

>> PBN PERFORMANCE-BASED NAVIGATION SOLUTIONS


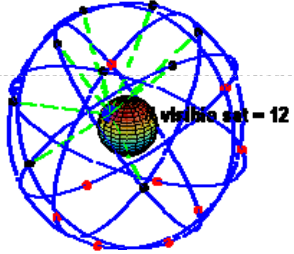


>> Performance Based Navigation

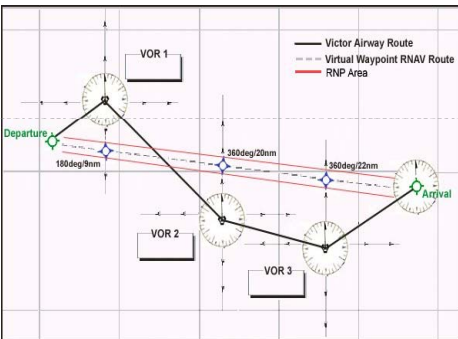
PBN & RNP CONCEPT



RNAV & RNP: GNSS based

visibility set = 12



© QUOVADIS. All rights reserved. Confidential and proprietary document.

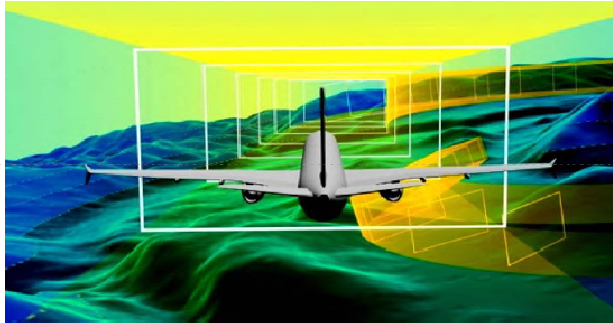
Global Navigation Satellite System = A worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary to support the required navigation performance for the intended operation.

RNAV = Capability to fly from waypoint to waypoint defined by geographic fixes (LAT/LONG) and not necessarily with ground navaids

RNAV can also use DME-DME information but restricted.

Critical Phase of flight: RNP & RNP AR


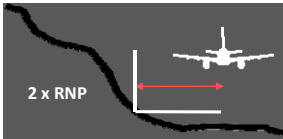
- Arrivals & Departures: RNAV 1 or RNP1 STAR & SIDs
- Approaches:
 - RNP APCH (RNAV GNSS) – 0.3 NM
 - RNP AR (RNAV RNP) – 0.3 NM or below



5

© QUORAVIS. All rights reserved. Confidential and proprietary document.

RNP AR Protection Areas



6

© QUORAVIS. All rights reserved. Confidential and proprietary document.

>> PBN PERFORMANCE-BASED NAVIGATION SOLUTIONS




>> Performance Based Navigation

SAFETY BENEFITS

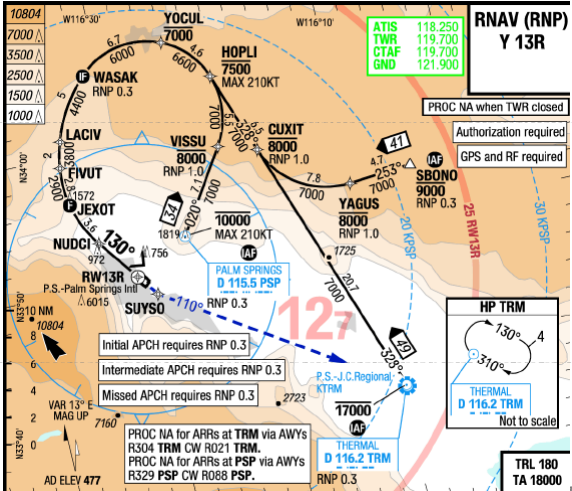


Fully Managed and Stabilized approaches




8

- Fully Protected Trajectories
- Fully Managed Approach
- Smooth 3° descent
- Reduction in minima
- Fully Managed Missed App.




© QUOVADIS. All rights reserved. Confidential and proprietary document.




Removal of visual procedures

- Without additional ground equipment

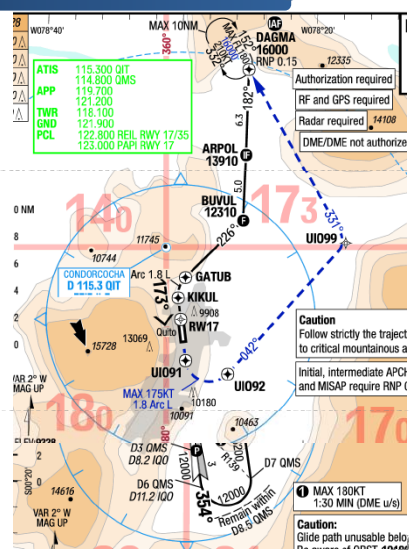


© QNOVA/ADS. All rights reserved. Confidential and proprietary document.



Removal of Circle to Land

- Instrument Approach followed by a visual maneuver to land on opposite runway
- 25 times safer to use straight-in rather than Circle to Land
- Responsible for several fatal accidents
- Approaches need flexibility in terms of trajectories (curved path) requiring RNP AR.



© QNOVA/ADS. All rights reserved. Confidential and proprietary document.



Non-normal operations

© QUORAVIS. All rights reserved.

- RNP AR procedures cover
 - Missed Approach engine-out
 - Departures and EOSID



11


Taking into considerations aircraft performance and specific airport environment



CAUTION
RF Capacity Required
RNP 0.3 Required

See Chart ZPLJ SID-1

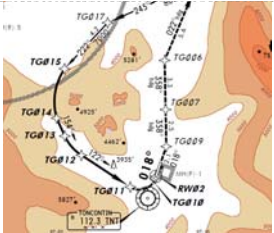
Diversion Points between departure and Engine out departure



Safely improved airport access


© QUORAVIS. All rights reserved. Confidential and proprietary document.

- Lower minima
 - Optimized obstacle protection area compared to conventional Non-precision approaches (VOR, NDB, Circle to land...)
 - Decision height (DH) **as low as 250 ft AGL**
 - Less diversions & missed approaches
- Reduced visibility criteria
 - Tegucigalpa: 2000ft lower
 - Cuzco from 8KM to 4KM on departures



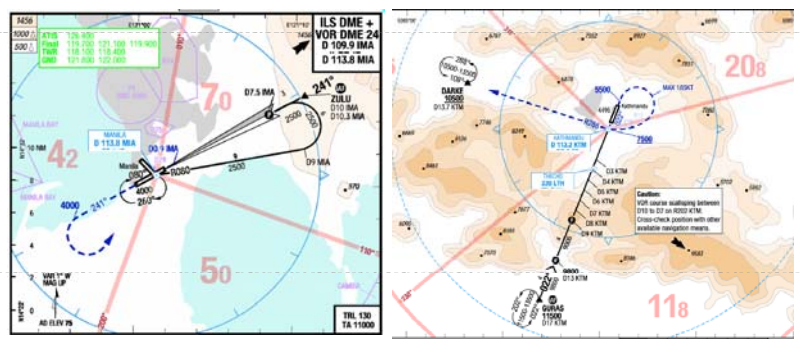
Li Jiang RNP AR		Minima (ft)	Minima (ft)	Visibility (m)
RWY 02				
Conventional	Circling	MDA 11417	DH 4058	10 000
RNP AR	RNP AR	DA 7730	DH 420	1 900

12



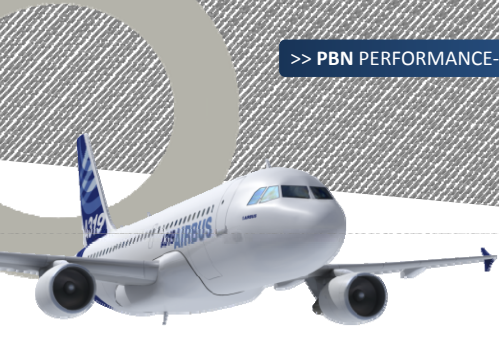
Independent from ground Based nav aids failure

- Allows to keep flying in case of ground NAVAIDS outage or maintenance



13


© QUOVADIS. All rights reserved. Confidential and proprietary document.




>> PBN PERFORMANCE-BASED NAVIGATION SOLUTIONS

>> Performance Based Navigation

SAFETY BENEFITS, YES BUT...



14



Performance Based Navigation relies on...





WGS84 needs to be updated

- Process in place to gather *New Obstacles*
- Process in place to evaluate *impact on procedures*
- Process in place for *temporary obstacles*



RAIM prediction needs to be determined

- At dispatch
- with Masking information coming from terrain data
- and looking at Satellite Maintenance (NANUs)



Navigation database needs to be validated

- every 28 days
- compared with a "golden" database
- For RNP AR... and RNP approaches



Training is Key

- Crew and Dispatch
- ATC (Tower & Center)
- New Phraseology
- New MEL items...


© QONVADIS. All rights reserved. Confidential and proprietary document.

> Authorities

Procedure Design is more complex

ACTOR	INITIATION	GENERAL PLAN	TERMINATION
Project Manager / Customer	Customer's needs	1. Project set up	
Pilot Engineer / Project Manager / Procedure Designer	Preliminary	2. Pre-study	2. Preliminary Procedures
		3. Request from Customer to obtain data survey	3. Data survey to be provided to Qonvadis
		4. Agreement on data survey	
Pilot / Project Manager / Procedure Designer	Operational and in Procedures	5. Conceptual pre-design	5. Conceptual pre-design
		6. Procedure validation?	
		7. Procedure optimization	6. Preliminary Procedure Validation report
Procedure Designer		7. Procedure coding	7. NTR coding table
ATIS Operator	ATIS Message	8. RNAV Navigation db coding	8. Plan checked to ATIS-DB
		9. Nav. Db Coding complete?	
Project Manager		10. Computer based simulations	10. Simulation Report
Pilot / Project Manager	Procedure Test Order	11. Simulator session	11. Simulation session report
Customer		12. PBN procedure acceptance	
Customer / Pilot / Project Manager	Validation Flight Program	13. Validation flight	13. Validation flight report
Customer		14. Procedure delivery	14. Customer Acknowledgement

> Authorities



Risk of Mismatched Design

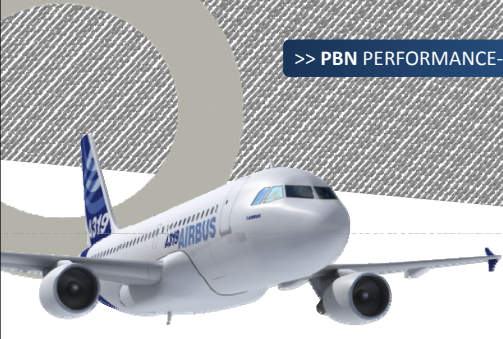
PBN will improve Safety only if it is done adequately, if not, result could be negative

- **Procedure not flown**
 - No benefits (overlays of conventional procedures)
 - Not approved by authorities
 - Longer than conventional (Noise reduction case)
 - Procedure does not integrate well with Conventional Traffic
 - Procedure cuts VFR or helicopter traffic
 - ATC not trained to manage PBN traffic
- **Procedure is flown but contains flaws**
 - Vertical profile too steep = Missed Approach
 - Procedure not optimized for payload
 - Missed Approach too steep
 - Departure too steep
 - Procedures not checked for Terrain warning (TAWS alerts)
- **Procedure contains dangerous flaws**
 - Missing obstacles
 - Performance does not match required vertical profile

© QUOVADIS. All rights reserved. Confidential and proprietary document.

17


>> PBN PERFORMANCE-BASED NAVIGATION SOLUTIONS

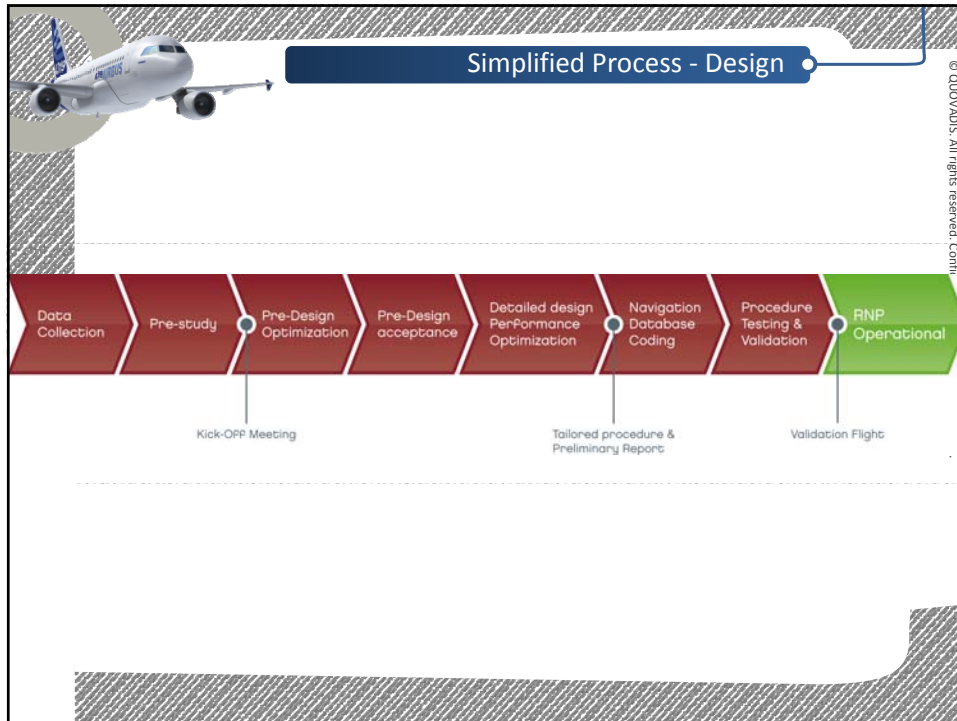


>> Performance Based Navigation

RNP SUCCESS DEPENDS ON METHODOLOGY & VALIDATION

18





Data Collection

- **AIP /ETOD**
 - High Definition Digital Elevation Model
 - Additional data survey often required

20

○ WGS84 data is critical

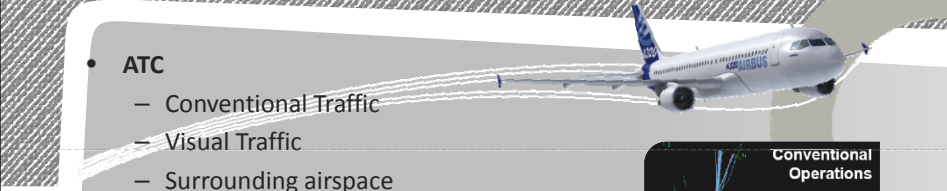
This slide details the 'Data Collection' phase. It features a blue header with the title 'Data Collection' and an image of a Virgin Atlantic airplane. A bulleted list specifies requirements for AIP/ETOD, including a High Definition Digital Elevation Model and the need for additional data surveys. Two images are included: one showing two surveyors in red vests using a tripod-mounted instrument on a city street, and another showing a 3D Digital Elevation Model (DEM) of a terrain. A small number '20' is located at the bottom right of the slide content. A red line with a circle at the end points to the text 'WGS84 data is critical' at the bottom of the slide.

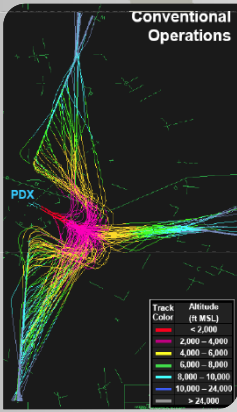
Data Collection

- **ATC**
 - Conventional Traffic
 - Visual Traffic
 - Surrounding airspace
 - Sectors

- **Weather & Wind**
 - Area of turbulences / instability
 - Mountain waves
 - Historical winds

- **Route information**
 - Altitude constraints

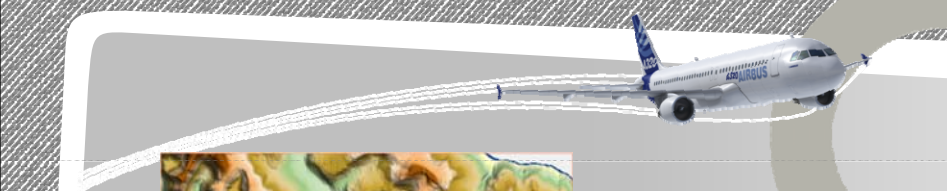


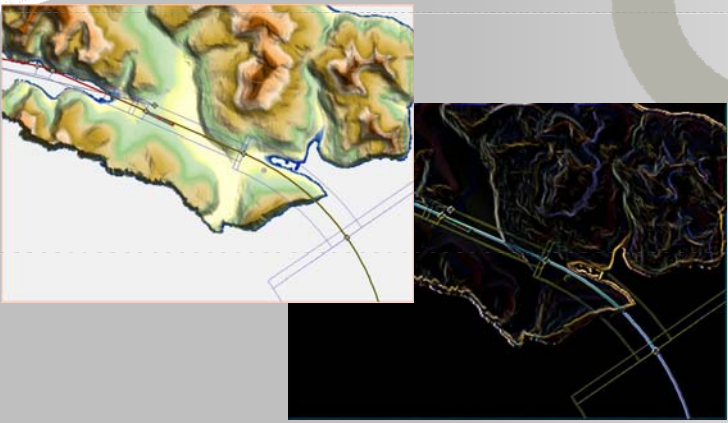


21

○ Gathering all information

Pre-study: Economics vs. Safety






22

○ Setting Objectives all together



Validation program

- Procedure technical report
- FOSA
- Simulator session with Authorities
- Validation flight(s)
 - Airbus pilots onboard



25

>> PBN PERFORMANCE-BASED NAVIGATION SOLUTIONS



>> Performance Based Navigation


SUMMARY



26



Summary



- **PBN enhances Safety...**
 - Fully managed and protected trajectories
 - Often Better minima & vertical profile than conv. NPA
 - Remove circle to land & visual approaches
 - PBN brings ATC and airlines together

- **...if and only if;**
 - Procedures developed with all stakeholders' inputs
 - Properly Designed with all data
 - Properly validated (FMS, Simulator, etc...)
 - Authorities have a process in place to approve:
 - procedures
 - operators

27

ICAO – IATA PBN Go Team Task Force



 Mexico – April 2011



© QUOVADIS. All rights reserved. Confidential and proprietary document.

This document and all information contained herein is the sole property of QUOVADIS..

No intellectual property rights are granted by the delivery of this document or the disclosure of its content. This document shall not be reproduced or disclosed to a third party without the express written consent of QUOVADIS. This document and its content shall not be used for any purpose other than that for which it is supplied.

The statements made herein do not constitute an offer. They are based on the mentioned assumptions and are expressed in good faith. Where the supporting grounds for these statements are not shown, QUOVADIS. will be pleased to explain the basis thereof.

QUOVADIS logo is registered trademarks.

