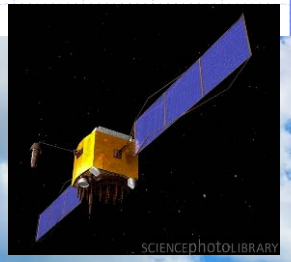
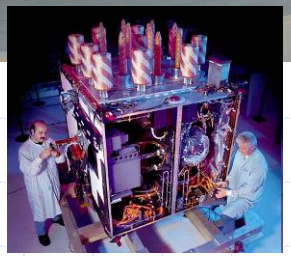
Controller Training Case Study

Implementation of new RNP AR APCH for RWY07 (North Circuit) at HKIA





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Content

1. ICAO Guidance
2. Hong Kong PBN Implementation Controller Training Strategy
3. Doc9613 Controller Training
   - Core Training
   - Training Specific to this navigation specification
4. Case Study – RNP AR APCH implementation
5. Dual Runway Ops and PBN
6. QA

ICAO Doc 9613 Performance-based Navigation (PBN) Manual

- Volume II
  - Part C – Implementing RNP Operations
    - Chapter 6 – Implementing RNP AR APCH
      - Ch. 6.2.6 Controller Training
        - Core Training
        - Training specific to this navigation specification

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Strategy

As Hong Kong decided to implement RNP1, RNP4 and RNP AR APCH, we provide Core Training based on the Doc9613 guidance on a regular basis for all controllers.

Training specific to this navigation specification is provided prior to the implementation of a new PBN procedure.

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6.2.6.2 Core training (a)

a) How RNP systems work (in the context of this navigation specification):

- include functional capabilities and limitations of this navigation specification;
- ii) accuracy, integrity, availability and continuity including on-board performance monitoring and alerting;
- iii) GPS receiver, RAIM, FDE, and integrity alerts;
- iv) waypoint fly-by versus fly-over concept (and different turn performances); and
- v) RF leg applications in RNP AR APCH procedure design;

6.2.6.2 Core training (b)(c)

- **b) Flight plan requirements;**
- **c) ATC procedures:**
  - i) ATC contingency procedures;
  - ii) separation minima;
  - iii) mixed equipage environment;
  - iv) transition between different operating environments; and
  - v) phraseology.

6.2.6.3 Training specific to this navigation specification

- **a) Related control procedures:**
  - i) vectoring techniques (where appropriate):
    - — RF leg limitations;
    - — airspeed constraints;
- **b) RNP AR APCH procedures:**
  - i) approach minima; and
  - ii) additional requests for altimeter settings;
- **c) impact of requesting a change to routing during a procedure.**

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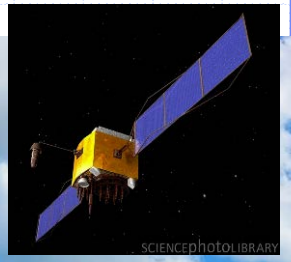
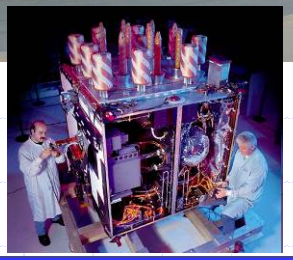
Controller Briefing

Implementation of new RNP AR APCH for RWY07 (North Circuit) at HKIA





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Content

1. Background
2. ICAO required training material for Controllers
3. Approach Procedures Details
   - Test Flight Result
4. Instruction/Guidance
5. QA

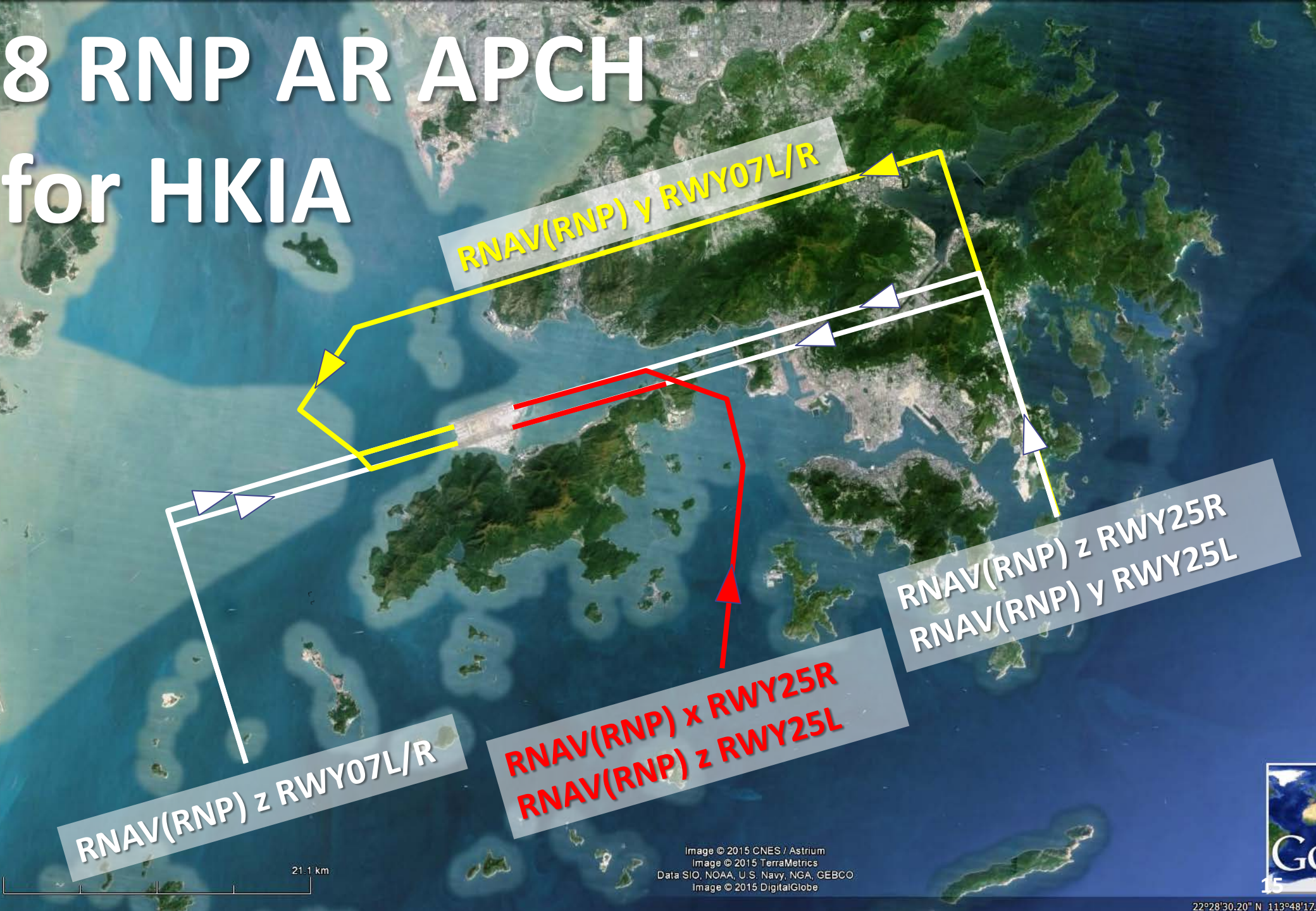
Background

- 2 RNP AR APCH published on 5 February 2015 (AIP Sup 15/14 in December 2014)
  - RNAV (RNP) y RWY 07R
  - RNAV (RNP) y RWY 07L

- Test Flight on RNAV(RNP)y RWY07L conducted on 22nd June 2015

- Full implementation: 23rd July 2015
  (OI 21/15, revised AIP Sup will be issued in due course)

8 RNP AR APCH for HKIA



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ICAO Navigation Specification for approach:

RNP APCH

VS

RNP AR APCH

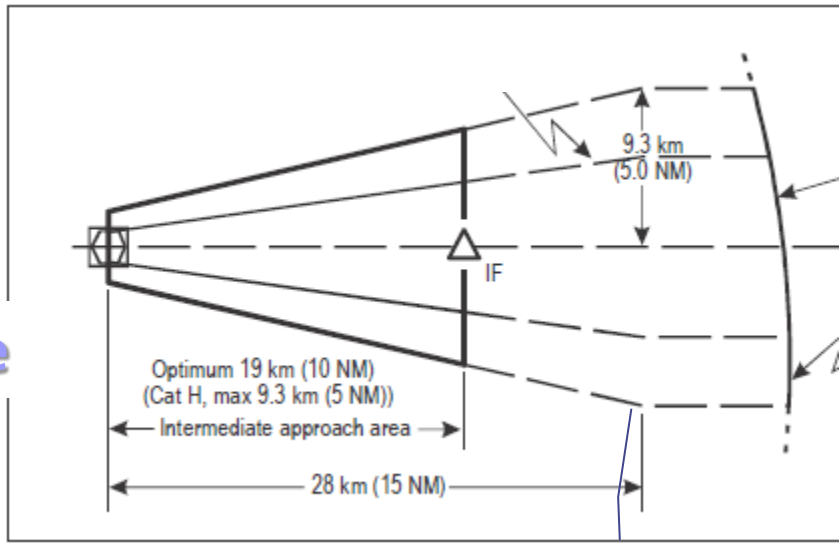
ICAO Training for RNP AR APCH implementation – 1

Part Chapter	Navigation specification	En-route oceanic/remote	En-route continental	Arrival	Approach				DEP
					Initial	Intermediate	Final	Missed[1]	
B, Ch.1	RNAV 10	10							
B, Ch.2	RNAV 5[2]		5	5					
B, Ch.3	RNAV 2		2	2					2
B, Ch.3	RNAV 1		1	1	1	1		1	1
C, Ch.1	RNP 4	4							
C, Ch.2	RNP 2	2	2						
C, Ch.3	RNP 1[3]			1	1	1		1	1
C, Ch.4	Advanced RNP (A-RNP)[4]	2[5]	2 or 1	1	1	1	0.3	1	1
C, Ch.5	RNP APCH[6]				1	1	0.3[7]	1	
C, Ch.6	RNP AR APCH				1-0.1	1-0.1	0.3-0.1	1-0.1	
C, Ch.7	RNP 0.3[8]		0.3	0.3	0.3	0.3		0.3	0.3

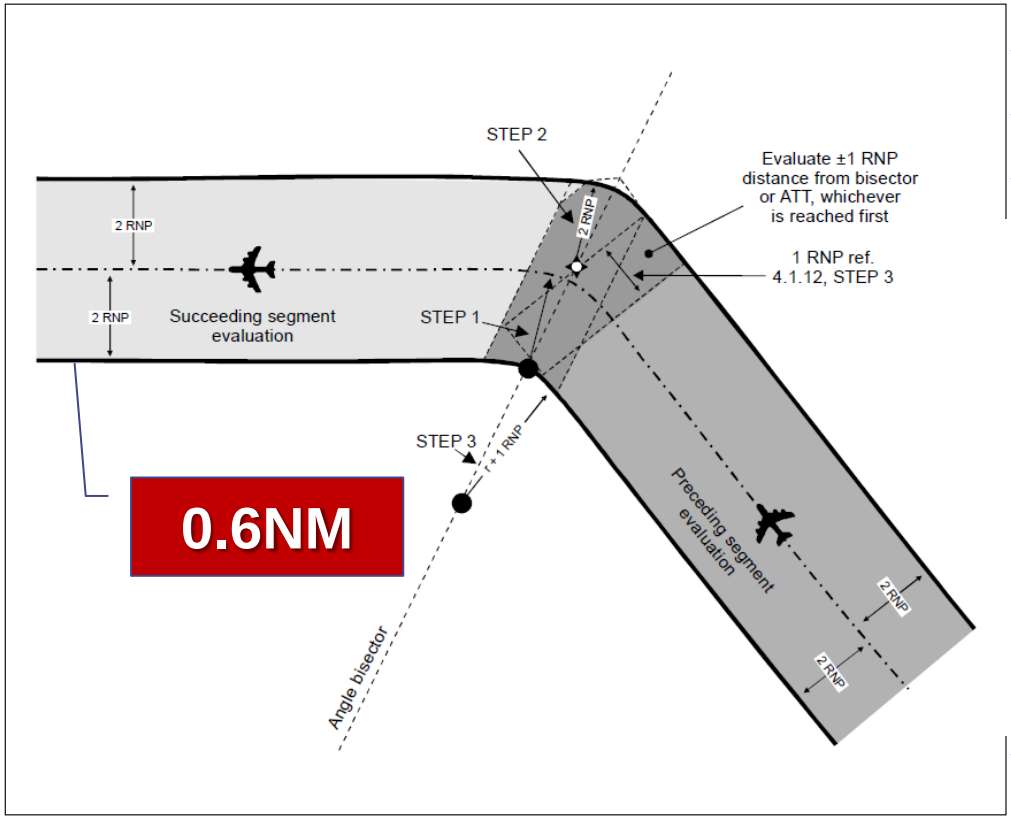
- ICAO Doc 9613 PBN Manual 4th edition

Why AR for Hong Kong?

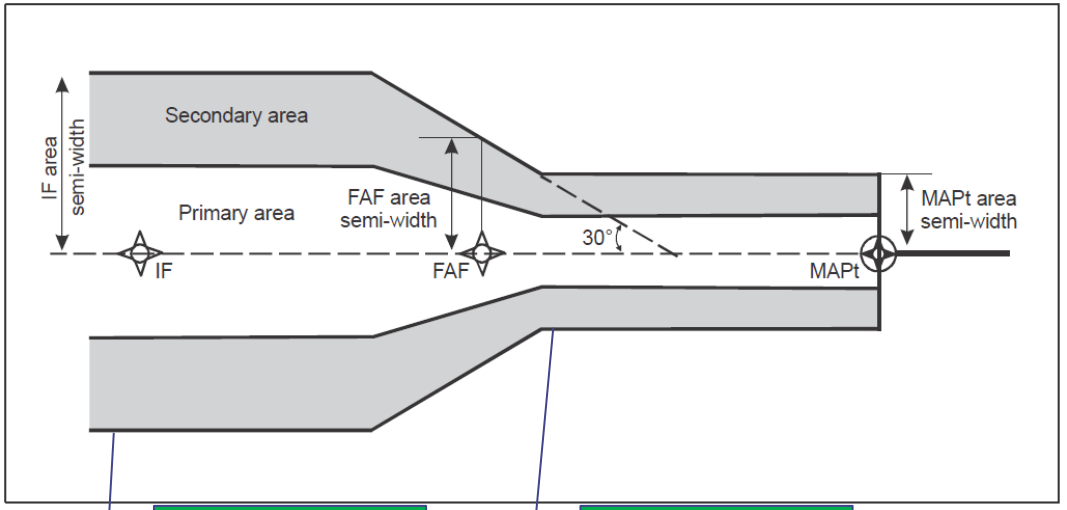
Conventional Procedure



5NM



0.6NM



2.5NM

0.95NM

RNP AR APCH Protection Area

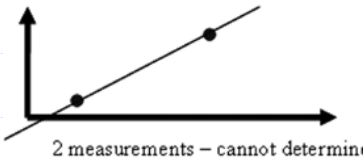
RNP APCH Protection Area

ICAO Training for RNP AR APCH implementation – 2

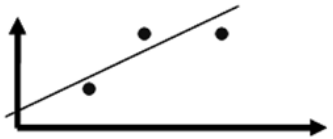
- What actually **AR** means:
  - Specific training requirement on
    - Pilots and Controllers
  - Specific requirements on operators about
    - Aircraft performance
    - Pilots training program and material
    - Documentation
    - Airworthiness
- Only CPA and ANZ acquired AR from FSAD

ICAO Training for RNP AR APCH implementation – 3

- GNSS is Mandatory!
  - Receiver Autonomous Integrity Monitoring (RAIM)



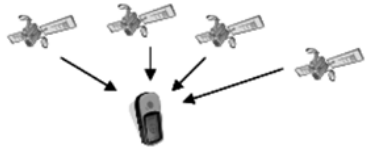
2 measurements – cannot determine if one is erroneous.



3 measurements – can detect if there is one erroneous measurement, but cannot determine which is erroneous.

4 or more measurements – can detect and isolate an erroneous measurement.

(a)



4 measurements – 4 equations, 4 unknowns leads to one solution, zero measurement residuals.

5 measurements – solution determined in least squares sense, can detect if there is one bad measurement.

6 or more measurements – can detect and isolate a bad measurement.

(b)

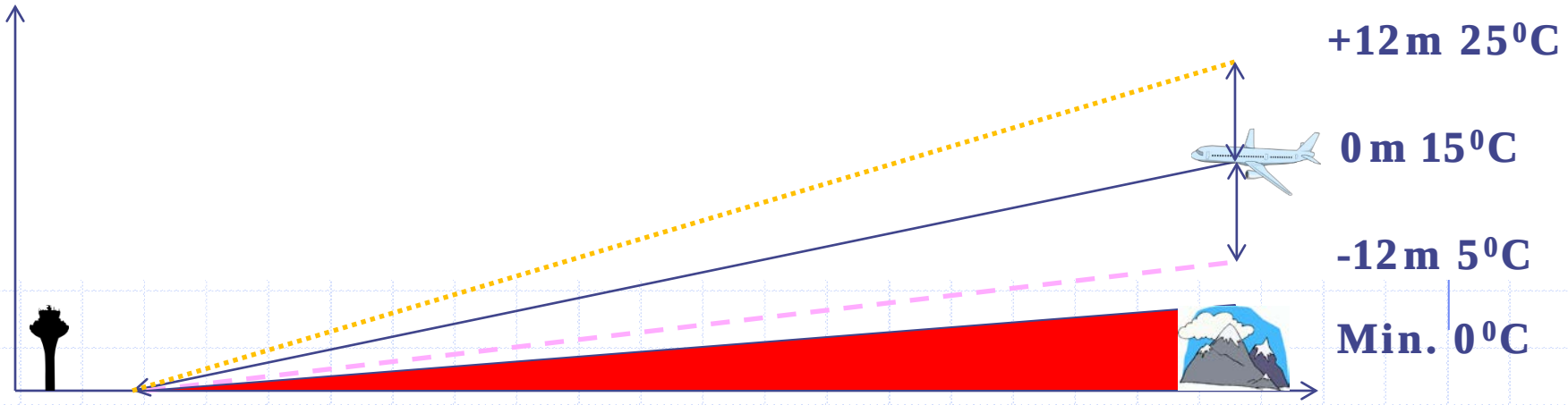
ICAO Training for RNP AR APCH implementation – 4

- ICAO approach procedures Nomenclature
  - Procedure Identifier on Charts: RNAV(RNP) RWYXX
    - When more than one RNP AR APCH
      - RNAV(RNP) z RWYXX
      - RNAV(RNP) y RWYXX
  - RWY07 RNP AR APCH
      - RNAV(RNP) z RWY07L/R (ILS overlay)
      - RNAV(RNP) y RWY07L/R (North Circuit)

- Commonly known as RNAV APCH/RNP APCH

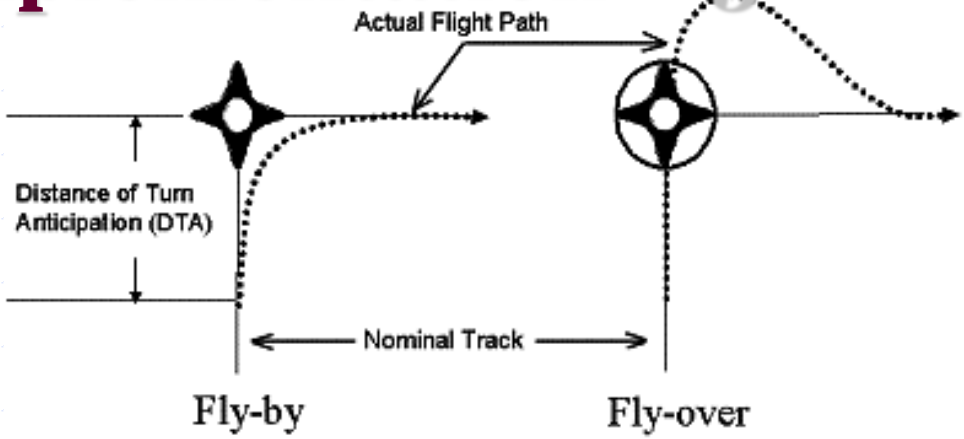
ICAO Training for RNP AR APCH implementation – 5

- **BaroVNAV:**
  - **VNAV based on barometric altimetry**
    - **Most update QNH must be passed (1 hectopascal = 30ft)**
    - **Vertical profile affected by temperature**
      - **Higher than 15^{0}C – above 3^0 path (e.g. at 25^{0}C, 12m higher at FAF)**
      - **Lower than 15^{0}C – below 3^0 path (e.g. at 5^{0}C, 12m lower at FAF)**
    - **Temperature correction: min 0^0**

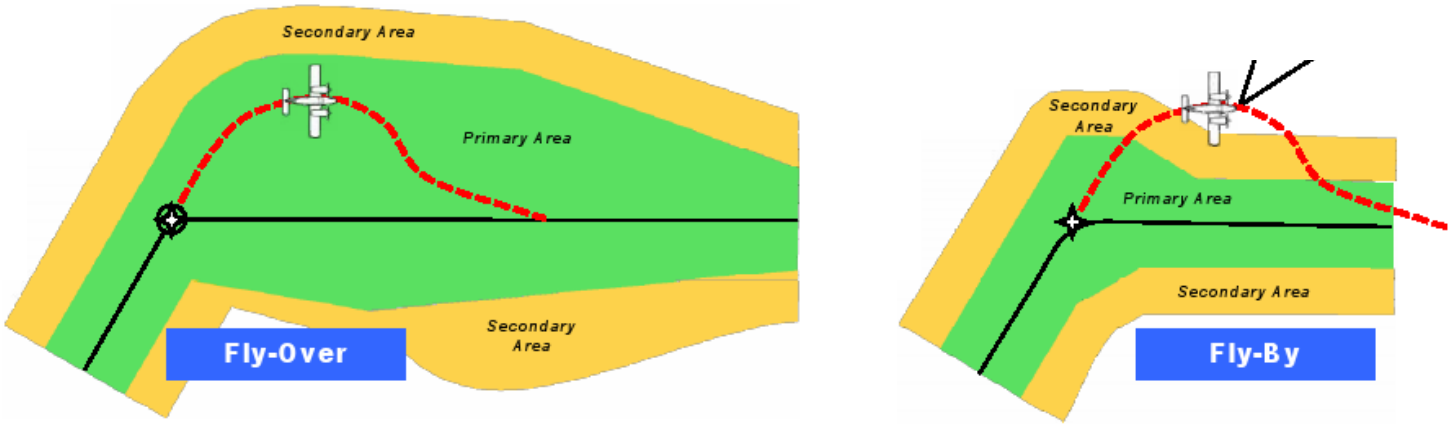


ICAO Training for RNP AR APCH implementation – 5

- FlyBy vs FlyOver waypoint
  - Different size of protection area

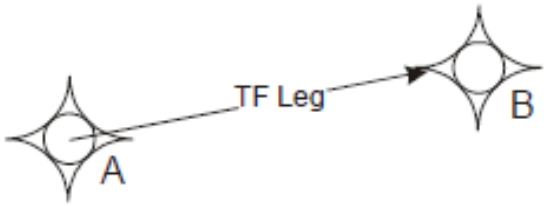


Identical turns drawn to scale : Fly-Over vs Fly-By Protected Areas

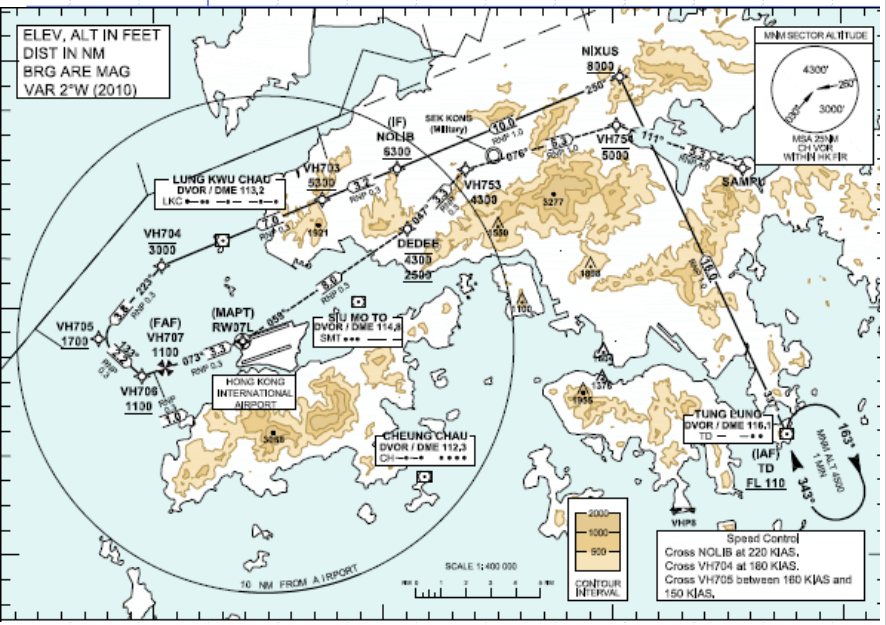


* Drawing courtesy of EuroControl

ICAO Training for RNP AR APCH implementation – 6



Hong Kong RNP AR APCH Path Terminators



Serial Number	Path Descriptor	Waypoint Identifier	Fly-over	Course/ Track (°M)	Magnetic Variation	Distance (NM)	Turn Dir	Altitude (ft)	Speed (KIAS)	VPA (°)	Navigation Specification
01	IF	TD	-	-	-	-	-	+FL 110	-	-	RNP AR APCH
02	TF	NIXUS	-	337	+2.0	16.0	L	+8000	-	-	RNP AR APCH
03	TF	NOLIB	-	250	+2.0	10.0	-	+6300	220	-	RNP AR APCH
04	TF	VH703	-	250	+2.0	3.2	-	+5300	-	-	RNP AR APCH
05	TF	VH704	-	250	+2.0	7.0	L	-3000	180	-	RNP AR APCH
06	TF	VH705	-	223	+2.0	3.8	L	+1700	-160 +150	-	RNP AR APCH
07	TF	VH706	-	133	+2.0	2.2	L	+1100	-	-	RNP AR APCH
08	TF	VH707	-	073	+2.0	1.0	-	1100	-	-	RNP AR APCH
09	TF	RW07L	Y	073	+2.0	3.3	L	-	-	-3.0	RNP AR APCH
10	TF	DEDEE	-	058	+2.0	8.0	L	-4300 +2500	-	-	RNP AR APCH
11	TF	VH753	-	047	+2.0	3.3	R	4300	-	-	RNP AR APCH
12	TF	VH754	-	076	+2.0	6.3	R	-5000	-	-	RNP AR APCH
13	TF	SAMPU	-	111	+2.0	5.3	-	-	230	-	RNP AR APCH

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New Procedures Overview wef 23th July 2015

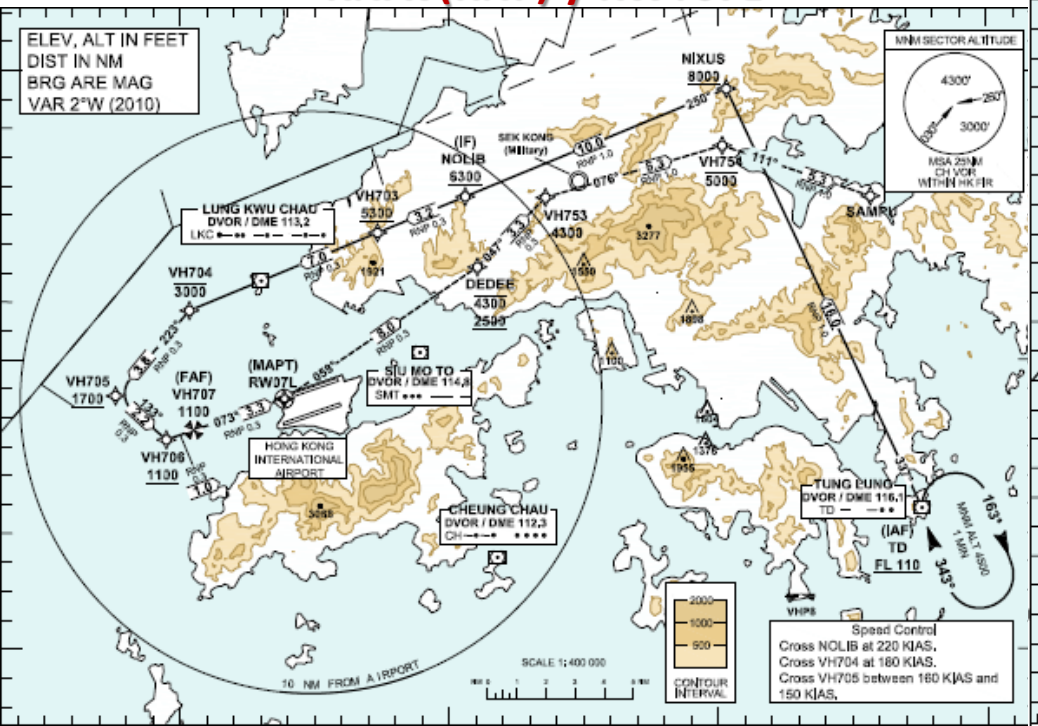
- **2 RNP AR APCH (AIP Sup A15/14)**
  - RNAV(RNP) y RWY07L
  - RNAV(RNP) y RWY07R

- 2 RNP AR APCH (AIP Sup A15/14) for all AR approved aircraft wef 23rd July 2015
  - RNAV(RNP) y RWY07L
  - RNAV(RNP) y RWY07R

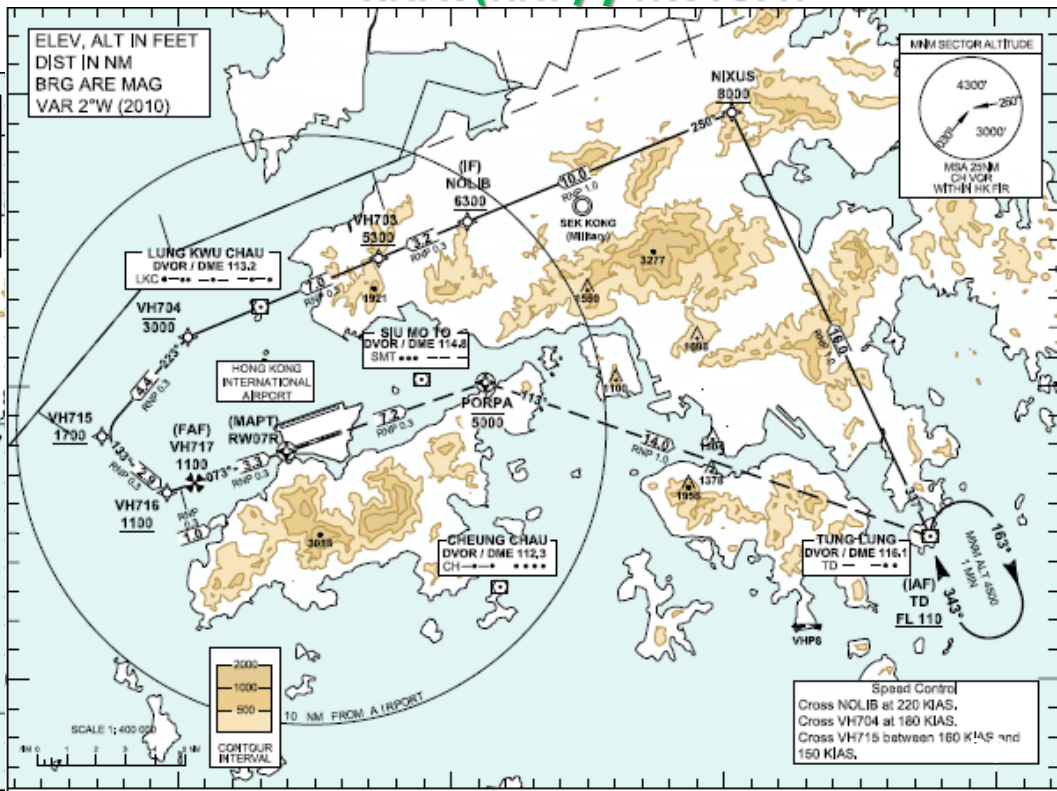
Certified GNSS Receiver Mandatory

- Available when weather prevents aircraft from following approach path from the South (e.g. Bad weather at LIMES)

RNAV(RNP) y RWY07L

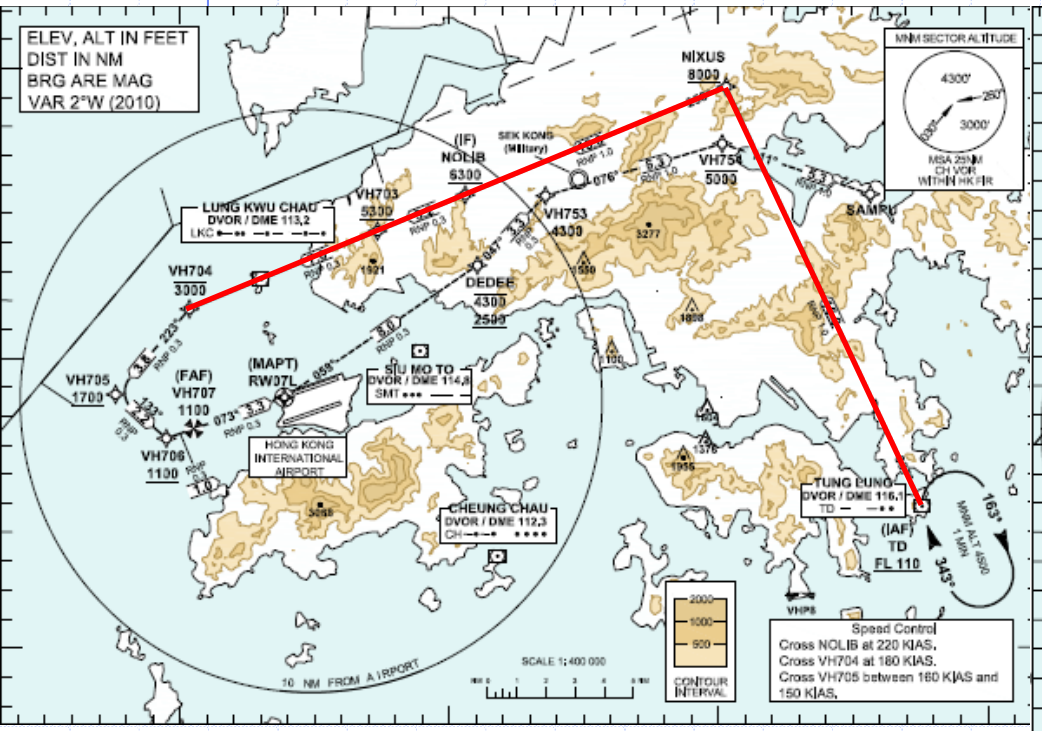


RNAV(RNP) y RWY07R

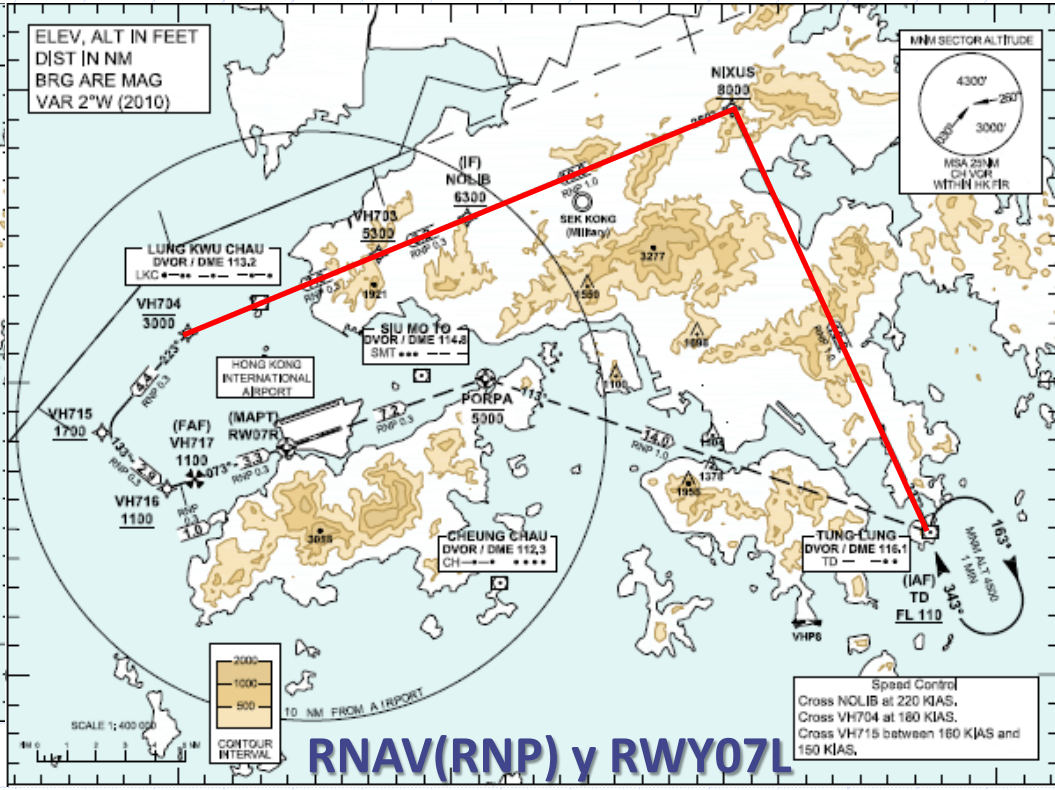


Commonality for the 2 RNP AR APCH

VH704	VH703	NOLIB	Same	IAF
-3000ft	+5300ft	+6300ft	downwind	TD
180kts	~18NM	220kts		FL110
	from THR	Last waypoint to resume		



RNAV(RNP) y RWY07L



RNAV(RNP) y RWY07L

Details for RNAV(RNP) y RWY07L

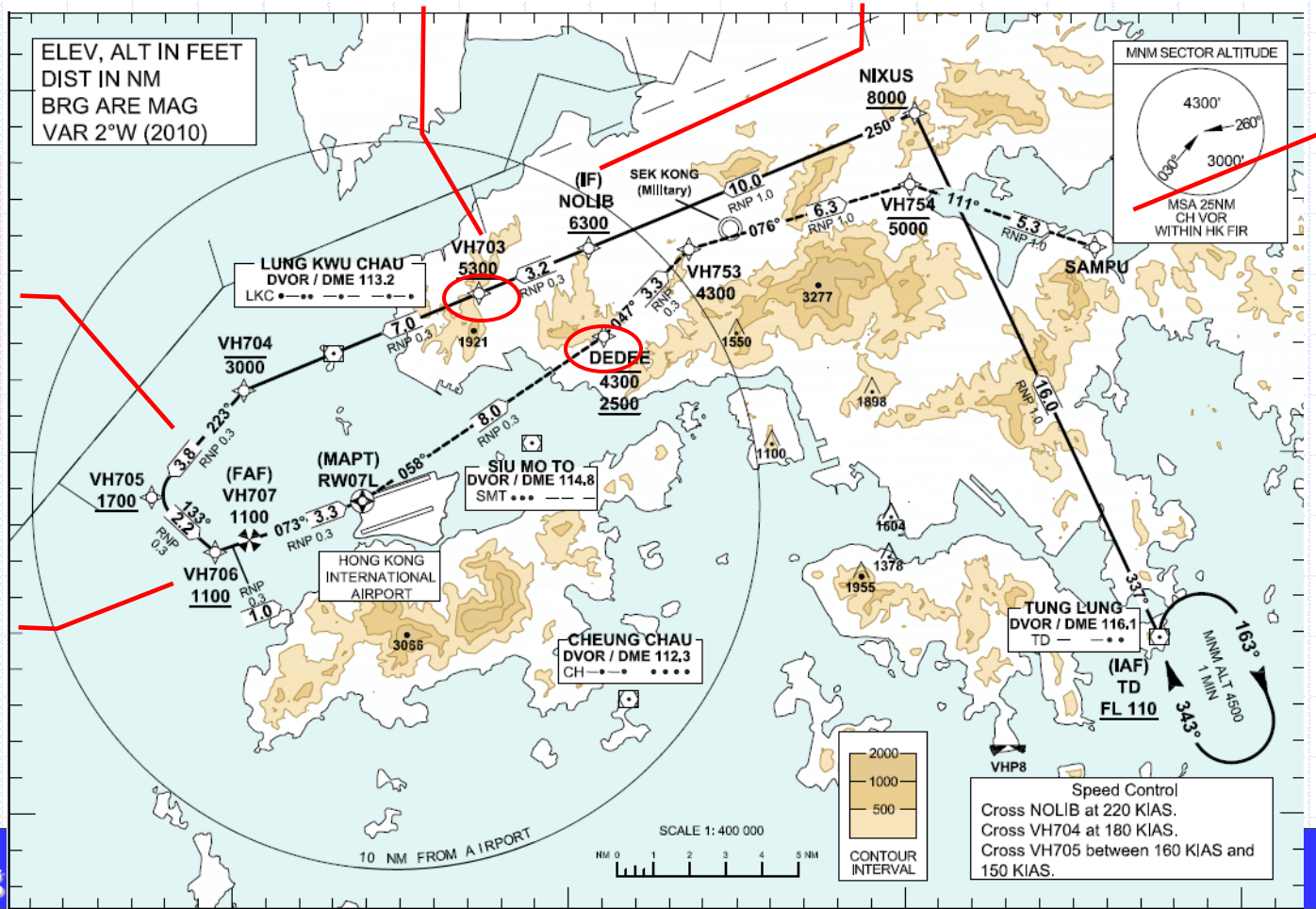
After VH703 >3NM from MAP track

Vertically separated from MAP track

Missed approach same as RNAV(RNP) z RWY07L

Minimum Distance For tracks on base

~4NM final FAF 3.3NM 1100ft



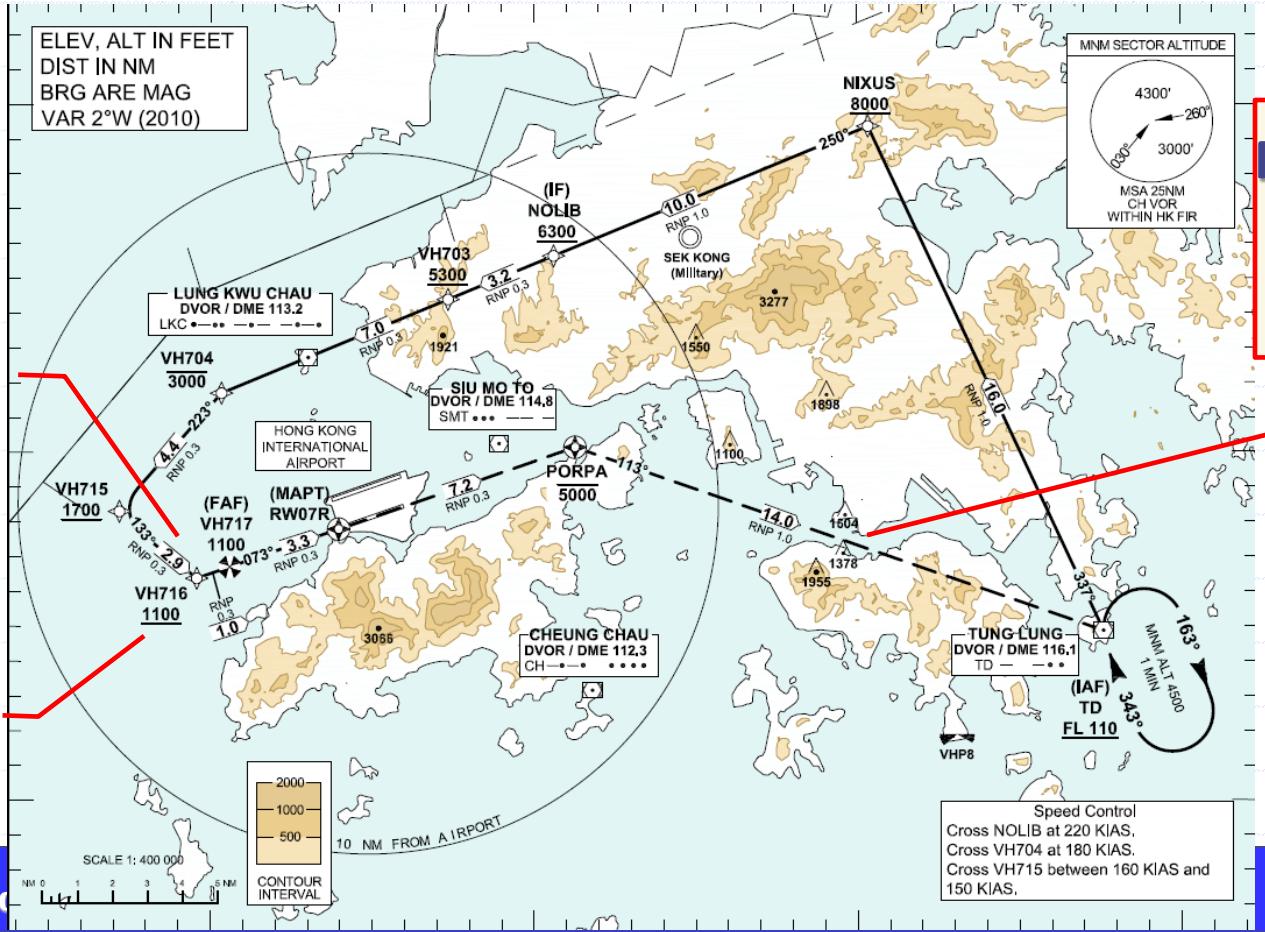
Details for RNAV(RNP) y RWY07R

APCH and MAP tracks are laterally separated

Missed approach track from PORPA to TD

Flight Sim & Flight Validation Confirmed No GPW

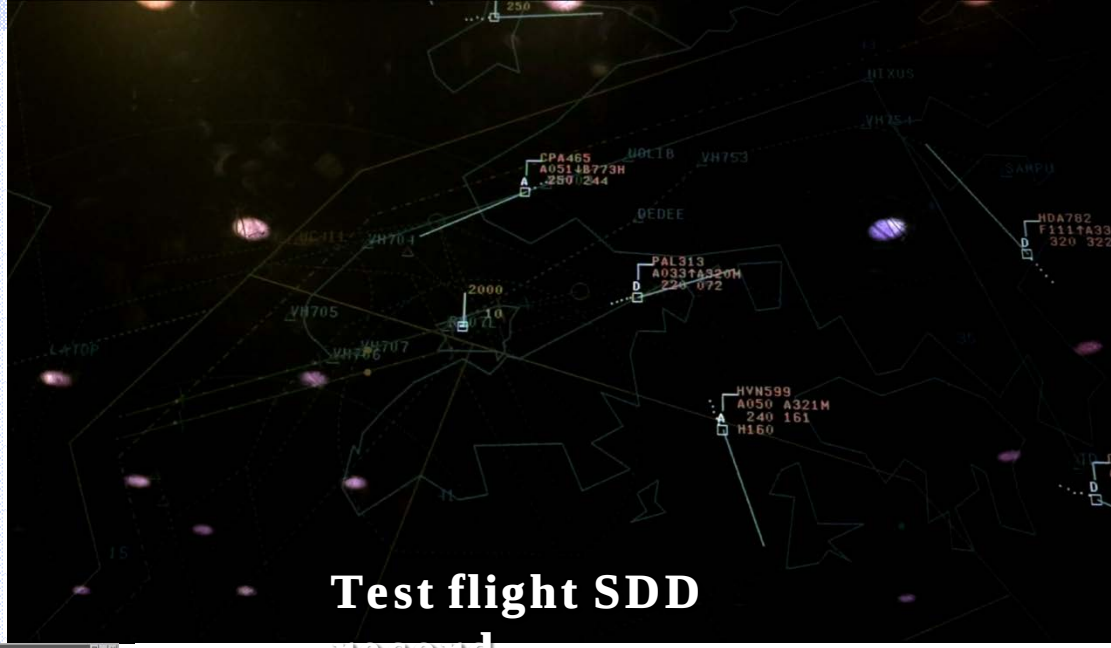
~4NM final FAF 3.3NM 1100ft



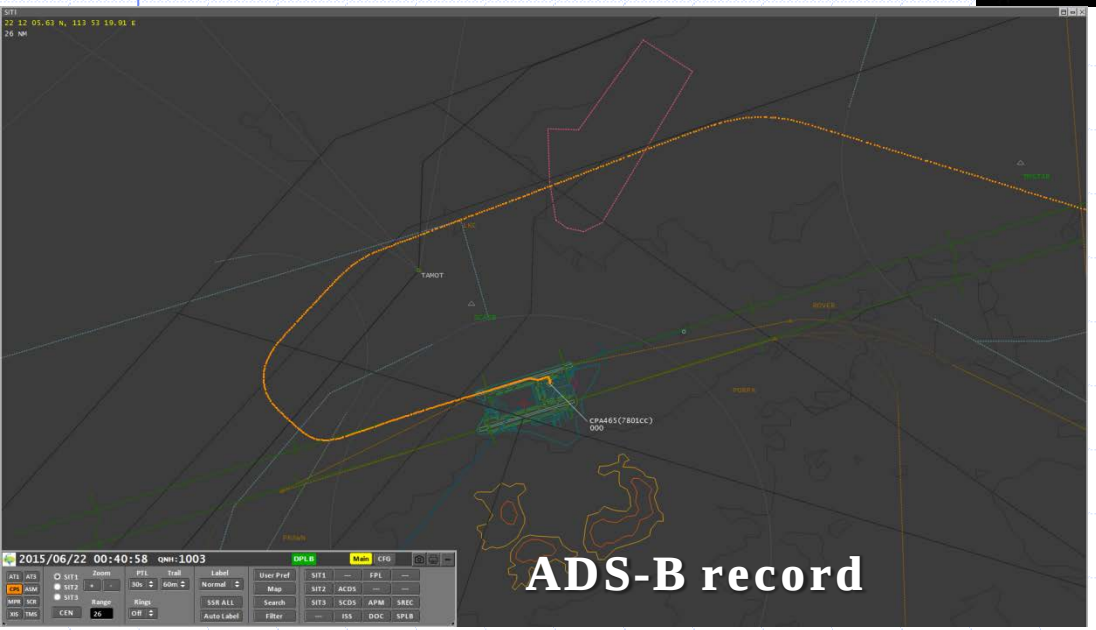
Test Flight Result

- Test Flight on RNAV(RNP)y RWY07L conducted on 22nd June 2015

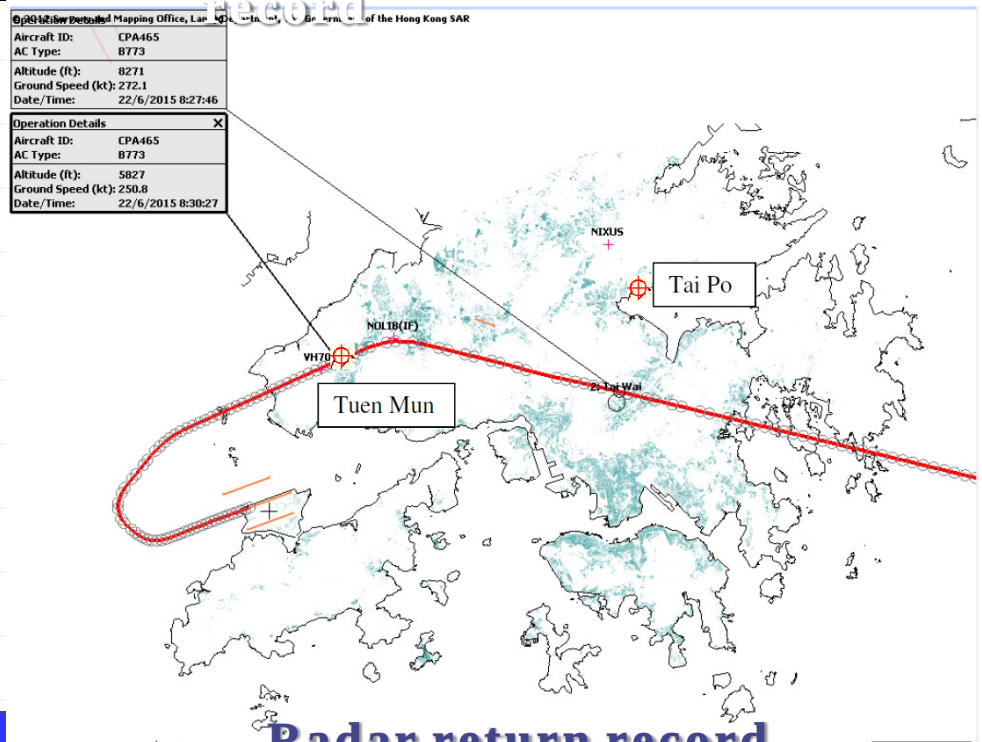
- Test Flight
  - Flight Track max ANP 0.03NM (55.56m)
  - Vertical Profile within limit
  - Noise measured by APSD



Test flight SDD record



ADS-B record



Radar return record

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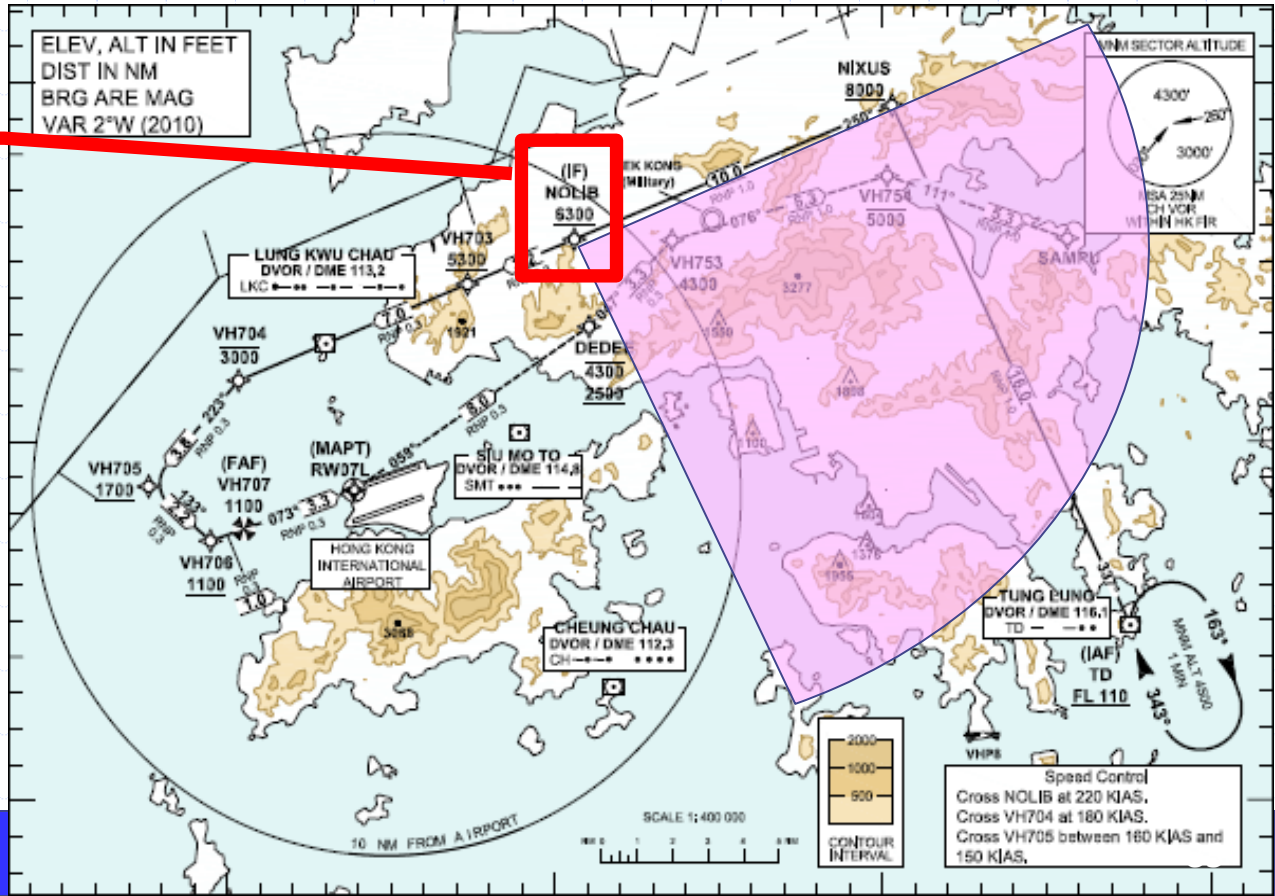
Instruction/Guidance

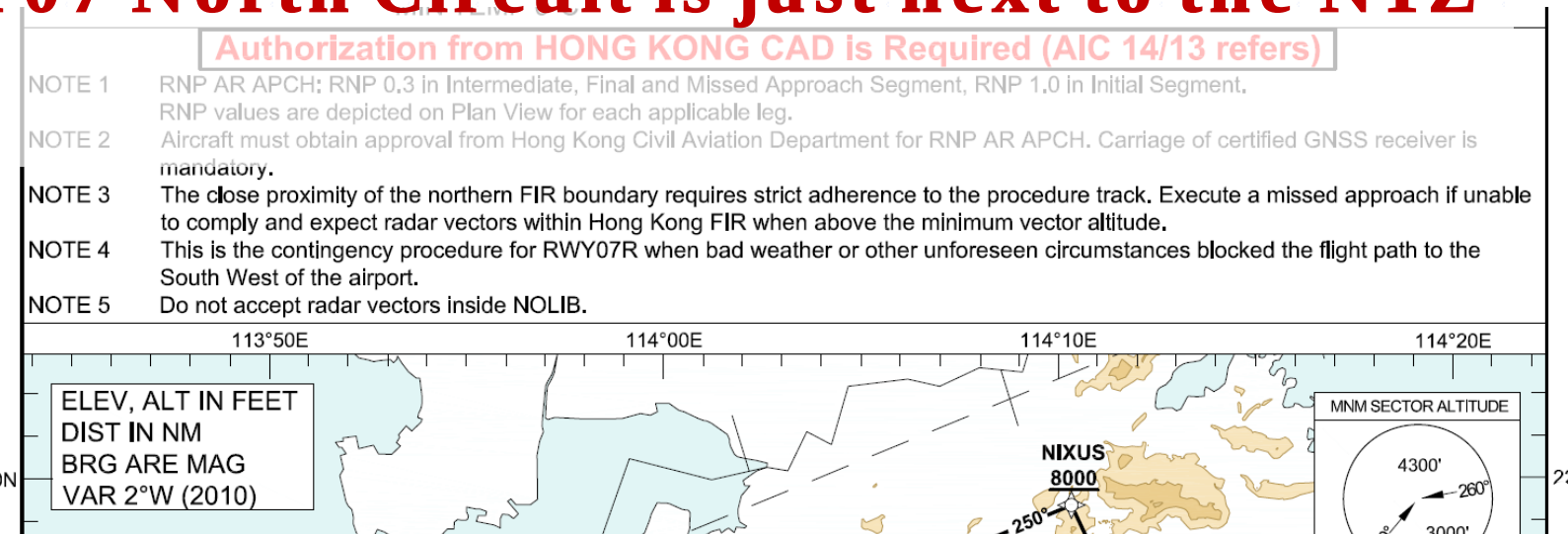
- OI 21/15
- SDD map
  - RNAV (RNP) y RWY 07L – SDD Map 243
  - RNAV (RNP) y RWY 07R – SDD Map 241

NOLIB is the last waypoint to intercept the procedure

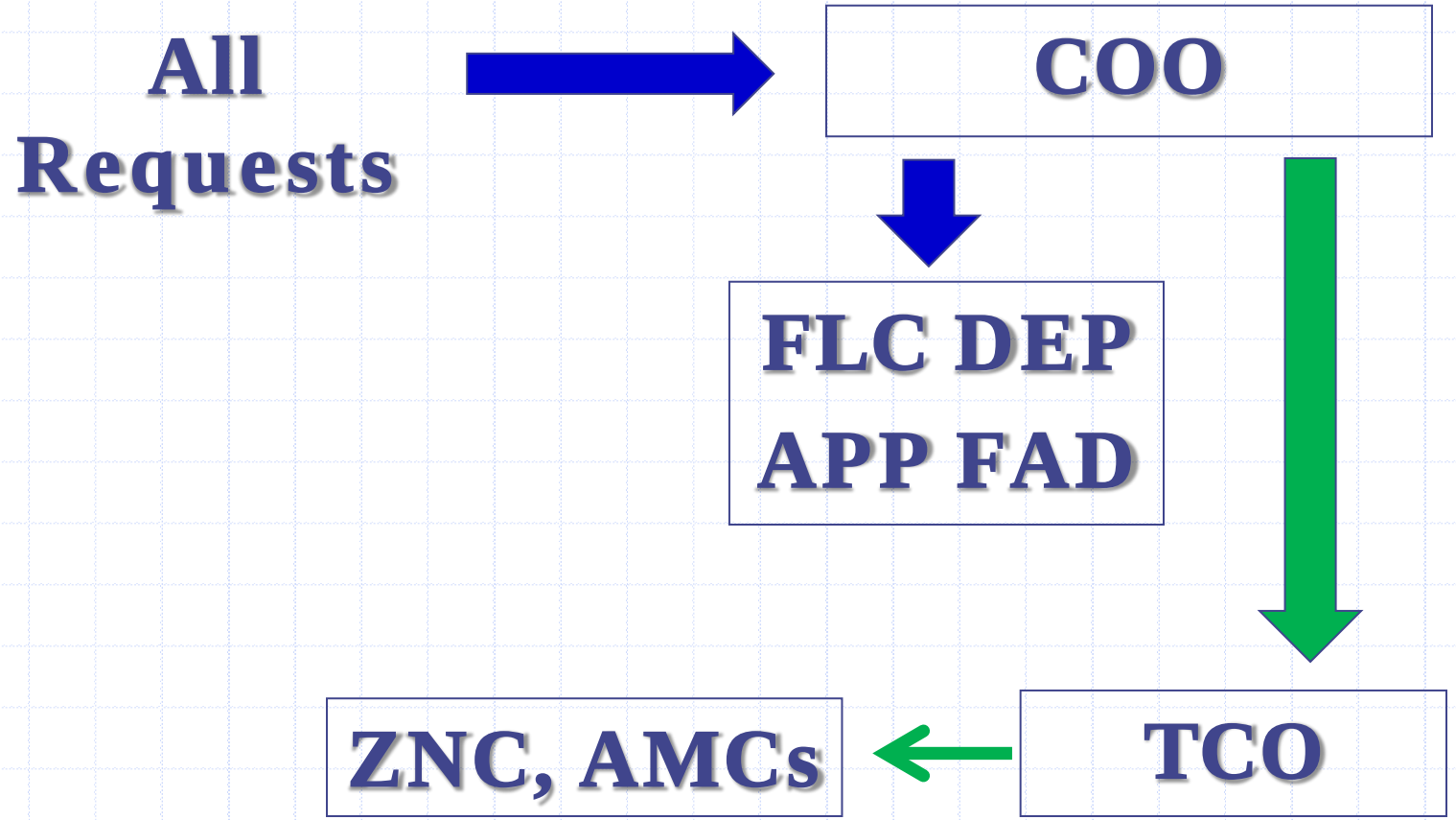


Instruction/Guidance

- Aircraft commenced the approach shall not be intervened
- In case a missed approach / deviation is required, aircraft shall climb on track until above MVA
- **Reminder: The downwind and base of RWY07 North Circuit is just next to the NTZ**



Instruction/Guidance – Coordination



Instruction/Guidance – ATC phraseologies

- **The ATC phraseologies for issuing approach clearance shall be:**

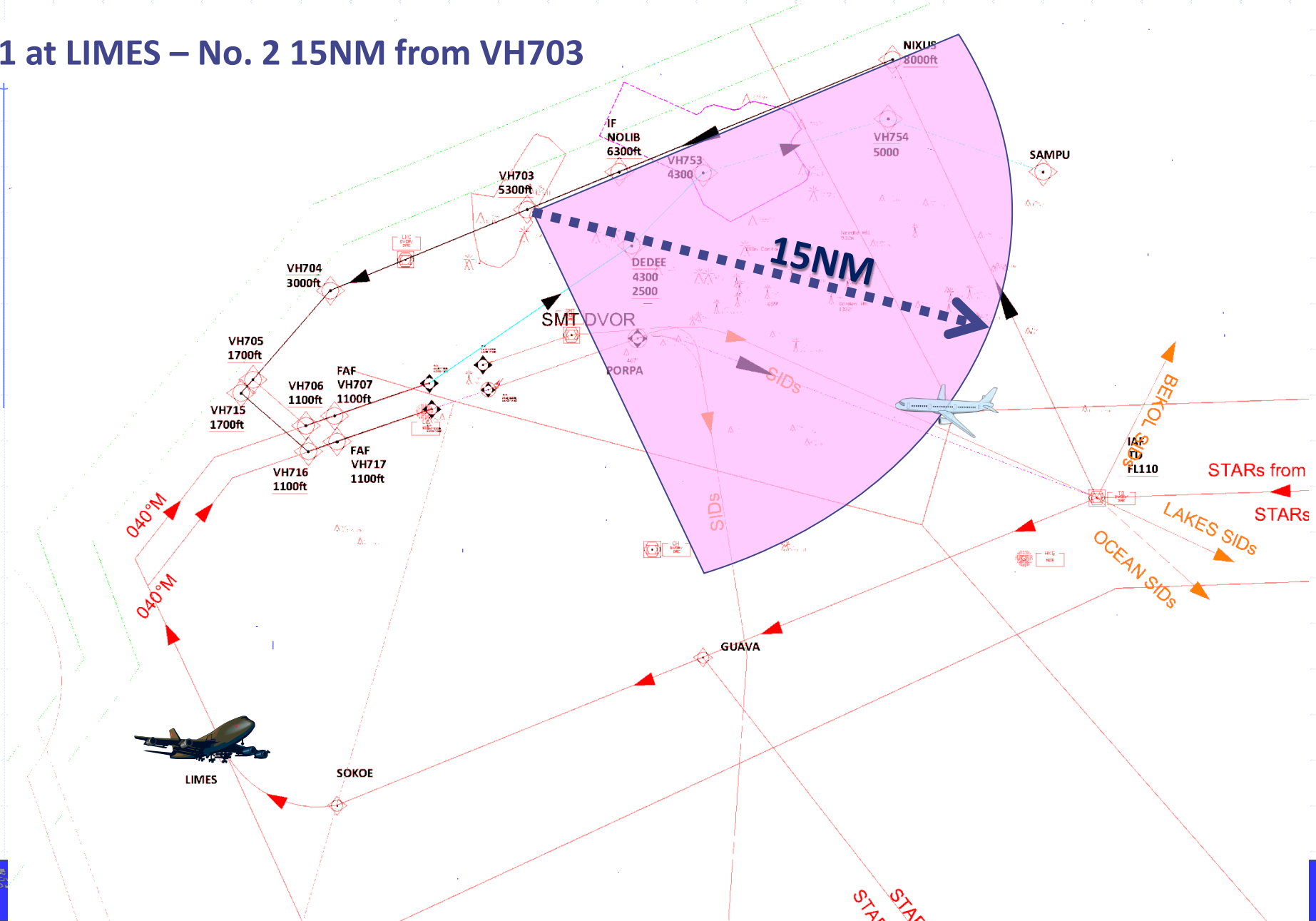
"Cleared RNAV "YANKEE" Approach, RWY 07L" (for RNAV (RNP) y RWY 07L);

or

"Cleared RNAV "YANKEE" Approach, RWY 07R" (for RNAV (RNP) y RWY 07R).

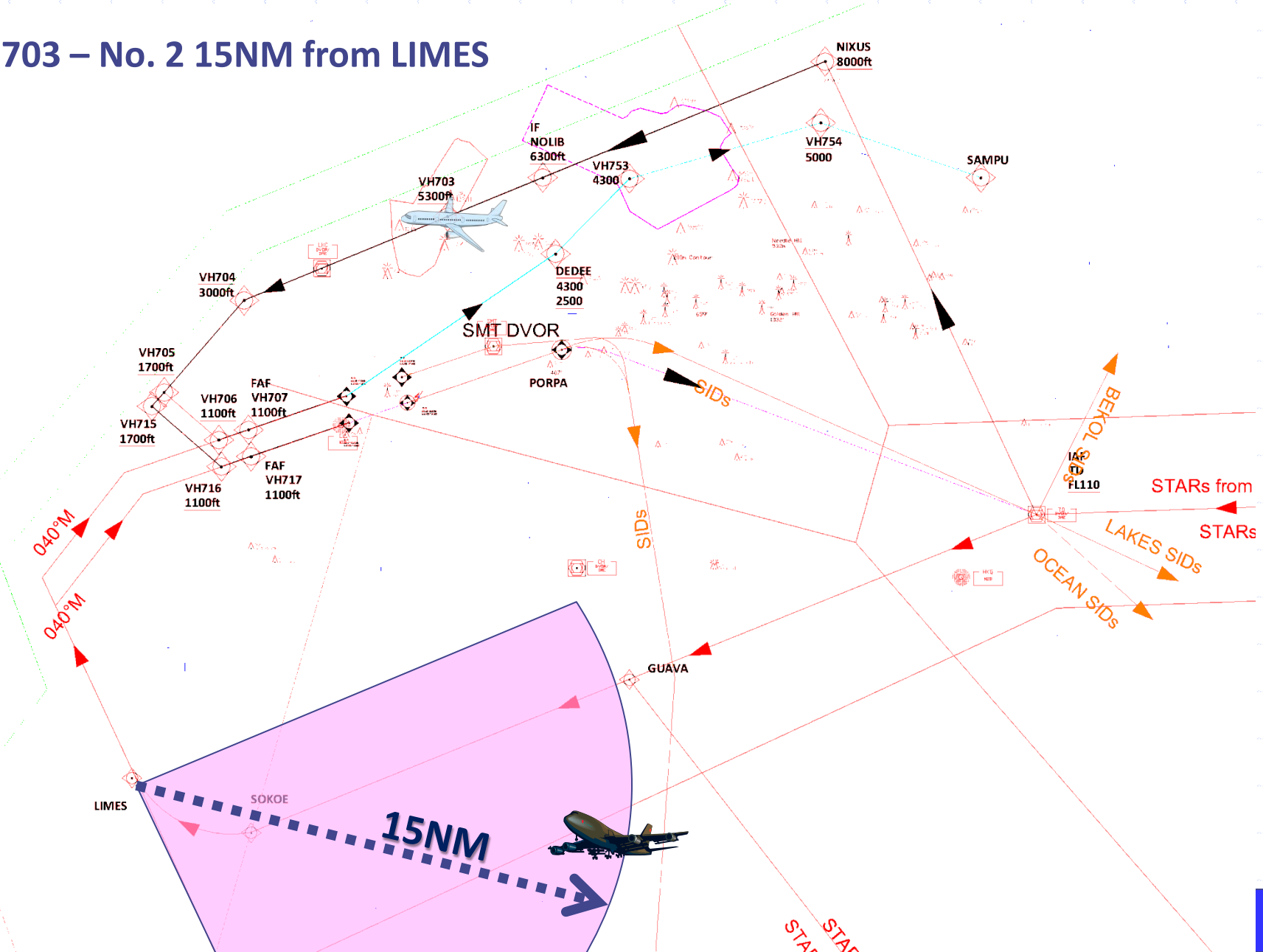
Instruction/Guidance – Integration of Arrivals

No.1 at LIMES – No. 2 15NM from VH703



Instruction/Guidance – Integration of Arrivals

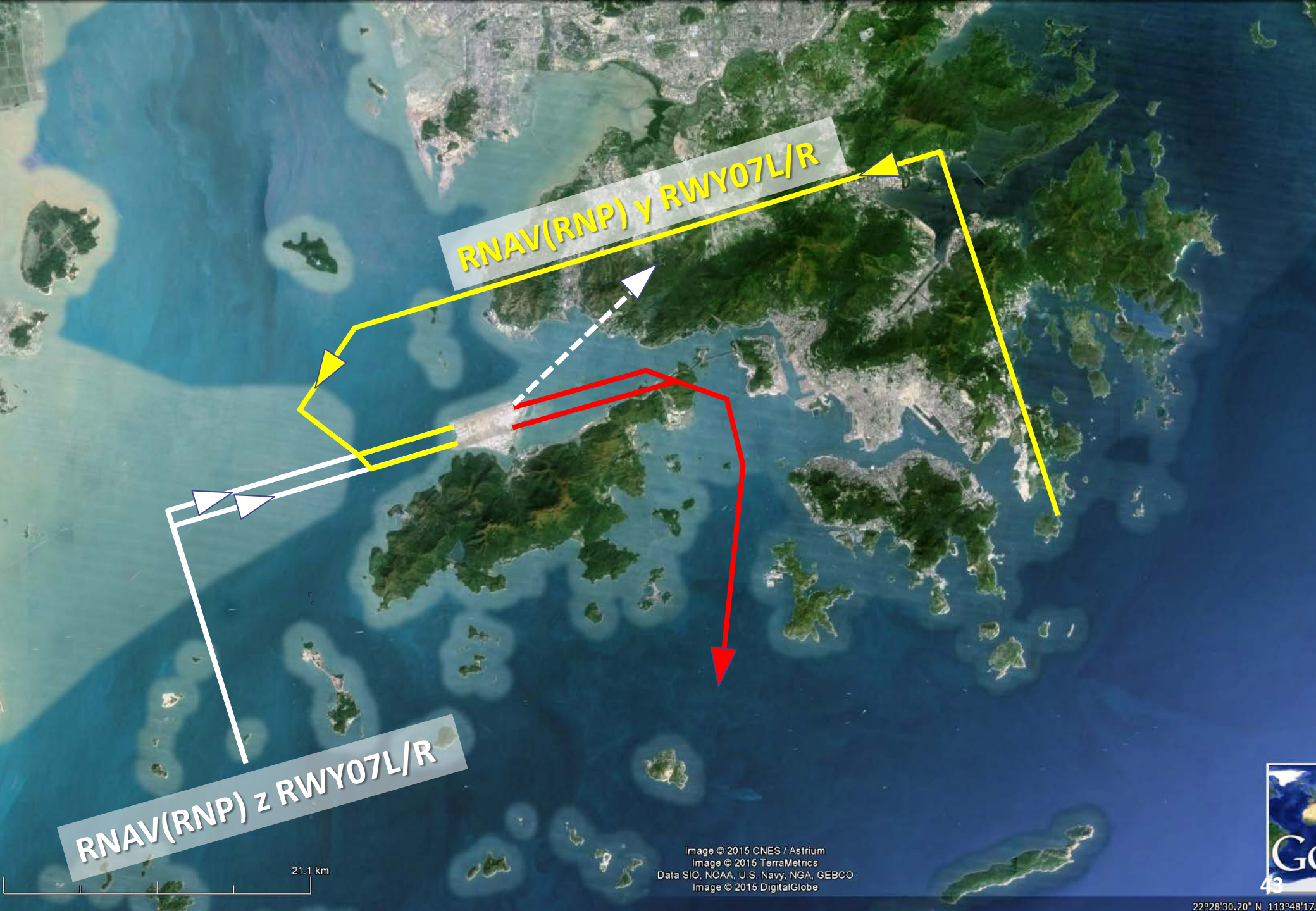
No.1 at VH703 – No. 2 15NM from LIMES



Pilot report Unable RNAV

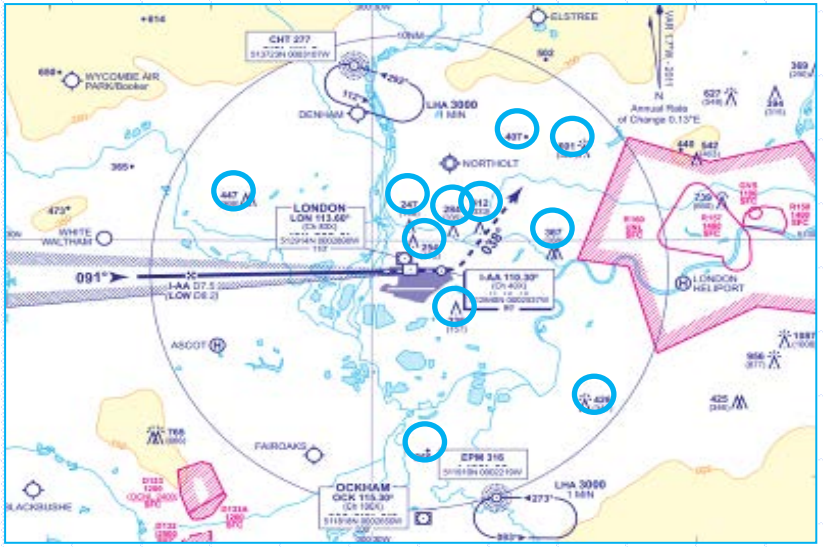
- In any case pilot report unable RNAV or cases of similar nature, controllers shall instruct the flight to continue the procedure and commence climb with no delay. Radar vector shall be given when above MVA, then further assistance.

Dual Runway Operation

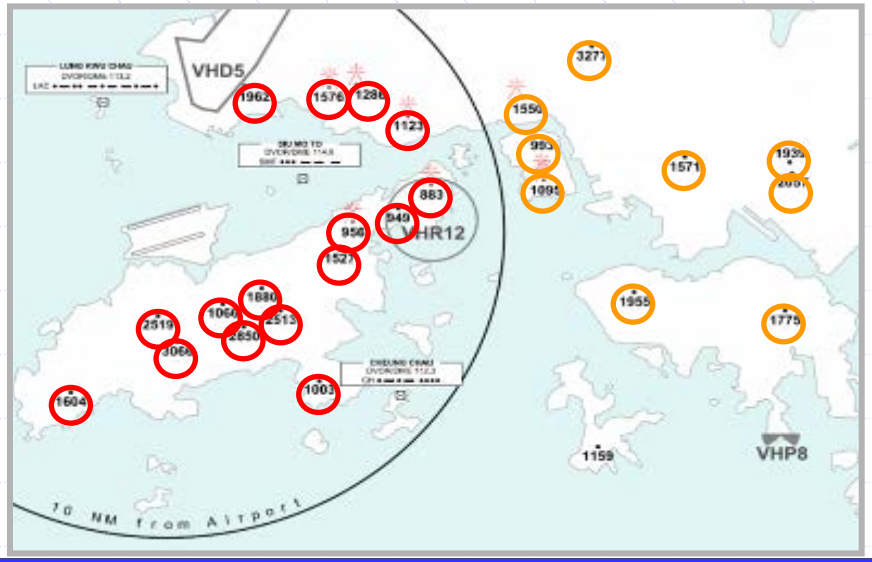

RNAV(RNP) y RWY07L/R
RNAV(RNP) z RWY07L/R
21.1 km
Image © 2015 CNES / Astrium
Image © 2015 TerraMetrics
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2015 DigitalGlobe

Considerations for runway operation arrangement

- Distance between runways
- Airspace restriction
- Terrain & obstacles
- Navigation equipment
- Approach procedure
- Density of movement
- Aircraft type

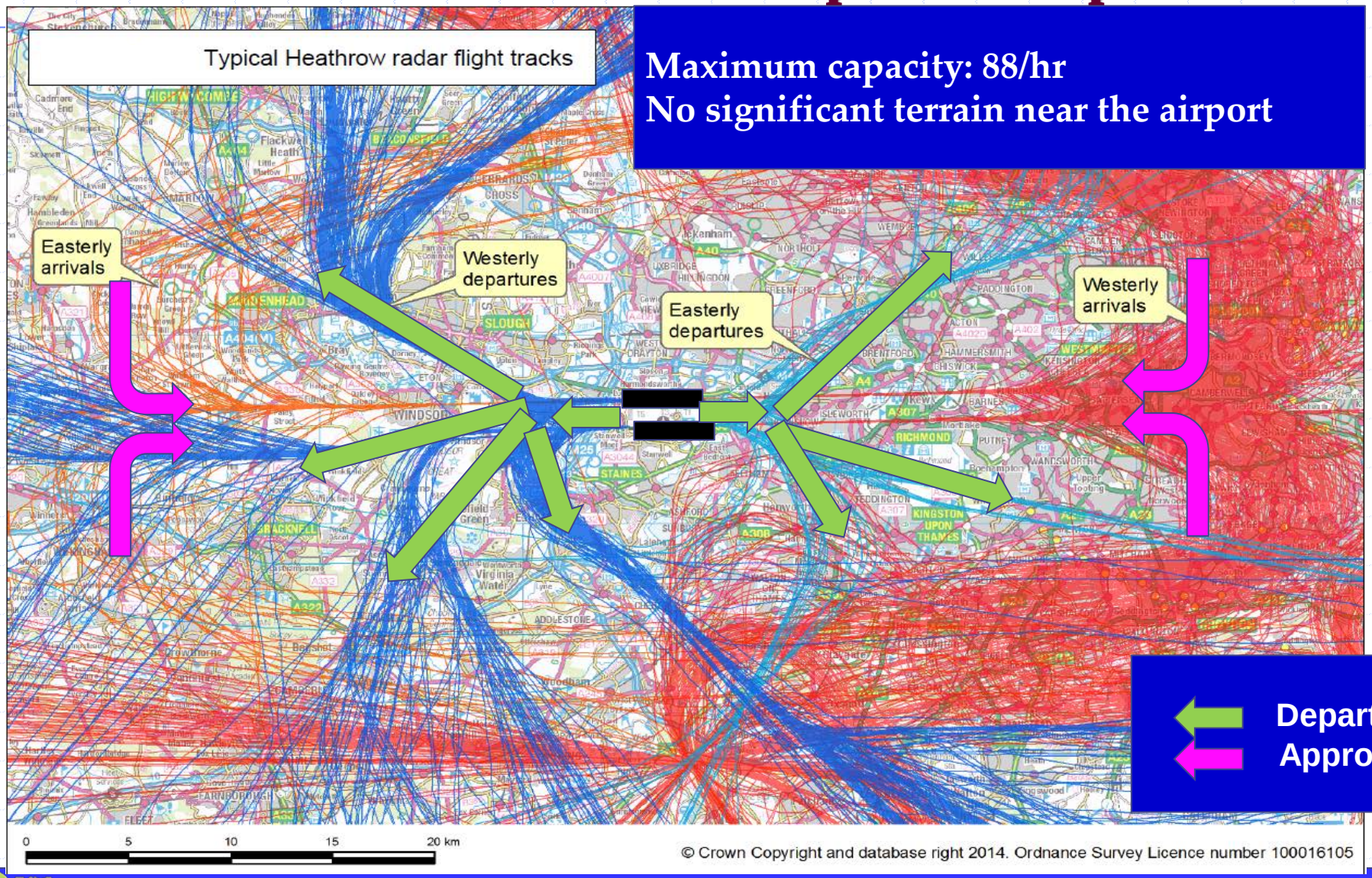


London Heathrow Airport



Hong Kong International Airport

London Heathrow Airport Airspace



Hong Kong International Airport Airspace

Maximum capacity: 68/hr
Complex Terrain closed to the airport
Segregated parallel operations

ICAO Doc9643

Mode 1, independent parallel approaches:

simultaneous approaches to parallel or near-parallel instrument runways where radar separation minima between aircraft on adjacent extended runway centrelines are not prescribed; and

Mode 2, dependent parallel approaches:

simultaneous approaches to parallel or near-parallel instrument runways where radar separation minima between aircraft on adjacent extended runway centrelines are prescribed.

Mode 3, independent parallel departures:

simultaneous departures from parallel or near-parallel instrument runways.

Note.— When the spacing between two parallel runways is less than the specified value dictated by wake turbulence considerations, the runways are considered as a single runway with regard to separation between departing aircraft.

Mode 4, segregated parallel operations:

simultaneous operations on parallel or near-parallel instrument runways in which one runway is used exclusively for approaches and the other runway is used exclusively for departures.

ICAO Doc9643

Mode 1, independent parallel approaches:

simultaneous approaches to parallel or near-parallel instrument runways where radar separation minima between aircraft on adjacent extended runway centrelines are not prescribed; and

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Challenges and Benefits of PBN implementation from ATC perspective

Challenges

- Mixed Nav. Spec operation
  - Complex procedure structure may reduce efficiency
- Proliferation of procedures
  - Much more SID/STAR/Approach
  - Unfamiliar with new and infrequent used procedures
- New procedure implementation more frequent

Benefit

- Better Airspace and Flight procedure design
- Reduce workload
  - Less conflict point for parallel route design – unrestricted climb and descent
  - Radar vector and R/T reduced
  - Applicable to both ATC/ Pilots
- Track adherence/ accuracy
  - Tracks are Repeatable and predictable
- Enhance capacity

Q&A

Thank you for your attention