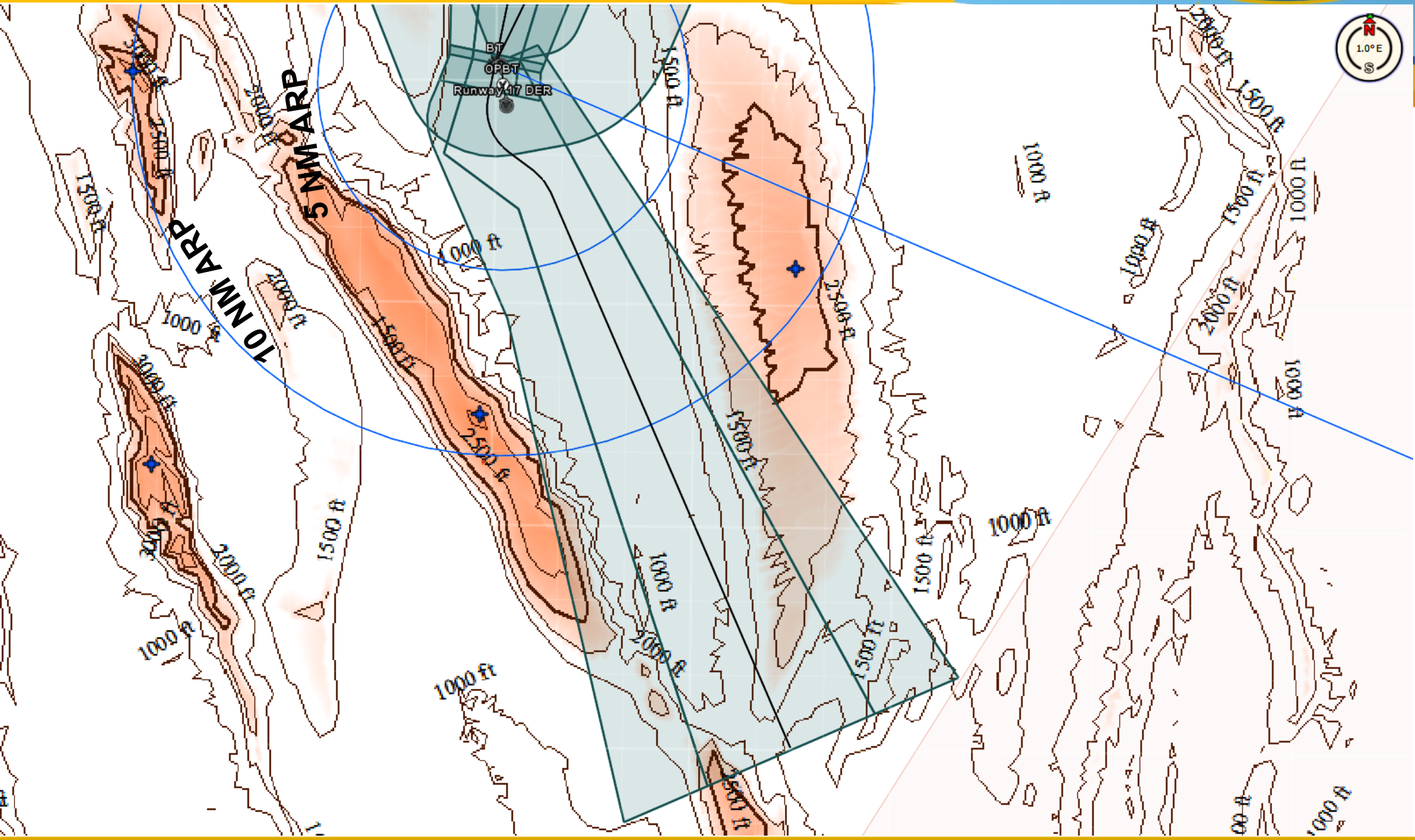
Bhit NDB RWY17



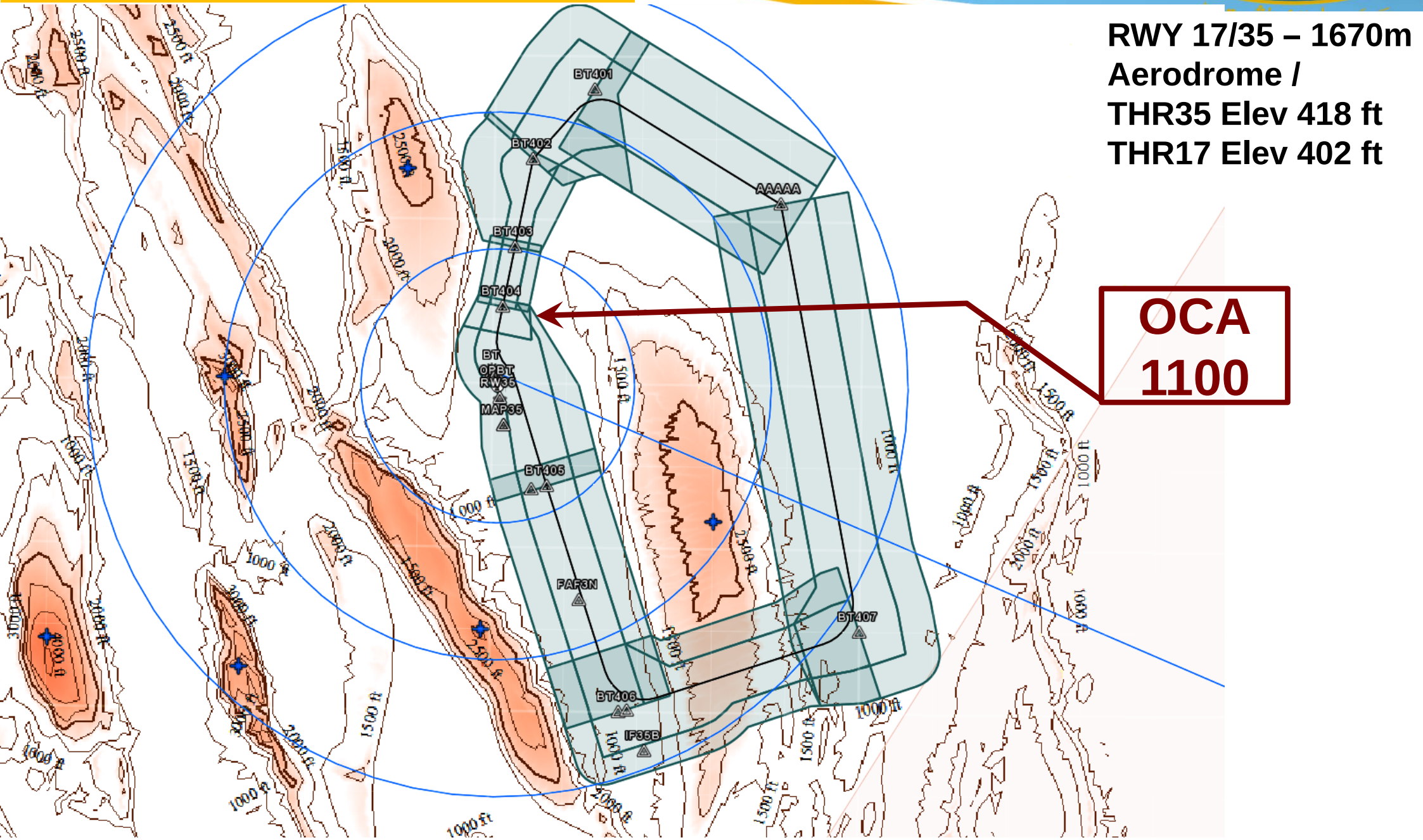
Bhit NDB RWY17 Initial / Final



Bhit NDB RWY17 Missed App



Bhit RNP RWY17



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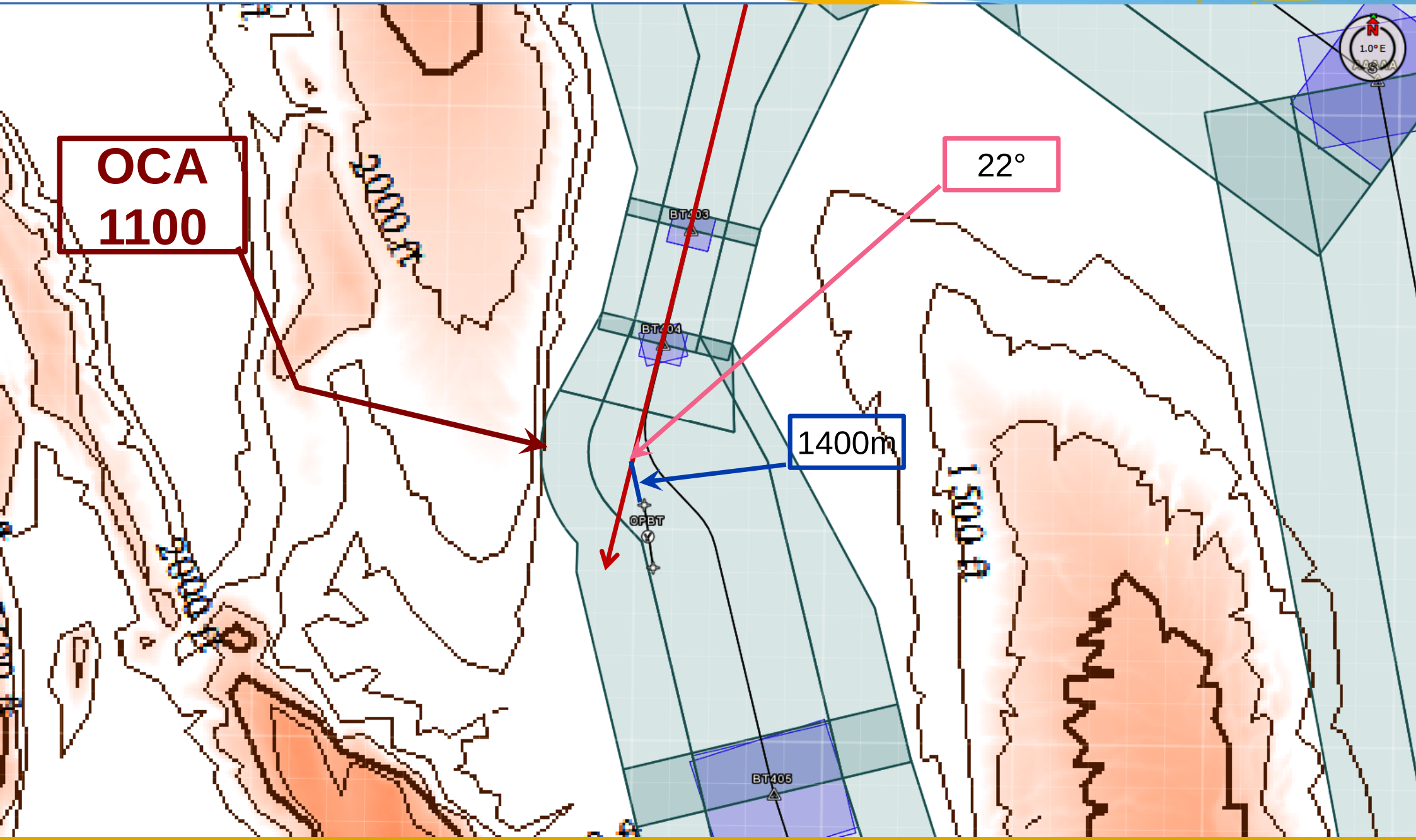
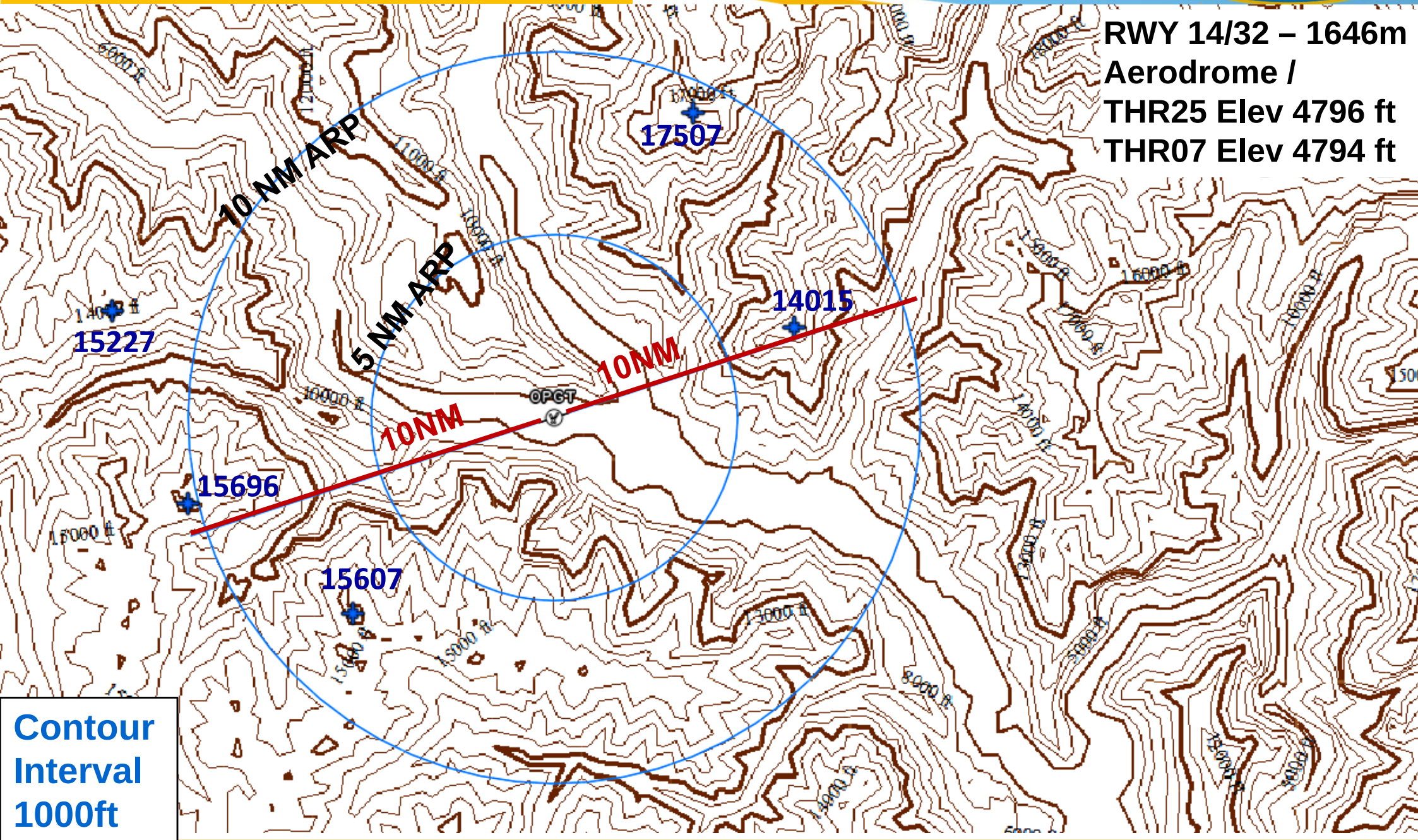


Typical Examples on way forward

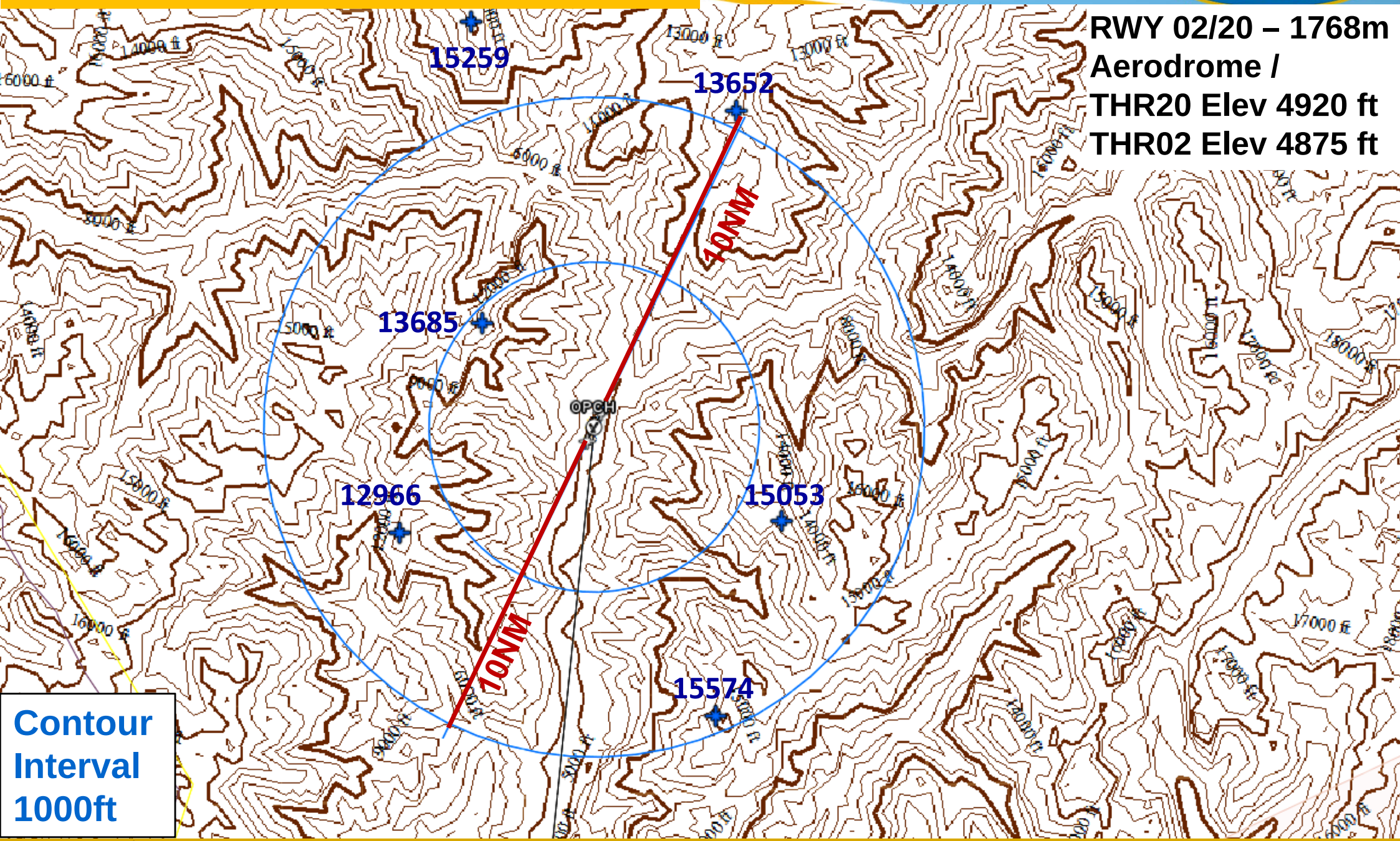
Gilgit /Chitral Airports

- Typical terrain surrounded airports having operation using ATR42-500 / ATR72-500
- Regular demand for all weather operations
- Runway alignment even at FROP at 300 feet above aerodrome impracticable
- Similar constraints for missed approach
- VFR operation with specific crew by RPT holders
- RNAV Visual, may lead to improvement on profile but in VMC only

Gilgit Environment



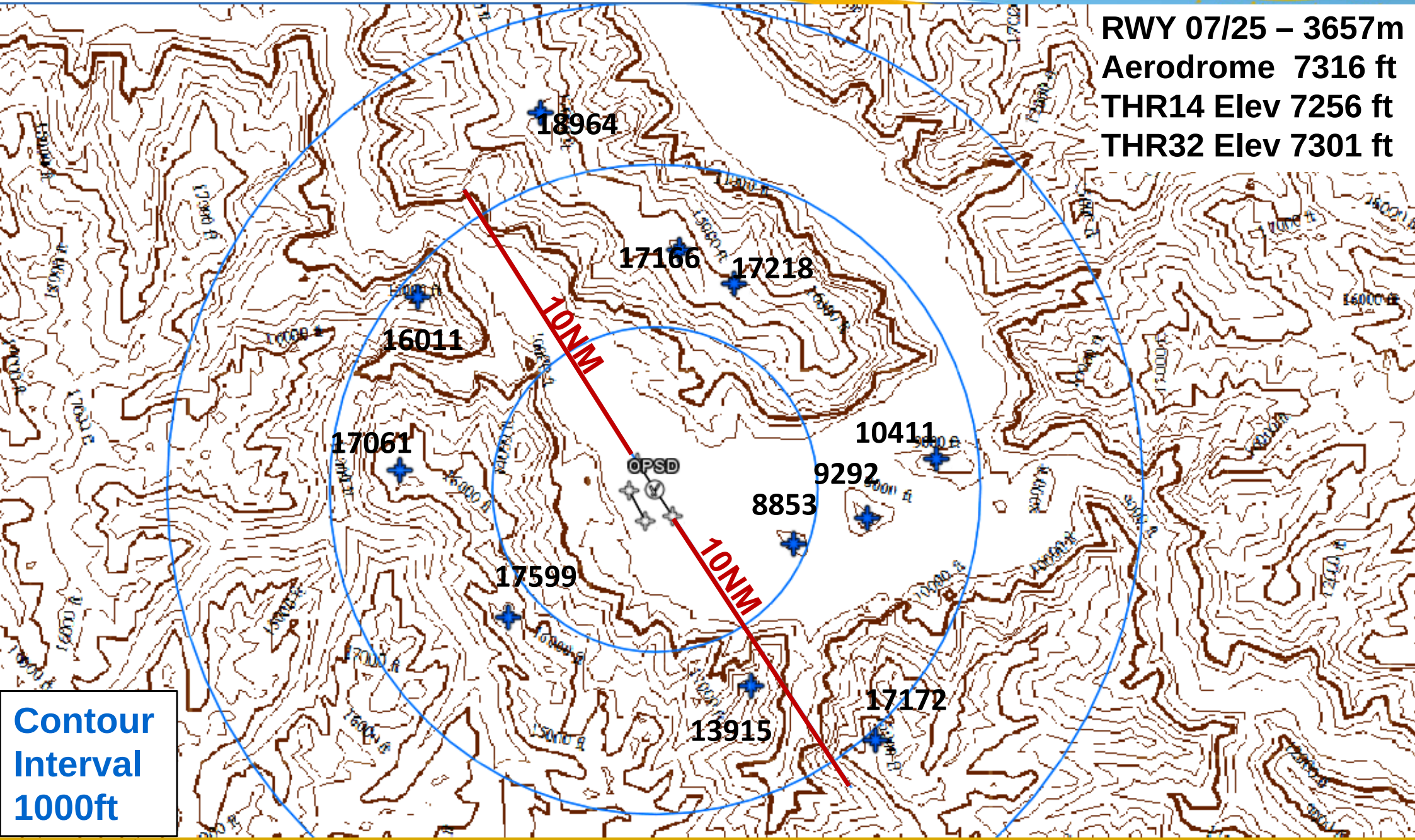
Chitral Environment



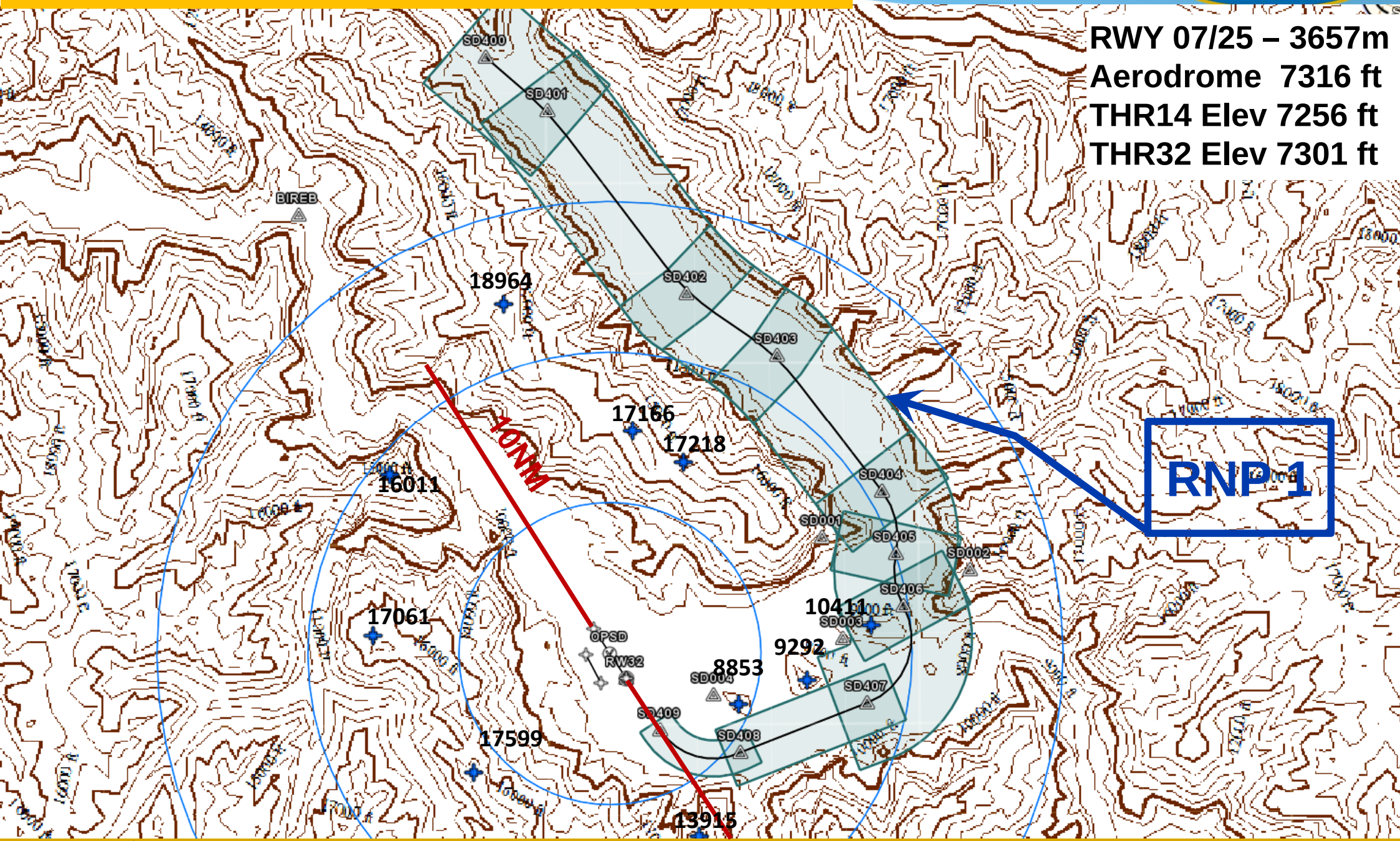
Skardu Airport

- Airport with terrain rich environment with infrastructure supporting A320 operation
- Huge demand for all weather operations
- FROP on runway axis is possible for 500ft above aerodrome
- Approach RWY14 and Missed Approach RWY32 compliant with Doc 9905 still not practicable
- Specific criteria where user can comply provisions are under consideration

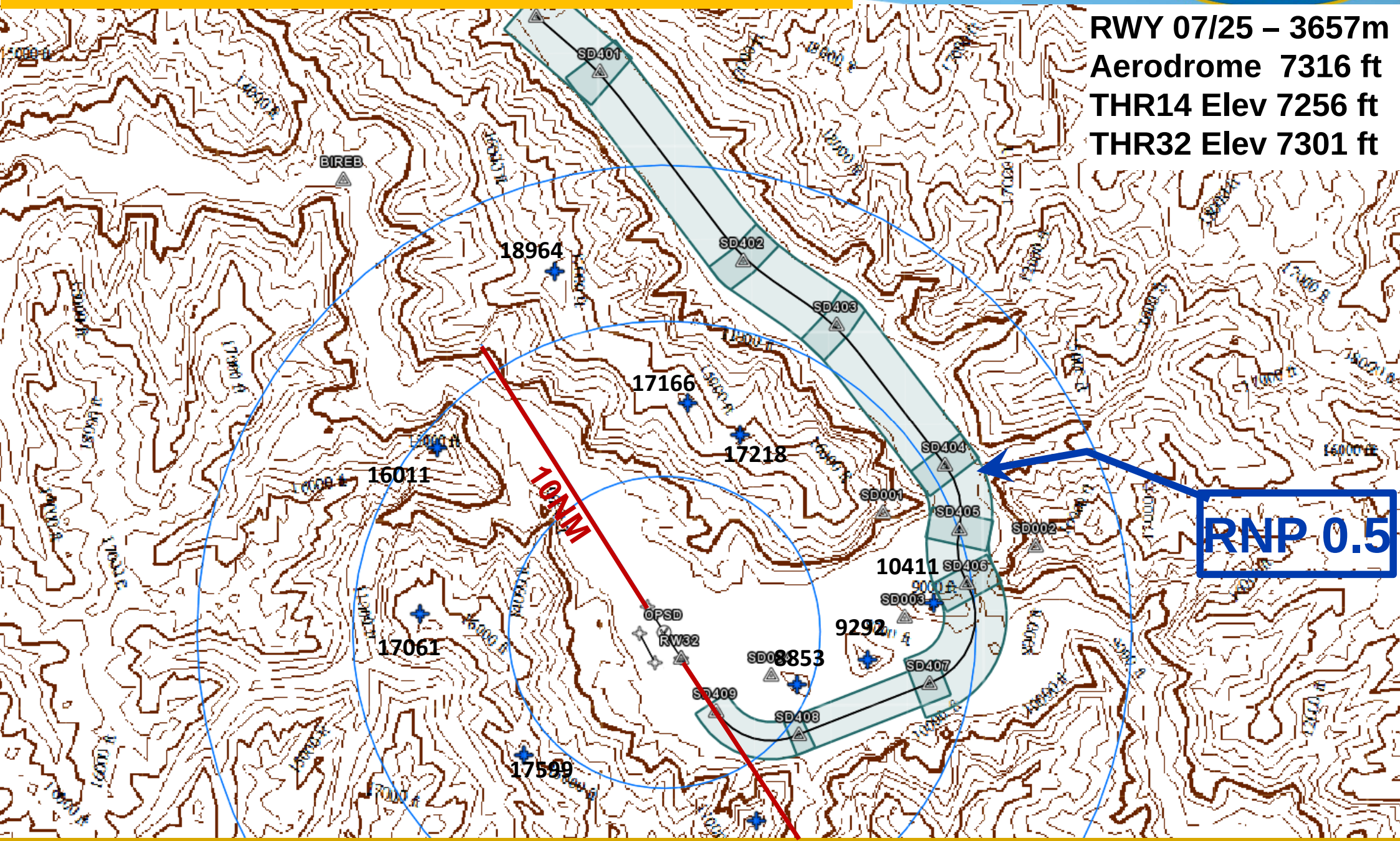
Skardu Environment



Skardu RNP AR Concept



Skardu RNP AR Concept



CONCLUSION

- With Technological Developments, access to challenging aerodromes has become more practicable in the current era
- While the access has become easier, it has significantly enhanced challenges to meet safety of aircraft operation
- IFP designer SKA provide competence to address challenges
- Challenging airports are therefore not only a design project and may be treated as new airspace concept project with involvement of all relevant stakeholders
- There may be a number of airports where all weather operations still not practicable resulting in huge demand for RNAV Visual

Questions ?