INTERNATIONAL CIVIL AVIATION ORGANIZATION

REPORT OF THE FIRST MEETING OF THE PERFORMANCE BASED NAVIGATION TASK FORCE (PBN/TF/1)

BANGKOK, THAILAND
9 – 11 JANUARY 2008

The views expressed in this Report should be taken as those of the PBN/TF and not of the Organization.

Adopted by the PBN/TF
and published by the ICAO Asia/Pacific Office

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ATTACHMENTS

PART I - HISTORY OF THE MEETING

1. Introduction

1.1 The First Meeting of the Performance Based Navigation Task Force was held in Bangkok, Thailand from 9 to 11 January 2008 at the Kotaite Wing of the ICAO Asia/Pacific Office.

2. Attendance

2.1 The Meeting was attended by 50 participants from Australia, Bhutan, China, Hong Kong China, India, Japan, Malaysia, Maldives, New Zealand, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, United States, Vietnam, IATA and IFALPA and ICAO. A list of participants is at **Appendix A** to this report.

3. Opening of the Meeting

3.1 The Meeting was opened by Mr. Mokhtar A. Awan, Regional Director, ICAO Asia/Pacific Office. In his opening remarks the Regional Director welcomed participants to the meeting. Mr. Awan reminded the meeting that the Eleventh Air Navigation Conference, taking note of the lack of harmonization in the implementation of RNP/RNAV between different geographical areas, recommended that ICAO address the issue and expedite implementation of RNP and RNAV in a harmonized manner. The Regional Director further highlighted the deliberations from the APANPIRG/18 which resulted in the establishment of the Performance Based Navigation Task Force. Elaborating on the subsequent impetus provided by the 36th Session of the ICAO Assembly, by adopting an Assembly Resolution (36-23), which specified timelines for the implementation of Performance Based Navigation, the Regional Director stressed on the need to pragmatically address the issues at the regional level. Touching upon the benefits of Performance Based Navigation over the conventional navigation system, Mr. Awan emphasized on its significant relevance to the Asia Pacific Region in terms of fostering the projected growth in air traffic. The Regional Director wished all participants a successful meeting.

4. Officers and Regional Office

4.1 Mr. Ian Mallett, Head of Aerodromes and CNS/ATM, Airways and Aerodromes Air Transport Operations Group, Civil Aviation Safety Authority, Australia chaired the meeting.

4.2 Mr. David VanNess, Implementation and Resource Development Coordinator, ICAO PBN Programme, ICAO Montreal provided technical guidance to the meeting.

4.3 Mr. Fareed Ali Shah, Regional Officer Flight Safety, was the Secretary for the meeting and was assisted by Mr. Li Peng, Regional Officer CNS, Mr. Sujan K. Saraswati, Regional Officer CNS, Mr. Andrew Tiede, Regional Officer ATM and Mr. Kyotaro Harano, Regional Officer ATM.

5. Documentation and Working Language

5.1 The working language of the meeting as well as all documentation was in English.

5.2 Five (5) Working Papers and five (5) Information Papers were presented to the meeting. A list of papers is included at **Appendix B** to this Report.

PART II - REPORT ON AGENDA ITEMS

Agenda Item 1: Adoption of Agenda

1.1 The following Agenda was adopted for the meeting:

Agenda Item 1:	Adoption of Agenda
Agenda Item 2:	Election of Chairperson of the Task Force
Agenda Item 3:	Introduction to PBN
Agenda Item 4:	Outcomes of APANPIRG/18, 36th Assembly, and 44th DGCA
Agenda Item 5:	Review Terms of Reference
Agenda Item 6:	Develop Task List and Action Plan (including Regional PBN Implementation Plan; Guidance Material: sample documentation and checklist; facilitate training; etc.)
Agenda Item 7:	Working Arrangements for PBN Task Force
Agenda Item 8:	Any other business
Agenda Item 9:	Date and venue for the next meeting

Agenda Item 2: Election of Chairperson of the Task Force

2.1 The Secretary called for nominations for a Chairperson of the Asia Pacific Performance Based Navigation Task Force (PBN/TF).

2.2 The Representative from the People's Republic of China proposed Mr. Ian Mallett, Head of Aerodromes and CNS/ATM, Civil Aviation Safety Authority of Australia to be the Chairperson. He provided a brief overview of Mr. Mallett's career and wide ranging experience and expressed his confidence that Mr. Mallett would provide able leadership to the Task Force.

2.3 The Representatives from Pakistan and Thailand seconded the proposal and Mr. Ian Mallett was unanimously elected as Chairperson of the PBN Task Force.

2.4 Mr. Ian Mallett assumed the Chair and thanked the participants for the honour bestowed and the confidence placed in him. He wished all participants a very happy new year. Briefly outlining the modalities for the meeting, Mr. Mallett stressed upon the need for standardization. In keeping with the APANPIRG/18 conclusions, Mr. Mallett requested the States to urgently nominate PBN Focal Contact Person in their organizations and indicated that an action item on the issue would be adopted by the meeting.

Agenda Item 3: Introduction to PBN

3.1 To provide a backdrop on PBN and its concepts, four presentations were made which generated significant interest.

3.2 Mr. Sujan K. Saraswati, Regional Officer CNS provided an overview on the *Implementation of PBN*, a copy of the presentation is shown at **Attachment 1.** The meeting was informed that the Eleventh Air Navigation Conference took note of the lack of harmonization in the implementation

of RNP and RNAV and recommended that ICAO address this issue and also expedite the implementation of RNP and RNAV in a harmonized manner. The Required Navigation Performance Special Operational Requirements Study Group (RNPSORSG) was subsequently created in June 2003 to address these matters, and developed the concept of Performance Based Navigation (PBN). Benefits offered by PBN over the navaid -specific navigation routes were also discussed. Attention of Task Force was drawn to the deliberations of 36th Session of ICAO Assembly, wherein the States were urged to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the *Performance Based Navigation Manual* (Doc 9613).

3.3 Mr. David VanNess, Implementation and Resource Development Coordinator, ICAO PBN Programme, gave a presentation to the meeting providing an overview of the PBN concept, the PBN implementation processes in the PBN Manual, and the Airspace Concept, including context in the ICAO global ATM strategy and the elements necessary for development of the Airspace Concept. A copy of the presentation is retained at **Attachment 2**.

3.4 Mr. Doug Michael, Assistant Director ATM, IATA made a presentation on PBN benefits for airlines. He stated that IATA members support global implementation of the PBN concept, originally developed by ICAO and amplified by the aviation industry, in order to provide a seamless environment and standard flight crew procedures. Mr. Michael emphasized that IATA's aim is to promote safe, secure, efficient and economical air transport. He elaborated that increasingly, the navigation capability of aircraft had outstripped the service capabilities of the ATM system. Airlines continued to acquire or equip existing aircraft with improved and more capable avionics. The aircraft was the common component within the global ATM system and we could exploit its capabilities whilst harmonizing the ATM systems at the same time. Today, airspace capacity was restricted by high controller workload. A more autonomous operation of the aircraft, utilizing its on-board systems, reduces complexity and controller workload therefore unlocking latent capacity within the ATM system that is so desperately needed. With the growth of fleets in the Asia Pacific region, a significant percentage of these aircraft are RNAV/RNP capable today. PBN is applicable to all airspace environments, Low, Medium and High traffic density. Mr. Michael stressed that safety is the first concern of every aircraft operator, air traffic manager and regulator. This year's global hull loss accident rate to the end of the third quarter - projected to 31 December - would show the first rise in the annual serious accident rate since 1998. He further illustrated the Safety benefits of PBN, which include: CFIT Reductions, Stabilized Approaches, Safer Missed Approaches, Safer Non-Normal Procedures, Less Stress on Flight Crews, More Consistency, and No ILS Signal Distortion. Speaking of the intangible safety benefits, other PBN benefits are potentially high because of a high level of RNAV aircraft equipage in the Asia Pacific region. Performance Based Navigation promises to increase capacity while enhancing safety. RNP was initially developed to address problems at terrain and weather-challenged airports. Today, the world is recognizing that RNP's efficiency and operational benefits are valuable at ALL airports. It is clear that performance-based navigation is good for the environment. He concluded that: with aircraft accident rates rising, PBN addresses CFIT providing stabilized approaches; with global air traffic rising, PBN provides more efficient use of airspace; with global fuel prices rising, PBN allows track shortening saving time/fuel; with environmental concern growing globally, PBN is a green approach. PBN provides significant safety, efficiency, economic and environmental benefits to airlines. In support of ICAO after the release of the PBN Manual in 2007, IATA has been active in the implementation of PBN as an industry priority. A copy of the presentation is retained at **Attachment 3**.

3.5 Capt. Alex Passerini, Technical Pilot 737, Qantas Airways Ltd. was invited to make a presentation from the air operator's perspective. Capt. Passerini presented the current RNP-AR activities in the Qantas Airways' operation within the region. Specifically, Qantas has deployed RNP-AR approach and departure procedures utilising Boeing 737-800 aircraft to 9 Australian and 1 New Zealand port, with plans to deploy the capability to a further 10-12 Australian ports over the next 18 months. These ports include medium density traffic areas, non-radar procedural control and uncontrolled airspace. Qantas has trained all 580 B737 Flight Crew and have been approved by CASA to conduct RNP-AR operations down

to RNP 0.10 where required. Qantas reports that approximately 25,000 RNP-AR procedures have been flown in revenue service over the past 3 years, and they are now flying approximately 95 of these procedures every day. The safety benefits of providing 3D guidance for approach, missed approach and departure have been very significant. In addition, commercial payload uplift improvements along with fuel, noise and emission benefits have also been quantified and are of significant financial benefit. Qantas has also identified training benefits associated with simplification of approach types. The Qantas RNP-AR experience has been very positive and as a consequence Qantas is currently exploring RNP-AR opportunities for other aircraft models within their fleet A320, A330, A380, B747-400, B767 and B787 fleets. A copy of the presentation is retained at **Attachment 4**.

Agenda Item 4: Outcomes of APANPIRG/18, 36th Assembly, and 44th DGCA

4.1 The Meeting was informed by the Secretariat of the Outcomes of the APANPIRG/18, the 36th Session of the ICAO Assembly and the 44th DGCA Conference and noted the strong action items calling for accelerated PBN implementation that had been adopted by each of these groups. Copies of the full text of APANPIRG Conclusions 18/52, 18/53, 18/54 and 18/55, Assembly Resolution A36-23 and 44th DGCA Conference Action Item 44/6 have been included as **Appendix C.**

4.2 While discussing the outcomes from the APANPIRG/18, the Secretariat indicated that till date only 12 States had nominated *Focal Contact Person* for PBN coordination. States were once again requested to urgently nominate their Focal Contact Person to the Regional Office in accordance with APANPIRG Conclusion 18/55 to facilitate effective implementation of PBN at the Regional level. The Secretariat dealt at length with the ICAO Resolution 36-23 (Performance Based Navigation Global Goals) and requested the meeting to take note of the accelerated timelines for PBN implementation that had been adopted by the Assembly. Highlighting Action Items from the 44th DGCA Conference the Secretariat stressed on the need to implement PBN as per the ICAO guidance material.

4.3 On a query raised about the requirement of clause "(when required)" as reflected in paragraph 2. a) 1) of the Resolution, the Secretariat clarified that it was ultimately for the State to decide whether PBN for a particular airspace has to be implemented or not. The text of the Assembly Resolution needed to be broad enough to accommodate all circumstances whilst allowing States some flexibility in implementation.

4.4 China raised a concern as to how ICAO would support States in meeting the time schedule. The Chairperson indicated a need for the Representatives/Task Force Members/ Focal Contact Person to highlight upwards through the management chain that the senior officials of States represented at the 36th Assembly had agreed to the timeframe as reflected in the Assembly Resolution. As such there was a need for States to meet this commitment, allocate sufficient resources and address the issue of implementation with high priority.

Agenda Item 5: Review Terms of Reference

5.1 The Chairperson drew the attention of the Meeting to the Terms of Reference for the PBN Task Force as provided by the APANPIRG/18. He suggested that the meeting review the TORs critically and put forward its recommendations/observations on its viability.

5.2 Thailand sought a clarification on who would determine the 'established target levels of safety' (TLS) as reflected under paragraph a) of the Guiding Principles. The Secretariat informed the meeting that ICAO Doc. 7030 indicated the TLS at the Regional level.

5.3 New Zealand was of the view that while the schedule for implementation had been given in the Assembly Resolution, realistically speaking there would be resource constraints, particularly the shortage of experienced instrument procedure designers, which would significantly impede the

implementation process.

5.4 Hong Kong supported the issue raised by New Zealand and added that they were also experiencing a shortage of procedure designers. The representative further highlighted that the expertise (in RNP/RNAV procedure designing) was concentrated in some States only and that many States simply did not have this type of expertise available internally.

5.5 To a query raised by China about the requirement of completing the Regional PBN Roadmap for presentation to APANPIRG/19 by September 2008, while the target date in the ICAO Resolution was 2009 for the States and PIRGs to complete a PBN Implementation Plan, the Secretariat advised that the Regional PBN Roadmap may be required by the States for the preparation of their implementation plan and these roadmaps/plans were not required to be very rigid, they should evolve with time.

5.6 Pakistan was of the view that for the successful harmonized implementation of PBN, it was necessary that all the Stakeholders were involved and that the Regional Office should assume the coordination role.

5.7 India highlighted that while the design procedures for ILS, VOR approaches were clearly explained in the relevant ICAO design manual, however, for Baro VNAV, APV etc. there was not much clarity available in the documents. The Secretariat informed the meeting that the issue had been recognized and the task had been given to the Instrument Flight Procedure Panel. The meeting was informed that training on PBN Procedure Design had been organized in December 2007 by ICAO for COSCAP-NA with the support from DGAC France; another course for COSCAP-SA is scheduled for June 2008 and in December 2008 for COSCAP-SEA. States were urged to take advantage of such training.

5.8 Thailand, while highlighting/recognizing the need for training at all levels, suggested that a Training Catalogue be developed which should include information on what training was available and where. This would facilitate States to plan appropriate training for their personnel.

5.9 Summarizing the concerns / observations expressed in the meeting, the Chairperson listed the issues that needed to be addressed as:

1) Requirement of Training

2) Adequate guidance in ICAO Documents

3) Shortage of Procedure Designers

4) ICAO should effectively and efficiently take up framing of design standards

5) For many RNP/RNAV specifications, there are no separation standards

5.10 In reviewing the TOR against the provisions of Assembly Resolution A36-23, the meeting noted that clear references to implementation of approach procedures with vertical guidance (APV – Baro VNAV and/or augmented GNSS) were not explicitly reflected in the TOR. Although recognising that APV was effectively inherent in RNP approaches, the meeting agreed to expand the TOR to include a clarifying reference to approach procedures with vertical guidance.

5.11 To a question raised by the United States as to why a ‘long term’ implementation plan was not included in the Terms of Reference under paragraph c) of Guiding Principles, the Chairperson clarified that this was in line with the Assembly Resolution. However, the meeting recognized the significance of the position expressed by United States that it was very important to define and retain a

clear end state goal and set the near and medium term milestones to support the desired end state. Accordingly, the meeting agreed that clarifying text be added to paragraph c) in this regard.

5.12 Attached at **Appendix D** are the amendments to the TORs proposed by the Task Force. Recognizing that the TOR had been defined by APANPIRG, the meeting requested that the Secretariat to forward the proposed amendments to the TOR to APANPIRG/19 in September 2009 for consideration.

Agenda Item 6: Develop Task List and Action Plan (including Regional PBN Implementation Plan; Guidance Material: sample documentation and checklist; facilitate training; etc.)

6.1 The Chairperson highlighted the significance of Agenda Item 6 which entailed active involvement of all participants so that the Task Force meeting could come up with a pragmatic Task List and a viable Action Plan. He requested States to indicate their status of implementation till date and the difficulties that they envisaged in subsequent implementation of PBN.

6.2 The Chairperson stressed that while there were a lot of RNP/RNAV specifications, concurrently there was a shortage of defined airspace separation standards. The need for associated standards therefore needed to be addressed.

6.3 The Chairperson pointed out that operating mixed fleet with varied capabilities would be a cause for concern while developing an effective implementation plan. He suggested that some sort of a review of fleet be undertaken by IATA. The IATA Representative did not support the suggestion for a fleet review as different airlines may be operating their aircraft differently.

6.4 Australia felt that States should provide guidance to the operators as to where to invest (in terms of equipment) so that operators are fully aware of the developments taking place at the global level and how best they could take advantage of the technology that is available. While agreeing with the suggestion, the Secretariat stressed on the need to collect sufficient data on where the regional fleet stood vis a vis its equipage with regard to the requirements of PBN.

6.5 Australia while supporting the need for a review of the fleet capability (where we are now and where we go in future) also stressed on the need to undertake a similar review of the navigation infrastructure to determine its ability to support future PBN requirements. Australia pointed out that RNAV operations are supported with surveillance, and radar coverage may be a cause of concern in the Asia Pacific region.

6.6 Thailand suggested that an Action Item be developed whereby States should come back with information on their existing radar coverage.

6.7 IATA stated the need to address two specific areas:

1) ICAO should define the CNS/ATM requirements to support RNP/RNAV; and

2) Both the regulators and operators must clearly understand and appreciate the requirements of the approval process and work towards meeting the requirements of RNP/RNAV

6.8 Pakistan suggested the need to develop Tables and Checklists to support the implementation of PBN. It also sought clarification if it would be appropriate for States to impose restrictions on non-compliant aircraft and whether reserved airspace should be developed for such aircraft. The Secretariat clarified that conventional aircraft would continue to operate in the foreseeable future as such it may not be appropriate for States to impose restrictions.

6.9 New Zealand expressed concern over the difficulties faced by States/operators in showing compliance with the frequent changes/amendments introduced by ICAO. As an example it highlighted that both the PBN Manual and the RNP AR Manual were in draft form but these were expected to be used by States/operators to implement PBN. New Zealand sought assurances as to the viability of these documents. The Secretariat informed the meeting that the PBN Manual would stay in Draft form till the completion of the series of PBN seminars so that any feedback from the seminars could be incorporated. Translation of the Manual in different languages was also causing a delay in the final approval process. However, Vol II of the PBN Manual should be considered as final as it had been issued to States by State Letter under the signature of the Secretary General. It was anticipated that the PBN AR Manual would also receive approval soon.

6.10 Hong Kong China highlighted the issue of AIS data integrity. It suggested that ICAO be requested to review the SARPS in Annex 15 related to RNP.

6.11 Briefly summarizing the issues highlighted during the meeting the Chairperson urged the States to critically consider what issues they would face in implementing PBN at the State level. He suggested the formation of two sub groups to address:

1) Regional Plan and;

2) State Implementation Plan and State Documentation.

6.11.1 He suggested that the two sub groups could consider adapting the two model documents that had been provided (PBN Implementation Plan for States and the CAR/SAM Roadmap for PBN) after necessary changes/amendments to meet the Regional requirements.

6.12 The Secretariat presented WP 5 which included a *worksheet* that each State should complete and submit to ICAO, then keep them updated, providing detailed status regarding current and planned implementation of PBN terminal instrument procedures (SIDs and STARs) and approaches. While discussing the worksheet, the Meeting was requested to provide suggestions to further improve the layout/contents of the worksheet so that it facilitates effective and efficient reporting by States. It was recommended that the Focal Contact Person in each State should be responsible for providing the initial data to the ICAO APAC Regional office by 30 June 2008, and for updating the data as implementation occurs, or no less than an annual basis, by 15 January of each year. Attached at **Appendix E** is the sample Worksheet.

6.13 The Meeting noted that the worksheet proposal called for data to be collected for every end of every runway in the Asia/Pacific region. Recognizing that this would necessitate data gathering and continuous update in respect of the thousands of runway ends in use regionally, the meeting agreed to confine the data collection to runway ends at international aerodromes only and have that submitted to ICAO by June 2008. This was in accordance with ICAO's normal primary focus on international aerodromes. In this context, the meeting agreed that if a State had taken actions to put in place arrangements for PBN based approach/departure procedures at international aerodromes it would be a relatively small step to evolve these processes to include domestic runways. Data on domestic runway is to be submitted to ICAO by December 2008.

6.14 The Meeting met as a single body for the first day and subsequently on the second and third day the two sub groups worked independently to discuss development of the Regional Implementation Plan and the State Implementation Plan.

6.14.1 The plan developed by the First Meeting of the Regional Plan Sub Group Performance Based Navigation Task Force (PBN TF) is placed at **Appendix F**.

6.14.2 The plan developed by the First Meeting of the State Implementation Plan Sub Group Performance Based Navigation Task Force (PBN TF) is placed at **Appendix G**.

Agenda Item 7: Working Arrangements for PBN Task Force

7.1 The meeting agreed that the most effective way to progress the work of the PBN Task Force would be to adopt working methodologies as follows:

1) At the next Meeting the Task Force would initially meet in a plenary session and subsequently continue work as two sub groups.

2) Between the meetings the work would be conducted by email correspondence between the Rapporteur and the Task Force members keeping the Chairperson and the Secretary of the PBN Task Force informed.

Agenda Item 8: Any other business

Establishment of the National Working Group for PBN and GNSS Implementation

8.1 Thailand presented an Information Paper on the establishment of the National Working Group for Performance Based Navigation (PBN) and Global Navigation Satellite System (GNSS) Implementation in Thailand. The paper discussed the working group's Terms of References and the implementation roadmap related to PBN and GNSS implementation over Bangkok FIR. Recognizing the benefits of PBN and GNSS, in May 2007, Thailand established the national working group to foster a cooperative approach among Thailand aviation stakeholders in the implementations of PBN and GNSS over Thailand airspaces. Planning and implementation activities involved participations from Department of Civil Aviation of Thailand as the State regulator, representatives from Thai airline operators, Thai Pilot Association, and Aeronautical Radio of Thailand Ltd. as the air navigation service provider. The three areas of responsibility for the working group are 1) Policy and Implementation Planning; 2) Establishment of Standards and Requirements in accordance with appropriate ICAO requirements; and 3) Communication with Stakeholders.

Implementation of RNP Approaches for Phuket and Krabi International Airports

8.2 Thailand presented an Information Paper discussing the ongoing implementation of RNP Approaches with Baro-VNAV for Phuket and Krabi International Airports. The paper demonstrated the safety benefits of RNP Approaches in term of providing straight-in approach and vertical guide path, and reducing OCA/H. The RNP Approaches at Phuket and Krabi airports are planned to be commissioned in 2008. The meeting congratulated Thailand on the implementation progress.

8.2.1 IATA inquired if there was any plan to implement RNP Approaches and PBN procedures at Bangkok Suvarnabhumi airport. The meeting was informed that the PBN implementation activities for Suvarnabhumi airport is scheduled to start in 2008.

8.2.2 Hong Kong, China inquired if Thailand was planning any RAIM prediction NOTAM service. The meeting was informed that AEROTHAI was planning to provide the RAIM prediction service and RAIM outage NOTAM will be issued if more-than-ten-minute losses of services are predicted within the next seventy-two hours.

Implementation of RNAV in Japan

8.3 Japan provided an update on the implementation of RNAV. Japan implemented new RNAV1 standard Instrument Departures (SIDs) and Standard Instrument Arrivals (STARs) from September 27, 2007. As a result, RNAV operation will be available at major city pairs in Japan by 2010, and available at most other airports by 2012. RNAV routes currently being promulgated in the Japan AIP would require RNAV5 operational approvals from March 13, 2008. Track-to-track spacing of current RNAV routes would be reduced with RNAV5, and airspace capacity would be expanded producing a more efficient operation. In addition, the meeting was informed that Japan planned to replace RNAV (GNSS) approaches which currently do not require RNP 0.3 by RNP approaches in 2008, and implement RNP4 operation in the oceanic in the middle of 2008. Japan would implement RNP AR approaches at airports where beneficial in 2010.

Discussion

8.4 Following the presentation of the country updates by Thailand and Japan the need for RAIM prediction was raised. The Chair advised that the ICAO GNSS Manual, in line with requirements for conventional navigation aids, indicated that States should provide (NOTAM) reports on the status of GPS, if approved. This might take the form of retransmitting the US GPS Status Message and/or providing a RAIM reporting system. An example of such an automated system existed on the Airservices Australia web site - this provided RAIM outage predictions for RNAV (GNSS) approaches in Australia. For more specialised uses, such as Primary Means Enroute and RNP-AR, the approvals required the operator to have a prediction service that used the same algorithms as the approved aircraft.

Role of RASMAG

8.5 The Secretariat drew the attention of the meeting to the role and functions of the APANPIRG Regional Airspace Safety Monitoring Advisory Group (RASMAG). APANPIRG/14 (August, 2003) had noted that the regional airspace monitoring activities at that time were extensive and would continue to grow as more States established data link capability and implemented reduced vertical and horizontal separation minima. Recognizing the need to coordinate and harmonize airspace safety monitoring activities on a regional and inter-regional basis, under the terms of Decision 14/48 APANPIRG established RASMAG as a permanent body with defined Terms of Reference (TORs) to periodically review and evaluate the results of airspace safety assessment and monitoring and provide reporting directly to APANPIRG.

8.6 The establishment of RASMAG was intended to ensure that a group of multi-disciplinary experts with experience in conducting airspace safety monitoring, safety assessments and airspace safety management would be permanently available to advise APANPIRG and States on airspace safety matters. The RASMAG TORs were reviewed recently by APANPIRG/18 (September 2007), resulting in the updated TORs shown as **Appendix H** to this report.

8.7 During its eighth meeting (RASMAG/8, December 2007), RASMAG recalled that in the implementation of RNP and RVSM, major difficulties were being experienced around the region in setting up and operating the ATM safety management arrangements for contiguous airspaces involving several States, especially in terms of airspace safety monitoring and performance of safety assessments. In considering the introduction of PBN based procedures, RASMAG recognized that these procedures would require an appropriate safety basis for implementation.

8.8 RASMAG recalled that experience gained in implementation of airspace changes requiring safety assessments to be performed such as under RVSM and RNP had demonstrated the complexities involved in undertaking such work and highlighted the resource limitations of many States in this area. In this context, RASMAG recognized that as terminal area PBN implementations would be

conducted mainly in sovereign airspaces, individual States would again be mainly responsible for safety management matters. States would need to be able to conduct complex airspace and ATC system analysis and undertake safety assessments and related activities As such, it was likely that assistance would again be needed by some States.

8.9 Considerable effort and progress has been made by RASMAG to establish regional safety oversight mechanisms through the regional monitoring agencies (RMAs) and safety monitoring agencies (SMAs) for application of vertical and horizontal separation respectively. However, RASMAG considered that at this stage of the Asia/Pacific PBN implementation it was not clear what level of implementation and ongoing monitoring would be necessary and therefore it was difficult to assess what level of RASMAG involvement would be required.

8.10 Nevertheless, in fulfilling its objectives for facilitating the safe implementation of reduced separation minima and CNS/ATM applications within the Asia/Pacific regions in the context of airspace safety assessment and monitoring responsibilities, RASMAG offered support to the PBN Task Force to assist with the oversight of airspace safety and monitoring matters relevant to PBN implementations as the work of the Task Force progressed. To facilitate this process, the Secretariat would routinely provide update reporting to the 6 monthly RASMAG meetings for review.

Agenda Item 9: Date and venue for the next meeting

9.1 The Meeting recognized that significant extra work by the PBN Task Force would be necessary to finalize the plan by the two sub groups. The Meeting agreed to hold two meetings prior to the CNS/MET/SG/12 meeting as under:

1) Second Meeting of the PBN Task Force , 1 – 3 April, Bangkok

2) Third Meeting of the PBN Task Force, 16 – 18 July, Bangkok

10. Closing of the Meeting

10.1 The Representative from Pakistan thanked the ICAO Asia Pacific Office for the excellent arrangements for the conduct of the First PBN Task Force Meeting. He lauded the efforts by the Chairperson in providing focused leadership and Rapporteurs for their dedication and hard work. He wished the PBN Task Force success in the implementation of PBN.

10.2 In his closing remarks the Chairperson applauded the enthusiasm and interest displayed by all participants throughout the three day meeting. He was pleased to note that the PBN/TF Meeting had more than adequately identified the value of PBN and the work done in the field. Noting the guidance and direction provided by the 36th Assembly Resolution, the APANPIRG/18 and the 44th DGCA Conference, the Chairperson asserted that the PBN Task Force would spare no effort to ensure effective and efficient implementation of PBN in the Asia/Pacific region. Acknowledging that issues and impediments would still need to be addressed, the Chairperson exhorted that focus be maintained in the following areas:

- Continued education and training;
- ICAO must continue to provide assistance and direction; and further develop guidance on separation standards and approach procedures;
- The participants (TF members and Focal Contact Persons) need to go back and review their State legislation, regulations, and guidance so as to ensure that their State material adequately reflected the PBN requirements / material necessary to

move forward with implementation;

- Continued awareness of the need to educate the industry in relation to buying new aircraft/ equipment, and upgrading the avionics on board the aircraft;

- Complexity and need for PBN compliant aircraft; and

- Note the number of deliverables in the Implementation Plan /Task List.

10.3 The Chairperson asked the Task Force Members/Contact Persons to continuously bear in mind the Terms of Reference of the PBN Task Force and the expectations from the Assembly Resolution, the APANPIRG/18 decisions and the Action Items form the 44th DGCA Conference. He reminded the participants to note that the 2nd Meeting of the PBN Task Force is scheduled for 1-3 April, 2008 at Bangkok. Invitation to the meeting would be issued by the ICAO Asia/Pacific Office in due time. The Chairperson thanked the ICAO Asia/Pacific Office in hosting the meeting and Mr. David VanNess for providing technical guidance during the meeting. Mr. Mallett appreciated the work put in by the Secretary and his colleagues in ensuring the success of the meeting. The Chairperson thanked all participants for their cooperation and was specially appreciative of the two Rapporteurs Mr. Nappadol Pringvanich and Mr. Henrik Nielsen for successfully guiding the two sub groups and developing a fairly comprehensive Implementation Plan and Task List.

10.3.1 Mr. David VanNess, Implementation and Resource Development Coordinator, ICAO PBN Programme thanked the Regional Office for supporting the PBN Task Force Meeting. He appreciated the efforts of the Chairman and all participants, and complimented the APAC Region for taking the steps that are needed to be taken in the implementation of PBN.

10.4 The Secretary, PBN Task Force thanked the Chairperson and all participants for the support and cooperation.

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FIRST MEETING OF THE PERFORMANCE BASED NAVIGATION TASK FORCE (PBN/TF/1)
Bangkok, Thailand, 9 - 11 January 2008

LIST OF PARTICIPANTS

	ADMINISTRATIONS/ ORGANIZATIONS	NO.	NAME	DESIGNATION/ADDRESS	TEL/FAX/EMAIL	AREA OF INTEREST STATE PLAN (SP) / REGIONAL PLAN (RP)
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LIST OF WORKING PAPERS (WPs) AND INFORMATION PAPERS (IPs)

WORKING PAPERS

Number	Agenda	Title	Presented by
WP/1	1	Provisional Agenda	Secretariat
WP/2	3	Introduction to Performance Based Navigation	Secretariat
WP/3	4	Outcome of 36th ICAO Assembly, 44th Conference of DGCA Asia/PAC Region and APANPIRG/18 on Performance Based Navigation	Secretariat
WP/4	5	Terms of Reference for Performance Based Navigation Task Force	Secretariat
WP/5	6	State Performance Based Navigation (PBN) Approach and Terminal Implementation Status	Secretariat

INFORMATION PAPERS

Number	Agenda	Title	Presented by
IP/1	-	List of Working Papers and Information Papers	Secretariat
IP/2	6	CAR/SAM Roadmap for Performance Base Navigations (PBN)	Secretariat
IP/3	8	The Role of the APANPIRG Regional Airspace Safety Monitoring Advisory Group	Secretariat
IP/4	8	Establishment of the National Working Group for PBN and GNSS Implementation	Thailand
IP/5	8	Implementation of RNP Approaches for Phuket and Krabi International Airports	Thailand

OUTCOMES OF APANPIRG/18, 36th ASSEMBLY AND 44th DGCA

APANPIRG/18
Report on Agenda Item 3.5

3.5 Other Air Navigation Matters

Performance Based Navigation (PBN)

3.5.1 The meeting was advised of the worldwide growing importance of PBN in respect of aviation safety and developing plans to ensure a globally harmonized and coordinated transition to PBN by 2016 for international and domestic operations. The Eleventh Air Navigation Conference (September-October 2003, Montreal) recommended that ICAO, as a matter of urgency, address and progress the issues associated with the introduction of RNP and area navigation (RNAV) (Recommendation 6/5 refers). Discussions during the Worldwide Symposium on Performance of the Air Navigation System also identified a need to accelerate the implementation of PBN.

3.5.2 The meeting noted the considerable activities undertaken by ICAO in relation to PBN. The ICAO Required Navigation Performance Special Operational Requirements Study Group (RNPSORSG) addressed a divergence of implementation that resulted in a lack of harmonization between RNP applications and the significant confusion that had developed regarding concepts, terminology and definitions. As a result of the Study Group's work, ICAO developed the PBN concept. This concept includes two key "building block" elements: RNAV and RNP. PBN brings together, under one umbrella, a number of diverse RNAV and RNP applications encompassing all regimes of flight, from enroute to approach. PBN provides a framework of harmonized modern navigation operational approval requirements that make use of available navigation systems and aircraft capability. In addition to enhanced safety, PBN would provide significant benefits in terms of fuel savings, accessibility and flexibility in terminal areas and in addressing environmental problems (emissions and noise).

3.5.3 The meeting recognized that the State letter AN 11/45-07/22, *Guidance material for the issuance of performance based navigation (PBN) operational approvals*, was distributed on 27 April 2007 in order to avoid proliferation of operational approval requirements. The State letter contained guidance material on implementing PBN and provided the globally harmonized navigation specifications that could be used as the basis for operational approvals for PBN operations. This guidance material will become Volume II of the *Performance Based Navigation Manual* (Doc 9613).

3.5.4 Volume II of the new ICAO PBN Manual would contain detailed technical "Navigation Specifications" with standardized, harmonized airworthiness and operator requirements for several RNAV and RNP operations. These standardized Navigation Specifications draw from the extensive experience in technical requirements definition of States that have implemented PBN and also contain detailed recommendations for pilot and controller training.

3.5.5 The meeting noted that the RNPSORSG would resume work in 2008 to develop additional Navigation Specifications, possibly for RNP 2 and Advanced RNP 1. These specifications would be included in a future edition of the PBN Manual. Provisions are under development by the responsible ICAO groups and panels to align the Annexes and PANS-OPS with the PBN Manual.

3.5.6 The meeting noted that nine "Introduction to PBN" Seminars would be conducted over the next year in different ICAO Regions to familiarize States and stakeholders with the PBN concept and how to implement PBN. The next seminars were 11-14 September 2007 in Bangkok, Thailand and 17-21 September 2007 in New Delhi, India. Maximum participation by all stakeholders in PBN implementation was encouraged. The target audience was ATM planners, air navigation service providers, air operators, aerodrome operators, regulators, air traffic controllers and procedure

designers, among others. Additional information on the seminars and on PBN in general, including a Web-based PBN training course developed by EUROCONTROL for ICAO, can be found on the ICAO PBN website www.icao.int/pbn.

3.5.7 Recognizing that the PBN concept was now established, the meeting noted the need for ensuring a globally harmonized and coordinated transition to PBN for international and domestic operations. In this regard, the meeting urged States to ensure that all RNAV and RNP operations and procedures were in accordance with the PBN concept as detailed in State letter AN 11/45-07/22 and the PBN manual.

3.5.8 The meeting noted that a paper would be presented by the ICAO Secretariat to the 36th Assembly of ICAO in September 2007 proposing a resolution to be adopted by the Assembly setting the following global goals for implementation of PBN.

a) where RNAV operations are required, enroute (oceanic and continental) and terminal ATS routes should be implemented according to PBN by 2016, with intermediate milestones as follows:

   1) enroute oceanic and remote airspace (RNAV 10 or RNP 4): 100 per cent implementation by 2010;

   2) enroute continental airspace (RNAV 5, 2 and 1): 70 per cent by 2010, 100 per cent by 2014; and

   3) terminal area (RNAV 1 and 2, and basic RNP 1): 30 per cent by 2010, 60 per cent by 2014, 100 per cent by 2016; and

b) all instrument runway ends should have an approach procedure with vertical guidance (APV), either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014.

3.5.9 The meeting considered that implementation of PBN in the region was very important and would yield efficiency and safety benefits in the short term. The meeting anticipated that for PBN to become widely implemented considerable effort would need to be put into planning and identifying what airspace measures could be introduced and the level of air navigation service required. Additionally, PBN activities would require participation from the many disciplines involved, such as flight operations, air navigation service providers, safety management, industry partners both technical and operational, etc. Noting that the participation of all stakeholders in the development of a PBN implementation plan was essential, the meeting agreed that the establishment of a PBN Task Force would likely be the best vehicle to achieve the objective of an accelerated PBN implementation programme regionally. After consideration of the information provided and in order to ensure timely progress in PBN planning and implementation in the region, the meeting agreed to the following Conclusion.

Conclusion 18/52 – Establishment of a Regional Performance Based Navigation Task Force (PBN/TF)

That, an Asia/Pacific PBN Task Force, with terms of reference as outlined in **Appendix A** to the APANPIRG/18 Report on Agenda Item 3.5, be established to develop a PBN implementation plan for the Asia/Pacific Region and address related regional PBN implementation issues.

3.5.10 The meeting noted the need to convene the first meeting of the Task Force as soon as practicable in order to continue the impetus expected to be created by the upcoming PBN seminars.

3.5.11 The meeting noted that implementation of PBN would be enhanced by the development by States of a PBN implementation plan, geared towards achieving the global PBN implementation performance objectives. Guidance on developing the PBN implementation plan is contained in the PBN Manual. The PBN implementation plan should be developed in full cooperation and coordination with all stakeholders, including regulators, air navigation service providers (ANSPs), aerodrome operators, air operators and others, as appropriate. Some States may wish to implement PBN sooner than the performance objectives stated above in order to more quickly take advantage of the benefits that PBN has to offer. Other States might not be able to comply with all aspects of the performance objectives (e.g. operational constraints); however, this should be clearly substantiated in the implementation plan. In order to achieve the global goals mentioned above State PBN implementation plans should be in place by 2009. Accordingly the meeting formulated the following Conclusion.

Conclusion 18/53 – Development of State PBN Implementation Plans

That, the Regional Office encourages States to begin development of their State PBN implementation plans in harmony with the development of the Asia/Pacific Regional PBN implementation plan being coordinated by the Asia/Pacific PBN Task Force for submission to APANPIRG/19 (2008).

3.5.12 The meeting noted that there was a need for more information and understanding of how application of the PBN would impact upon the ATM system requirements and flight operations and what changes would need to be made to airspaces to gain PBN based benefits. Experience gained in implementation of airspace changes requiring safety assessments to be performed such as under RVSM and RNP has demonstrated the complexities involved in undertaking such work and highlighted the resource limitations of many States in this area. Implementation of PBN with related changes to airspaces, procedures and separation, etc would likely place new and challenging requirements on States who would require considerable assistance and guidance through seminars, workshops and guidance material. Recalling that one of the main requirements to operate aircraft in RNP and RVSM environments was State approval of aircraft and operators, the meeting considered that this would also be the case with PBN approvals. In this regard, the provision of model approval documentation and gaining the technical expertise to manage the process was an important consideration. In addition, as implementation of PBN proceeds, there will likely be a need to develop and/or maintain the currency of Standards and Recommended Practices (SARPs) and guidance material in order to ensure a globally harmonized response to operational demands. To facilitate progress in these specific areas, the meeting formulated the following Conclusion:

Conclusion 18/54 – Globally Harmonized SARPS and Guidance Material for PBN

That, ICAO be invited to continue to ensure development and maintenance of globally harmonized PBN SARPs and guidance materials to keep pace with operational PBN implementation demands, including development of model documentation suitable for adaptation by State regulatory authorities in implementing State aircrew and airframe approvals processes for PBN.

3.5.13 As well as encouraging States to participate in the upcoming Introduction to PBN Seminars, the meeting considered that States should also nominate a focal point of contact responsible for PBN implementation. In view of this, the meeting formulated a Conclusion as follows:

Conclusion 18/55 – Designation of Contact Person for PBN Implementation

That, by 31 December 2007, States designate a focal contact person responsible for performance based navigation implementation and provide details of the contact person to ICAO Asia/Pacific Regional Office accordingly.

3.5.14 The meeting noted that the coordinated effort generated by the development of Regional and State PBN implementation plans would support Global Planning Initiatives (GPIs) as defined in the latest edition of the ICAO Global Air Navigation Plan as well as the Global Safety Initiatives (GSIs) as defined in the recent edition of the ICAO Global Aviation Safety Plan. It would also constitute an expansion of the programme envisaged by the 33rd Session of the Assembly which adopted Resolution A33-16, *ICAO Global Aviation Safety Plan (GASP)* that requested the Council "to develop a programme to encourage States to implement approach procedures with vertical guidance (APV) utilizing such inputs as GNSS or DME/DME, in accordance with ICAO provisions."

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36th ASSEMBLY

A36-23: Performance based navigation global goals

Whereas a primary objective of ICAO is that of ensuring the safe and efficient performance of the global Air Navigation System;

Whereas the improvement of the performance of the Air Navigation System on a harmonized, worldwide basis requires the active collaboration of all stakeholders;

Whereas the Eleventh Air Navigation Conference recommended that ICAO, as a matter of urgency, address and progress the issues associated with the introduction of area navigation (RNAV) and required navigation performance (RNP);

Whereas the Eleventh Air Navigation Conference recommended that ICAO develop RNAV procedures supported by global navigation satellite system (GNSS) for fixed wing aircraft, providing high track and velocity-keeping accuracy to maintain separation through curves and enable flexible approach line-ups;

Whereas the Eleventh Air Navigation Conference recommended that ICAO develop RNAV procedures supported by GNSS for both fixed and rotary wing aircraft, enabling lower operating minima in obstacle rich or otherwise constrained environments;

Whereas Resolution A33-16 requested the Council to develop a programme to encourage States to implement approach procedures with vertical guidance (APV) utilizing such inputs as GNSS or distance measuring equipment (DME)/DME, in accordance with ICAO provisions;

Recognizing that implementation of approach with vertical guidance (APV) is still not widespread;

Recognizing that the Global Aviation Safety Plan has identified Global Safety Initiatives (GSIs) to concentrate on developing a safety strategy for the future that includes the effective use of technology to enhance safety, consistent adoption of industry best practices, alignment of global industry safety strategies and consistent regulatory oversight;

Recognizing that the Global Air Navigation Plan has identified Global Plan Initiatives (GPIs) to concentrate on the incorporation of advanced aircraft navigation capabilities into the air navigation system infrastructure, the optimization of the terminal control area through improved design and management techniques, the optimization of the terminal control area through implementation of RNP and RNAV SIDs and STARs and the optimization of terminal control area to provide for more fuel efficient aircraft operations through FMS-based arrival procedures; and

Recognizing that the continuing development of diverging navigation specifications would result in safety and efficiency impacts and penalties to States and industry;

The Assembly:

1. *Urges* all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the *Performance Based Navigation Manual* (Doc 9613);

2. *Resolves* that:

a) States and planning and implementation regional groups (PIRGs) complete a PBN implementation plan by 2009 to achieve:

1) implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones; and

2) implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014; and

b) ICAO develop a coordinated action plan to assist States in the implementation of PBN and to ensure development and/or maintenance of globally harmonized SARPs, Procedures for Air Navigation Services (PANS) and guidance material including a global harmonized safety assessment methodology to keep pace with operational demands;

3. *Urges* that States include in their PBN implementation plan provisions for implementation of approach procedures with vertical guidance (APV) to all runway ends serving aircraft with a maximum certificated take-off mass of 5700 kg or more, according to established timelines and intermediate milestones.

4. *Instructs* the Council to provide a progress report on PBN implementation to the next ordinary session of the Assembly; and

5. *Requests* the Planning and Implementation Regional Groups (PIRG) to include in their work programme the review of status of implementation of PBN by States according to the defined implementation plans and report to ICAO any deficiencies that may occur.

- - - - - - - -

44th DGCA

Action Item 44/6 **Implementation of Performance Based Navigation (PBN)**

Recognizing the importance of PBN for improving safety, capacity and efficiency of air navigation, the Conference urged the States to:

a) implement PBN as per ICAO guidance material;

b) support the PBN Task Force established by APANPIRG/18 and designate a focal contact point for coordinating implementation of PBN.

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Asia Pacific Air Navigation Planning and Implementation Regional Group
Performance Based Navigation (PBN) Task Force

Proposed Amendment by PBN/TF to the
Terms of Reference

1) Develop an Asia Pacific Regional PBN implementation plan, based on a gap analysis, and in line with the ICAO PBN goals and milestones. This PBN implementation plan must be based on the following strategic objectives and guiding principles.

Strategic objectives:

a) To ensure that the implementation of the navigation item of the CNS/ATM system is based on clearly established operational requirements.

b) To avoid undue equipage of multiple on board equipment and/or ground-based systems.

c) To avoid the need for multiple airworthiness and operational approvals for intra- and inter-regional operations.

d) To explain in detail the contents of the Regional Air Navigation Plan and of the Regional CNS/ATM Plan, describing potential navigation applications.

Guiding principles:

a) Pre- and post-implementation safety assessments will be conducted to ensure the application and maintenance of the established target levels of safety.

b) Continued application of conventional air navigation procedures during the transition period, to guarantee the operations by users that are not RNAV- and/or RNP-equipped.

c) The first regional PBN implementation plan should address the short term (2008-2012)**,** ~~and~~ medium term (2013-2016) **and take into account long term global planning issues**.

d) Target date for completion of the first regional PBN implementation plan is APANPIRG/19.

2) Carry out specific studies, develop guidance material and facilitate training to assist States with RNAV/RNP implementation in the en-route, terminal, and approach flight phases **including Approach Procedure with Vertical Guidance (APV)**, taking into account the performance based navigation (PBN) concept, according to the ICAO Strategic Objectives and Global Plan Initiatives (GPI) on this matter (GPI 5, 7, 10, 11, 12, 20, 21)

3) Identify other issues/action items arising from the work of ICAO or for consideration by ICAO in order to facilitate regional and global harmonization of existing applications as well as future implementation of Performance Based Navigation operations;

4) Review the States' PBN implementation documentation to ensure regional harmonization and for possible inclusion in ICAO-developed model documentation.

5) Address other regional PBN implementation issues as needed.

6) The Task Force should report to the APANPIRG, through the CNS/MET Sub-group in coordination with the ATM/AIS/SAR Sub-group and RASMAG.

Membership

Proposed membership of the Task Force should include, but is not limited to, the following:

Australia, China, Hong Kong-China, India, Japan, New Zealand, Singapore, Thailand, United States and IATA and IFALPA.

Rapporteur

At the first meeting the Task Force will elect a Rapporteur from among its members to Chair its meetings.

———————

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	NO	ICAO REGION	ICAO DESIG	AIRPORT NAME[5]	COUNTRY	INTL (Y/N)[1]	RUNWAY	INST RWY Y/N	RESTRICTIONS IF ANY	APPROACH TYPE[2,7]	APPR EFF DATE[6]	RNAV/RNP SID[3]	SID EFF DATE[6]	RNAV/RNP STAR[4]	STAR EFF DATE[6]	COMMENTS[7]
2	1															
3	2															
4	3															
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52

53 **1.** If the aerodrome is used for international operations, including as an alternate, enter 'Y', if not, enter 'N' **2.** If RNP APCH only, enter RNP APCH. If RNP APCH with Baro-VNAV only, enter RNP APCH-VNAV. If both enter BOTH. If RNP AR, enter RNP AR APCH. If there is an RNP AR to the same runway that also has an RNP APCH and/or RNP APCH-VNAV then enter the RNP AR on a separate line for that runway. If this block is filled out "RNP APCH", then provide some explanation in the comments block, e.g. either, "planning to upgrade to RNP APCH-VNAV by [date] or APV not feasible for [reason], **3.** If RNAV or RNP SID exists for this runway, note navigation specification, RNAV 1, RNAV 2, or Basic-RNP 1. If not based on a PBN navigation specification, enter RNAV. **4.** If RNAV or RNP STAR exists for this aerodrome note navigation specification, RNAV-1, RNAV 2, or Basic-RNP 1. If not based on a PBN navigation specification, enter RNAV. **5.** Should list all instrument aerodromes and runway ends in the State, as well as non-instrument runway ends that may be used by aircraft in excess of 5700 kg MTOW. Leave blank blocks J-O as appropriate, if PBN or RNAV approaches, SIDs or STARs are not implemented or planned to be implemented yet for that runway as part of the State PBN Implementation Plan. **6.** Enter actual effective date or proposed future effective date as 3-letter month-2-digit year: Oct-07 **7.** Provide any relevant comments

INTERNATIONAL CIVIL AVIATION ORGANIZATION

REPORT OF THE FIRST MEETING OF REGIONAL PLAN SUBGROUP TO THE FIRST MEETING OF THE PERFORMANCE BASED NAVIGATION TASK FORCE (PBN/TF/1)

BANGKOK, THAILAND
9 – 11 JANUARY 2008

The views expressed in this Report should be taken as those of the PBN/TF and not of the Organization.

Adopted by the PBN/TF
and published by the ICAO Asia/Pacific Office

Report of the First Meeting of Regional Plan Subgroup to the First Meeting of Performance Based Navigation Task Force (PBN/TF/1)

1. The First Meeting of Regional Plan Subgroup, Performance Based Navigation Task Force was held in Bangkok on 10-11 January 2008, during the First Meeting of the Performance Based Navigation Task Force.

2. The meeting was attended by participants from Australia, Bhutan, China, Hong Kong China, India, Japan, Malaysia, Maldives, New Zealand, Philippines, Singapore, Sri Lanka, Thailand, United States, Vietnam, ICAO, IATA and IFALPA.

3. Mr. Noppadol Pringvanich, Executive Officer Systems Engineering, Aeronautical Radio of Thailand, was nominated as the Chairperson of the Subgroup. Mr. Noppadol Pringvanich assumed the Chair and thanks the meeting for the honor bestowed.

4. The Chair reminded the meeting the task of the Subgroup to develop the PBN Regional Plan by the upcoming APANPIRG/19 meeting. He requested active participations from all subgroup members to ensure the successful completion of the Regional Plan.

5. The Subgroup collectively identified the issues/activities that are considered important for the development of the PBN Regional Plan. The important issues/activities that are identified are:
   - Identify clear goals and objectives
   - Focus on future implementations, while being mindful with transitional period
   - Identify short falls preventing successful implementations of PBN in the Region
   - Harmonize operational procedures
   - Harmonize operator approval process
   - Needs of safety assessments and monitors
   - Be compliance with ICAO PBN Manual
   - Identify ways and means to share resources and experiences
   - Needs of PBN trainings, especially in the fields of procedure design, ATC operation, flight crew operation, and approval process

6. Using CAR/SAM Roadmap for PBN as the basis for discussion, the Subgroup developed and agreed upon the Table of Content for APAC PBN Regional Plan as shown in **Attachment 1**.

7. The Subgroup discussed several alternatives on the categorization of routes. The three alternative proposals the Subgroup considered are:
   Choice 1
   - Oceanic & Remote
   - Continental En-route

   Choice 2
   - Remote oceanic
   - Oceanic
   - Remote continental
   - Continental en-route

   Choice 3
   - Remote
   - En-route

8. After discussion, the Subgroup selected Choice 2 as its preferred option. Reservation was also made for any possible future adjustments.

9. In regarding to the drafting of the Regional Plan, the Subgroup agreed that each section of the regional plan should be drafted in consistent with the guiding principles laid out in the Terms of Reference of the Task Force.

10. The Chair requested that the drafting of each section of the Regional Plan should be completed and submitted to the Chair two weeks prior the next Task Force meeting to facilitate document integration and dissemination.

11. The Subgroup developed and agreed upon the task list in **Attachment 2**.

12. The meeting congratulated the Chair for excellent chairmanship and meeting arrangement. The Chair appreciated the comments and looked forward to future cooperation from the Subgroup members.

13. The Chair thanked all the Subgroup members for their hard works and contributions. He wishes all the members a safe journey home.

Attachment 1: Table of Contents for APAC PBN Regional Plan

- Table of Contents
- Executive Summary
- Explanation of Terms
- Acronyms
- Introduction
    - Need for the Road Map
    - Navigation roles in supporting operations
    - Benefits of performance-based navigation
    - Goals & Objectives of PBN Implementation
    - Principles
- PBN Operational requirements & Implementation Strategy
    - Route
        - Remote oceanic
        - Oceanic
        - Remote continental
        - Continental en-route
    - TMA
        - Arrival
        - Departure
    - Approach
- Current Status & Forecast
    - APAC traffic forecast
    - Aircraft fleet readiness status
    - CNS Infrastructure
        - Existing navigation capabilities
            - GPS Assessment
            - Other PBN navigation infrastructure
        - Existing surveillance capabilities (Note: as related to PBN)
            - Surveillance requirements
            - Surveillance coverage maps
                - RADAR coverage map above 29000 ft
                - ADS-B coverage map above 29000 ft
        - Existing communication capabilities (Note: as related to PBN)
            - Communication requirements
- Implementation Roadmap of Performance Based Navigation
    - ATM Operational Requirements
    - Short Term
        - Route
            - Remote oceanic
            - Oceanic
            - Remote continental
            - Continental en-route
        - TMA
            - Arrival
            - Departure
        - Approach
        - Summary table & Implementation targets

Short Term (2008-2012)	
Airspace	**Navigation Specification**
Route - Remote oceanic	
Route – Oceanic	
Route - Remote continental	
Route - Continental en-route	
TMA – Arrival	
TMA – Departure	
Approach	

- Medium Term
  - Route
    - Remote oceanic
    - Oceanic
    - Remote continental
    - Continental en-route
  - TMA
    - Arrival
    - Departure
  - Approach
  - Summary table & Implementation targets

Medium Term (2013-2016)	
Airspace	**Navigation Specification**
Route - Remote oceanic	
Route – Oceanic	
Route - Remote continental	
Route - Continental en-route	
TMA – Arrival	
TMA – Departure	
Approach	

- Long Term (2016 and beyond)
  - Implementation strategies

- Transitional Strategies
- Safety Assessments & Monitors
  - Methodology
  - Roles & Responsibilities
- Post-implementation activities
  - Implementations status
  - Challenges

Appendix A -Reference documentation for developing operational and airworthiness approval
Appendix B – Practical Example of tangible benefits
Appendix C – Procedure to modify the regional plan

Attachment 2: Regional Plan Subgroup, PBN TF — TASK LIST

No.	PERFORMANCE OBJECTIVE	ICAO Strategic Objective	Associated GPI	Tasks/Strategy	Benefits	Deliverables	Target Date	Leader	Supporting Members	Status
1-1	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Introduction** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document	17 March 2008	Mr. Noppadol Pringvanich (AEROTHAI)	– Mr. Doug Michael (IATA)	Ongoing
1-2	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **PBN Operational requirements & Implementation Strategy** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document	17 March 2008	Mr. Noppadol Pringvanich (AEROTHAI)	– Mr. Doug Michael (IATA), – Mr. Tan Yean Guan (CAA Singapore), – Mr. Raymond Kwok-chu LI (CAD Hong Kong), – Mr. WXS Croos (Airport&Aviation Sri Lanka), – Capt Korn Mansumitchai (IFALPA), – Mr. Liu Song (CAAC)	Ongoing
1-3	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Current Status & Forecast: APAC traffic forecast** Section for Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document	17 March 2008	Mr. Doug Michael (IATA)	– Mr. Noppadol Pringvanich (AEROTHAI)	Ongoing

No.	PERFORMANCE OBJECTIVE	ICAO Strategic Objective	Associated GPI	Tasks/Strategy	Benefits	Deliverables	Target Date	Leader	Supporting Members	Status
1-4	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Current Status & Forecast: Aircraft fleet readiness status** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document	17 March 2008	Mr. Doug Michael (IATA)	– Mr. Noppadol Pringvanich (AEROTHAI)	Ongoing
1-5	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Current Status & Forecast: CNS Infrastructure** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document	17 March 2008	Mr. Noppadol Pringvanich (AEROTHAI)	– All RPSG members	Ongoing
1-6	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Safety Assessments and Monitors** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document	17 March 2008	Mr. Hajime Yoshimura (JCAB)	– Mr. Tan Yean Guan (CAA Singapore), – Capt. Alex Passerini (Qantas-Australia)	Ongoing
1-7	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Appendix A - Reference documentation for developing operational and airworthiness approvals** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document	17 March 2008	Capt. Alex Passerini (Qantas-Australia)	– Mr. Doug Michael (IATA), – Mr. Noppadol Pringvanich (AEROTHAI)	Ongoing

No.	PERFORMANCE OBJECTIVE	ICAO Strategic Objective	Associated GPI	Tasks/Strategy	Benefits	Deliverables	Target Date	Leader	Supporting Members	Status
1-8	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Appendix B – Practical Example of tangible benefits** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document	17 March 2008	Capt. Alex Passerini (Qantas-Australia)	– Mr. Edsall Williams (Airservices-Australia), – Mr. Noppadol Pringvanich (AEROTHAI)	Ongoing
1-9	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Draft **Appendix C – Procedure to modify the regional plan** Section for PBN Regional Plan	To facilitate the development of the Regional Plan	Draft document	17 March 2008	Mr. Li Peng (ICAO APAC)	– Mr. Noppadol Pringvanich (AEROTHAI)	Ongoing
1-10	PBN Coordination & Implementation	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Identify the short falls preventing the implementation of PBN	To identify preventive measures and to support PBN implementation	Working Papers	1 April 2008	All RPSG members		Ongoing
1-11	PBN Coordination & Implementation	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Identify training requirements	To assist States in their planning and implementations	Working Papers	1 April 2008	All RPSG members		Ongoing
1-12	PBN Coordination & Implementation	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Assess possibilities of future PBN seminar	To assist States in their planning and implementations	Working Papers, Information Papers	1 April 2008	All RPSG members		Ongoing

No.	PERFORMANCE OBJECTIVE	ICAO Strategic Objective	Associated GPI	Tasks/Strategy	Benefits	Deliverables	Target Date	Leader	Supporting Members	Status
1-13	PBN Coordination & Implementation	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Identify ways and means to share resources	To assist States in their planning and implementations	Working Papers	1 April 2008	All RPSG members		Ongoing
1-14	PBN Certification Process	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	Develop standard template for application & approval package	To harmonize PBN approval process within the region	Working Papers, Draft template	1 April 2008	Capt. Alex Passerini (Qantas-Australia)	– Mr. Doug Michael (IATA), – Capt. Aric Oh (IATA)	Ongoing
1-15	PBN Planning	A: Safety D: Efficiency C: Environment	GPI-5, GPI- 7, GPI-10, GPI-11, GPI-12, GPI-20, GPI-21	ICAO, via a State letter, to request States to update information on CNS infrastructure in the FASID table	To obtain information necessary for regional planning	State letters, Updated FASID table	1 April 2008	ICAO Bangkok Office		Ongoing

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INTERNATIONAL CIVIL AVIATION ORGANIZATION

REPORT OF THE PBN STATE IMPLEMENTATION SUB GROUP TO THE FIRST MEETING OF THE PERFORMANCE BASED NAVIGATION TASK FORCE (PBN/TF/1)

BANGKOK, THAILAND
9 – 11 JANUARY 2008

The views expressed in this Report should be taken as those of the PBN/TF and not of the Organization.

Adopted by the PBN/TF
and published by the ICAO Asia/Pacific Office

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PART I: INTRODUCTION

PART II: DISCUSSION

PART III: ATTACHMENTS

PART I INTRODUCTION

1. Time and Place

1.1 The first meeting of the PBN State Implementation Working Group under the Performance Based Navigation Task Force was held in Bangkok, Thailand in break-out sessions during the main 9 to 11 January, 2008 meeting at the Kotaite Wing of the ICAO Asia/Pacific Office. The PBN State Implementation Working Group was one of two working groups created – the other group was the PBN Regional Implementation Working Group.

2. Attendance

2.1 The working group meeting was attended by approximately 25 participants from the main TF1 meeting group consisting of Australia, Bhutan, China, Hong Kong China, India, Japan, Malaysia, Maldives, New Zealand, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, United States, Vietnam, ICAO, IATA and IFALPA.

3. Opening of the Working Group Meeting

3.1 The working group forum was initially chaired by Mr David van Ness (ICAO, Montreal) in caretaker mode until a representative from a regional member state could be found to chair the meeting. Mr Henrik Nielsen (CASA, Australia) chaired the meeting from the second session.

4. Aims

4.1 The aims of the working group, with regards to implementation of PBN, were to:

a) collectively assess the current levels of State operations and initial intent,

b) provide a list of issues which should be addressed during implementation, and

c) establish how States can best collaborate and share information and experiences.

PART II: DISCUSSION

5. Current Levels of State Operations and Initial Intent

5.1 The chairman proposed, and the meeting agreed, that each State representative shall provide a brief presentation at the next meeting on their current level of operation and initial intent with regards to implementation of PBN. This effort is intended to provide a collective 'picture' of the starting position and intent of the Region as a whole. It will also allow each state to be more closely aware of how it is progressing compared to other member States.

ACTION 1: *Each State representative is to provide a brief presentation on their current level of operation and initial intent, with regards to PBN.* ***TIME****: By the next meeting of the Working Group.*

6. List of Issues

6.1 The majority of the group's time was spent establishing a grouped list of issues that should be addressed during implementation of PBN. The meeting agreed that in this list, there are local as well as general issues. While the local issues must be specifically addressed by individual States, the meeting agreed that, where possible, collaboration should be instituted to help ensure that PBN is

implemented as widely as possible throughout the Regions. Further work is required to further tune the list and identify which are local and which are general issues. The current status of the list of issues is included at Attachment 1.

ACTION 2: *The List of Issues is to be further refined.* ***TIME****: At the next meeting of the Working Group.*

7. PBN Training Material

7.1 Mr Ian Mallett offered for Australia and QANTAS to develop a generic training framework with regards to achieving PBN operations. While the overall framework addresses training in general, it is intended that specific training material will be developed for areas including, but not limited to:

a) Pilots,

b) Controllers, and

c) Regulators.

7.2 IATA and IFALPA agreed to assist Australia and QANTAS with review of training material relating specifically to pilots.

ACTION 3: *Australia / QANTAS, with oversight by IATA / IFALPA, are to present progress of a training framework and packages for PBN training for Pilot, Controllers, and Regulators etc.* ***TIME:*** *At the next meeting of the Working Group.*

8. On-The-Job Participation Opportunities and Regulatory Oversight

8.1 Mr David van Ness suggested, and the meeting agreed, that each State should provide feedback to the next meeting, on their willingness to provide on-the-job training and quality assurance and assistance, specifically relating to PBN procedure design, for other States.

ACTION 4: *States are to provide feedback on their willingness to provide on-the-job training and assistance specifically with regards to PBN procedure design for other States.* ***TIME:*** *At the next meeting.*

9. Provision of Model Operational and Airworthiness Approval Documentation for PBN RNAV5

9.1 The meeting agreed that China, Hong Kong, and New Zealand work together to provide a generic Model Operational and Airworthiness Approval documentation for other States to use. This model is to be created from a combination of sources including documents from China, New Zealand, and is intended only as guidance.

ACTION 5: *China, Hong Kong, and New Zealand shall provide generic Model Operational and Airworthiness Approval Documentation for use by other States as guidance.* ***TIME:*** *At the next meeting.*

ATTACHMENT 1: LIST OF PBN IMPLEMENTATION ISSUES

Preliminary
- Senior Management (up to DG and Minister level)
- Education/Knowledge
- Commitment
- Timeline
- Safety Assessments

Gap analysis
- Equipage
- Personnel / Capability
- Shortage of procedure designers

Legislation
WGS 84
Benefits:
- Safety (CFIT)
- Access
- Airspace capacity
- Efficiency
- Environment
- Cost/Benefit Analysis
- All stakeholders
- RNP vs. RNAV

PBN implementation plan (short and medium term)
- CNS/ATM considerations integrated in PBN implementation plan
- Integration with Regional Plan
- Pans Ops criteria
- Regulations/Legislation

Navigation infrastructure plan
- Backup navigation strategy/plan
- Regional basis
- WGS 84
- Operations
  - Approach
  - Terminal
  - STARs
  - SIDs
  - Enroute
  - Oceanic/Remote
  - Aircraft Ops Spec Issues

Training
- Regulator
- Controller
- Procedure Designer
- Pilots
- Regulators
- Dispatcher
- Aircraft Maintenance
- Flight and Ground validation
- Flight Inspection

Fleet Equipage/Capability
- Domestic operators
- Intl operators operating to your airspace

Navaid infrastructure
Transition issues
Mixed fleet/mixed mode operations
Separation standards
AIS integrity
Coordination and cooperation with other States, Regions, FIRs
Regional Supp Procedures
User charges

ATTACHMENT 2: PBN — TASK LIST

No.	PERFORMANCE OBJECTIVE	ICAO Strategic Objective	Associated GPI	Tasks/Strategy	Benefits	Deliverables	Target Date	Leader	Supporting Members	Status
1	Current Levels of State Operations and Initial Intent: *Establish current Regional position*	A: Safety D: Efficiency C: Environment	GPI-5, GPI-11, GPI-21	Provide Brief to present to Working Group	Understand the starting point for implementation of PBN	Brief presented to Working Group	Next Meeting (1 – 3 Apr 08)	Mr Henrik Nielsen (CASA, Australia)		OPEN
2	List of Issues: *Establish list of Local and General Issues which should be addressed during implementation of PBN*	A: Safety D: Efficiency C: Environment	GPI-5, GPI-11, GPI-21	Establish source list of issues	Establish checklist of issues to be addressed	List of Issues	APANPIRG/ 19	Mr Henrik Nielsen (CASA, Australia)		OPEN
3	PBN Training Material: *Provide Training Framework and individual training packages for pilots, controllers, regulators etc*	A: Safety D: Efficiency C: Environment	GPI-5, GPI-11, GPI-21	Training framework and material	Provide training material to Regional States plus States of other Regions	Training packages	Framework by next Meeting (1 – 3 Apr 08)	Mr Henrik Nielsen (CASA, Australia)		OPEN

4	On-The-Job Training specifically with regard to PBN Procedure Design: *Establish ability and intent of States to offer participation*	A: Safety D: Efficiency C: Environment	GPI-5, GPI-11, GPI-21	Provide education for States, specifically relating to PBN Procedure Design	Greater spread of knowledge with regards to PBN Procedure Design	Training	Next Meeting (1 – 3 Apr 08)	Mr Henrik Nielsen (CASA, Australia)		OPEN
5	Provision of Model Operational and Air Worthiness Approval Documentation: *Model Approval Documentation*	A: Safety D: Efficiency C: Environment	GPI-5, GPI-11, GPI-21	Assist States with approval documentation	Greater understanding of approval process	Operational and Air Worthiness Approval Documentation	Next Meeting (1 – 3 Apr 08)	Mr Honghai Yang (China)		OPEN

———————

REGIONAL AIRSPACE SAFETY MONITORING ADVISORY GROUP (RASMAG)

Terms of Reference of the RASMAG

(LAST UPDATED APANPIRG/18, SEPTEMBER 2007)

The objectives of the Group are to:

a) facilitate the safe implementation of reduced separation minima and CNS/ATM applications within the Asia and Pacific Regions in regard to airspace safety monitoring; and

b) assist States to achieve the established levels of airspace safety for international airspace within the Asia and Pacific Regions.

To meet these objectives the Group shall:

a) review airspace safety performance in the Asia and Pacific Regions at the regional level and within international airspace;

b) review and develop as necessary, guidance material for airspace safety monitoring, assessment and reporting activities, including the duties, responsibilities and scope of regional monitoring entities;

c) recommend, and facilitate as necessary, the implementation of airspace safety monitoring and performance assessment services;

d) review and recommend on the competency and compatibility of monitoring organizations and recommend to APANPIRG specific airspace responsibility for individual regional monitoring entities;

e) review, coordinate and harmonize regional and inter-regional airspace safety monitoring activities;

f) review regional and global airspace planning and developments in order to anticipate requirements for airspace safety monitoring and assessment activities;

g) address other airspace safety related issues as necessary;

h) facilitate the distribution of safety related information to States, and

i) provide to APANPIRG comprehensive reports on regional airspace safety and coordinate with other contributory bodies of APANPIRG as appropriate.

Task List

To review the safety monitoring programmes in the Asia and Pacific Regions for implementation and operation of:

a) reduced vertical separation minimum (RVSM);

b) reduced horizontal (lateral and longitudinal) separation minima using RNP;

c) aircraft separation applications using data link, e.g. ADS and CPDLC; and

d) ATS Unit to ATS Unit operational messaging using AIDC.

……..……..

IMPLEMENTATION OF PERFORMANCE BASED NAVIGATION (PBN)

Presented by
the International Civil Aviation Organization

Aviation Challenges

:

- Growing demand for RNAV approaches (safety, accessibility)
- Growing demand for solutions to airspace congestion
- Growing fuel efficiency requirements
- Growing Environmental requirements

Most can be met with current technology, but standardization, harmonization and operational requirements have to be put into place

PERFORMANCE BASED NAVIGATION (PBN)

Background
ICAO RNP Concept

a) FANS identified need for performance based navigation and developed *Required Navigation Performance* capability concept :
   a) To avoid need for selection between competing systems
b) Manual on Required Navigation Performance (doc 9613)
c) Addressed only the en-route phase of flight (RNP-10 and RNP-4) for oceanic and remote applications
d) No ICAO RNP requirements for continental enroute and terminal applications. This led to:
   a) Proliferation of national standards
   b) Wide variety of functional requirements
   c) Variety of required navigation sensors
   d) Differing air crew requirements
   e) Lack of global harmonization

PERFORMANCE BASED NAVIGATION (PBN)

AREA NAVIGATION

Definition:

ICAO: Area Navigation is a method of navigation enabling aircraft to fly on any desired flight path:

-- within the coverage of referenced NAVAIDs, or

-- within the limits of the capability of self-contained systems or

-- a combination of these capabilities

The concept of PBN relies on the use of an area navigation system

PERFORMANCE BASED NAVIGATION (PBN)

Adjustment to the RNP Concept Required

Earlier concept of RNP and RNAV included the requirement of accuracy only. PBN concept in addition includes the requirements of functional integrity, continuity and availability.

Harmonization of current RNAV and RNP operations.

Development of new navigation specifications to meet operational demands.

Clear distinction between operations that require performance monitoring and alerting and operations that don't require performance monitoring and alerting.

PERFORMANCE BASED NAVIGATION (PBN)

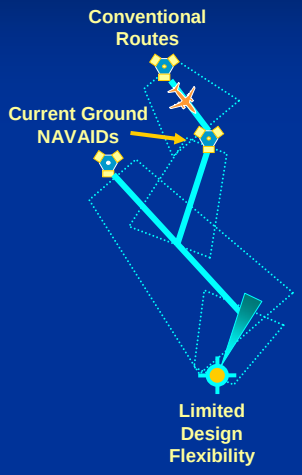
RNAV & RNP in PBN

RNAV- Future applications of Performance Based Navigation (PBN) **without** the requirement of on-board performance monitoring and alerting.

RNP – Future applications of Performance Based Navigation (PBN) **with** the requirement of on-board performance monitoring and alerting

PERFORMANCE BASED NAVIGATION (PBN)

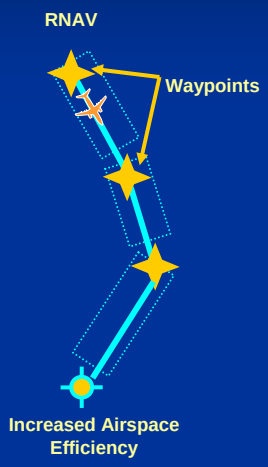
CONVENTIONAL NAVIGATION



- Based on Ground-based Navigation Aids (NAVAIDs)
  - Aircraft overfly Navaids or intersections
- Display Accuracy is a Function of Distance
  - Protected Area Grows ("Splayed")
- Limited Design Flexibility

PERFORMANCE BASED NAVIGATION (PBN)

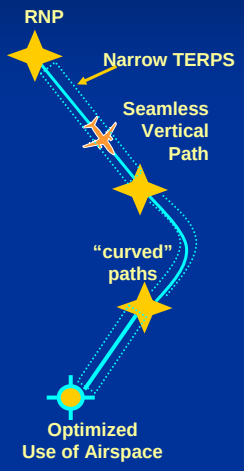
AREA NAVIGATION (RNAV)



- Ground Based Radio Navigation Aids (NAVAIDs) or
- Space Based Navigation System
  - -- Aircraft fly waypoints
  - -- Need not fly over NAVAIDS or intersections
- Protected Area Constant ("Linear")
- Increased Design Flexibility

PERFORMANCE BASED NAVIGATION (PBN)

REQUIRED NAVIGATION PERFORMANCE (RNP)



Adds to Area Navigation (RNAV)

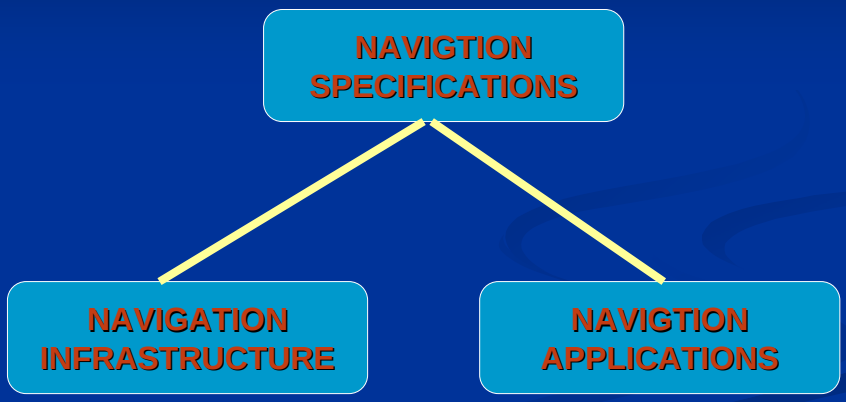
-- On Board Monitoring and Alerting

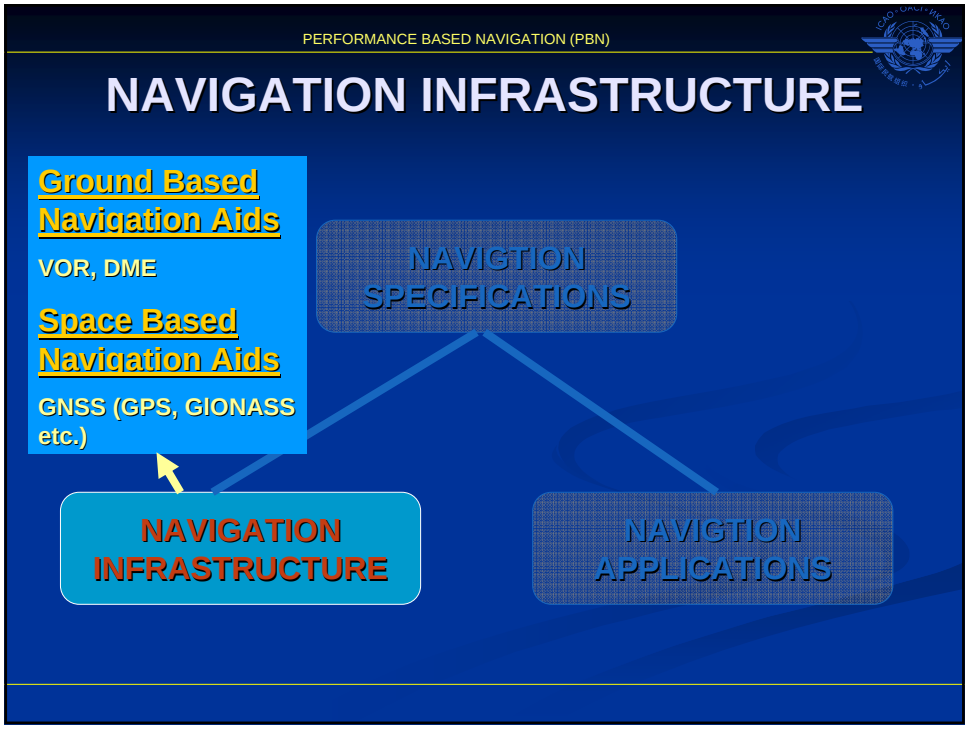
-- May incorporate Radius to Fix Turns

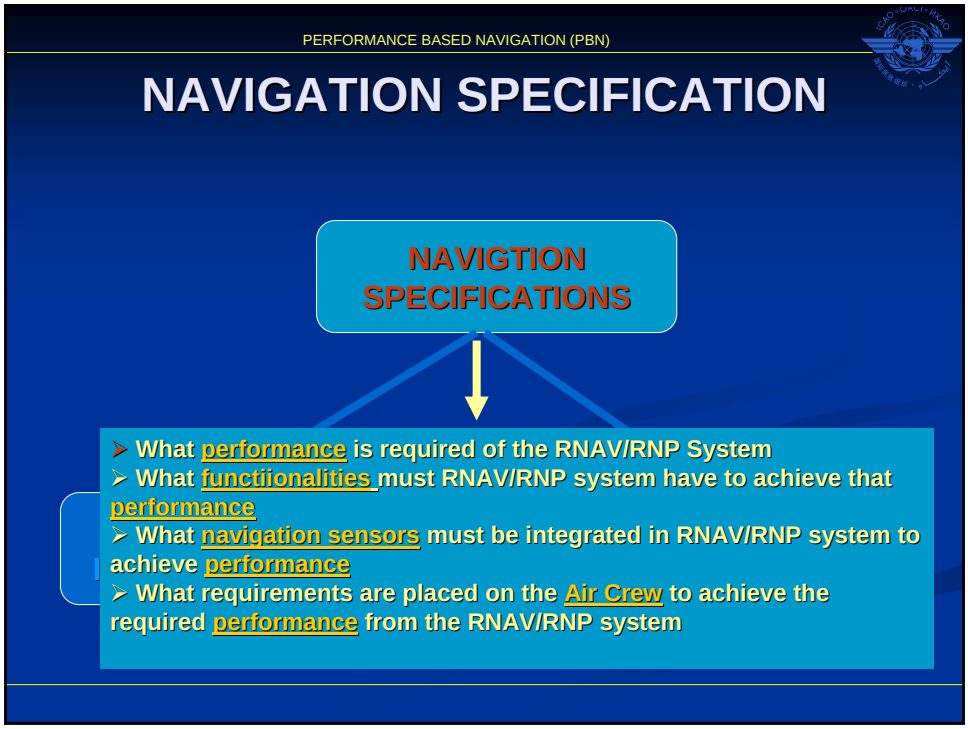
Optimized Use of Airspace

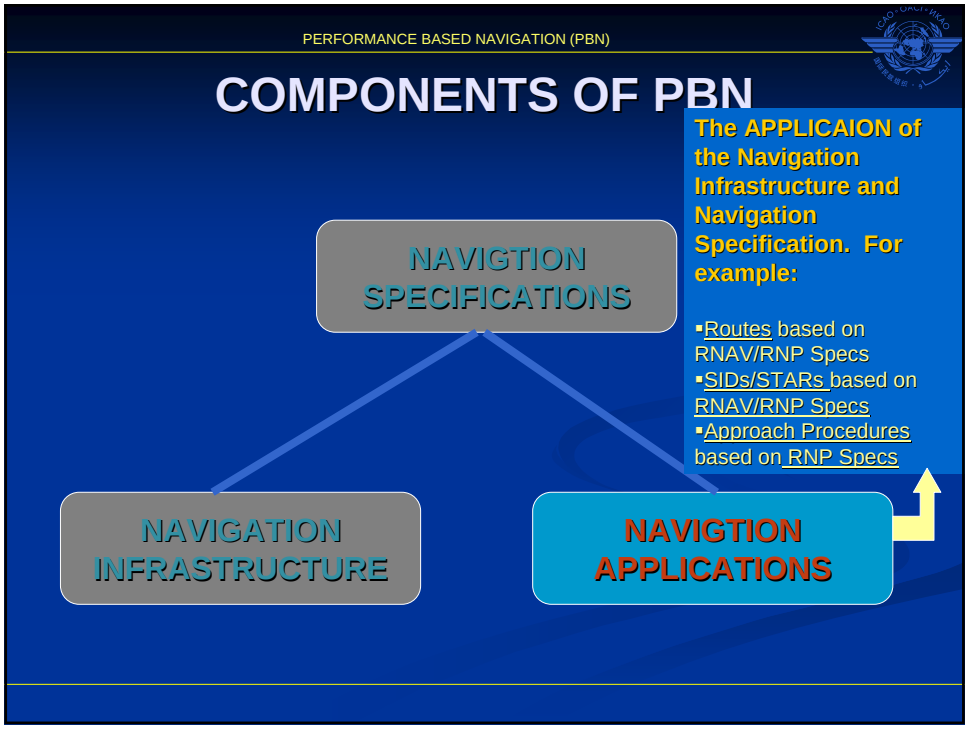
PERFORMANCE BASED NAVIGATION (PBN)

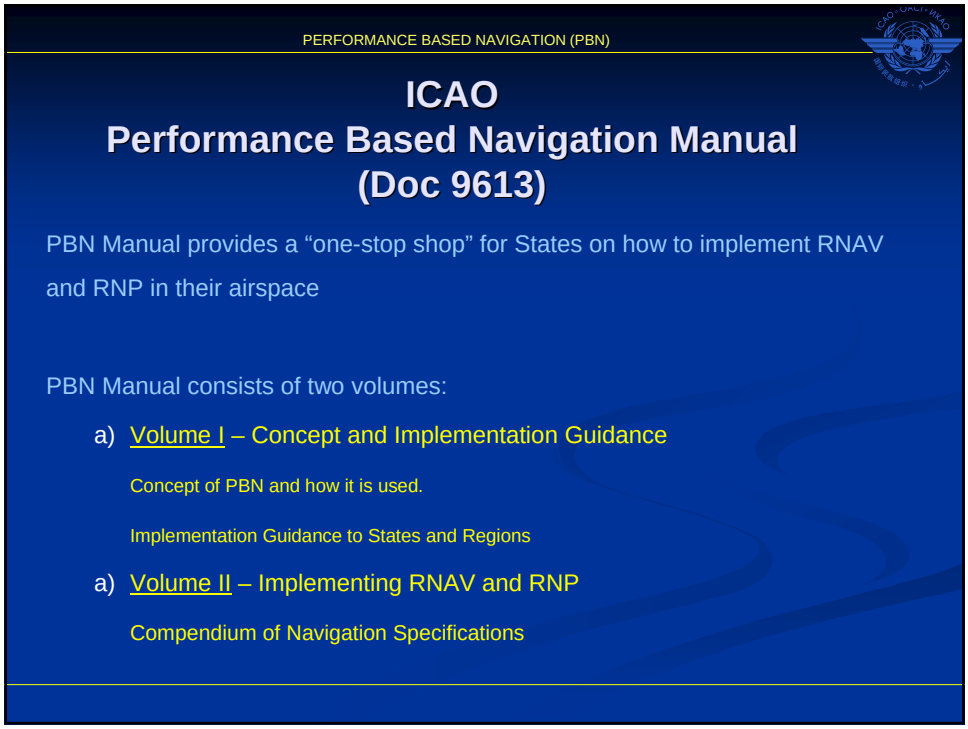
COMPONENTS OF PBN




PERFORMANCE BASED NAVIGATION (PBN)
NAVIGATION INFRASTRUCTURE
Ground Based Navigation Aids
VOR, DME
Space Based Navigation Aids
GNSS (GPS, GIONASS etc.)
NAVIGTION SPECIFICATIONS
NAVIGATION INFRASTRUCTURE
NAVIGTION APPLICATIONS


PERFORMANCE BASED NAVIGATION (PBN)
NAVIGATION SPECIFICATION
NAVIGTION SPECIFICATIONS
What performance is required of the RNAV/RNP System
What functiionalities must RNAV/RNP system have to achieve that performance
What navigation sensors must be integrated in RNAV/RNP system to achieve performance
What requirements are placed on the Air Crew to achieve the required performance from the RNAV/RNP system


PERFORMANCE BASED NAVIGATION (PBN)
COMPONENTS OF PBN
The APPLICAION of the Navigation Infrastructure and Navigation Specification. For example:
▪Routes based on RNAV/RNP Specs
▪SIDs/STARs based on RNAV/RNP Specs
▪Approach Procedures based on RNP Specs
NAVIGTION SPECIFICATIONS
NAVIGATION INFRASTRUCTURE
NAVIGTION APPLICATIONS


PERFORMANCE BASED NAVIGATION (PBN)
ICAO
Performance Based Navigation Manual
(Doc 9613)
PBN Manual provides a “one-stop shop” for States on how to implement RNAV and RNP in their airspace
PBN Manual consists of two volumes:
a) Volume I – Concept and Implementation Guidance
Concept of PBN and how it is used.
Implementation Guidance to States and Regions
a) Volume II – Implementing RNAV and RNP
Compendium of Navigation Specifications

PERFORMANCE BASED NAVIGATION (PBN)

Harmonization of existing navspecs

Simplification results in lower costs for Operators and ANSP

Area of Application	Nav accuracy	Designation of navigation standard: *Current situation*	Designation of navigation specification: PBN concept *(new)*
Oceanic/ Remote	10	RNP 10	**RNAV 10 (RNP 10 label)**
	4	RNP 4	**RNP 4**
EnRoute- Continental	5	RNP 5 Basic RNAV	**RNAV 5**
En Route - Continental and Terminal	2	USRNAV type A	**RNAV 2**
Terminal	1	USRNAV type B and P-RNAV	**RNAV 1**

PERFORMANCE BASED NAVIGATION (PBN)

Harmonization of RNAV operations not covered by existing nav specs

Area of Application	Nav accuracy (NM)	Designation of navigation standard: *Current situation*	Designation of navigation specification: PBN concept *(new)*
Terminal	1	Basic-GNSS SBAS	**Basic-RNP 1**
Approach	1-0.3	Basic-GNSS (Baro-VNAV) SBAS	**RNP APCH**
Approach	1-0.1	RNP SAAAR (US)	**RNP AR APCH**

PERFORMANCE BASED NAVIGATION (PBN)

APANPIRG/18 (3 – 7 September 2007)

Outcomes

Conclusion 18/52 – Establishment of a Regional Performance Based Navigation Task Force (PBN/TF)

That, an Asia/Pacific PBN Task Force, with terms of reference as outlined in **Appendix A** to APANPIRG/18 Report on Agenda Item 3.5, be established to develop a PBN implementation plan for the Asia/Pacific Region and address related PBN implementation issues.

Conclusion 18/53 – Development of State PBN Implementation Plans

That, the Regional Office encourages States to begin development of their State PBN implementation plans in harmony with the development of the Asia/Pacific Regional PBN implementation plan being coordinated by the Asia/Pacific PBN Task Force for submission to APANPIRG/19 (2008)

Conclusion 18/55 – Designation of Contact Person for PBN Implementation

That, by 31 December 2007, States designate a focal contact person responsible for performance based navigation implementation and provide details of the contact person to ICAO Asia/Pacific Regional Office accordingly.

PERFORMANCE BASED NAVIGATION (PBN)

36th Session of ICAO Assembly

(18 – 28 September 2007)

Outcomes

Urges **all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the *Performance Based Navigation Manual* (Doc 9613)**

Urges **that States include in their PBN implementation plan provisions for implementation of approach procedures with vertical guidance (APV) to all runway ends serving aircraft with a maximum certificated take-off mass of 5700 kb or more, according to established timelines and intermediate milestones.**

Instructs **the Council to provide a progress report on PBN implementation to the next ordinary session of the Assembly and**

Requests **the Planning and Implementation Regional Groups (PIRGs) to include in their work programme the review of status of implementation of PBN by States according to the defined implementation plans and report to ICAO any deficiencies that may occur.**

PERFORMANCE BASED NAVIGATION (PBN)

36th Session of ICAO Assembly
(18 – 28 September 2007)
Resolution

***Resolve* that:**

a) **a) States and planning and implementation regional groups (PIRGs) complete a PBN implementation plan by 2009 to achieve:**

i) implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones; and

ii) implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) for all instrument runway ends, either as the primary approach or as back up for precision approaches by 2016 with intermediate milestones as follows: 30 percent by 2010, 70 percent by 2014 and

b) **b) ICAO develop a coordinated action plan to assist States in the implementation of PBN and to ensure development and/or maintenance of globally harmonized SARPs. Procedures for Air Navigation Services (PANS) and guidance material including a global harmonized safety assessment methodology to keep pace with operational demands.**

PERFORMANCE BASED NAVIGATION (PBN)

IMPLEMENTATION ROLE
ICAO HEADQUARTERS

- Organize seminars for the benefit of States and international bodies
- Develop and maintain a website for information/FAQ (www.icao.int/pbn)
- Assist PIRGs in setting up PBN goals and developing regional PBN implementation plans/PBN Roadmaps
- Coordinate and assist in PBN implementation planning and execution
- Identify and address follow-on training needs and other potential obstacles in implementation

PERFORMANCE BASED NAVIGATION (PBN)

PBN SEMINAR SCHEDULE

PERFORMANCE BASED NAVIGATION (PBN)

IMPLEMENTATION ROLE REGIONAL OFFICES

- Assist in organizing seminars
- Provide focal points for PBN in Regional Offices
- Monitor progress in the implementation of PBN in the Region
- Coordinate development of Regional PBN Implementation Plan/PBN Roadmap
- Manage Regional PBN Task Force
- Coordinate implementation planning and execution of PBN en-route operations
- First level assistance in Region for PBN implementation planning and execution of terminal and approach operations.

IMPLEMENTATION ROLE STATES

- Participate in development of Regional PBN implementation plan/PBN Roadmap
- Develop State PBN implementation plan by the end of 2009
- Provide focal point for PBN implementation
- Involve other stakeholders in PBN implementation
- Identify issues or "Showstoppers" that could delay implementation of PBN and pass them on to ICAO HQ
- Implementation of WGS 84 is one of the "Showstoppers" identified. So organize to implement WGS 84.

Action Items
44th DGCA Conference

Action Item 44/6 **Implementation of Performance Based Navigation (PBN)**

Recognizing the importance of PBN for improving safety, capacity and efficiency of air navigation, the Conference urged the States to:

a) implement PBN as per ICAO guidance material

b) support the PBN Task Force established by APANPIRG/18 and designate a focal contact point for coordinating implementation of PBN.


ICAO • OACI • ИКАО
国际民航组织 • ايكاو
Thank You

PBN
Performance Based Navigation

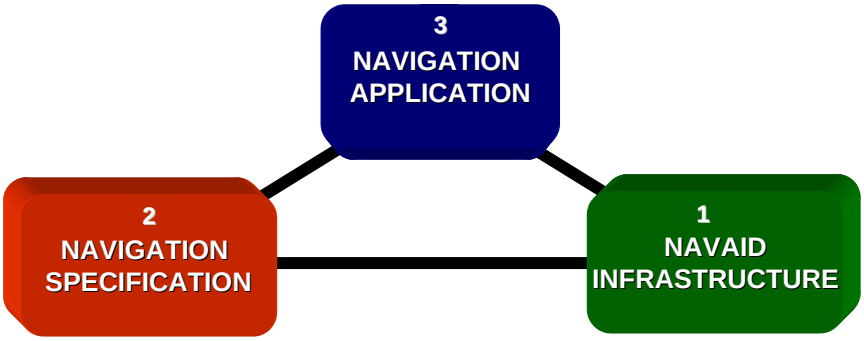
- Overview -

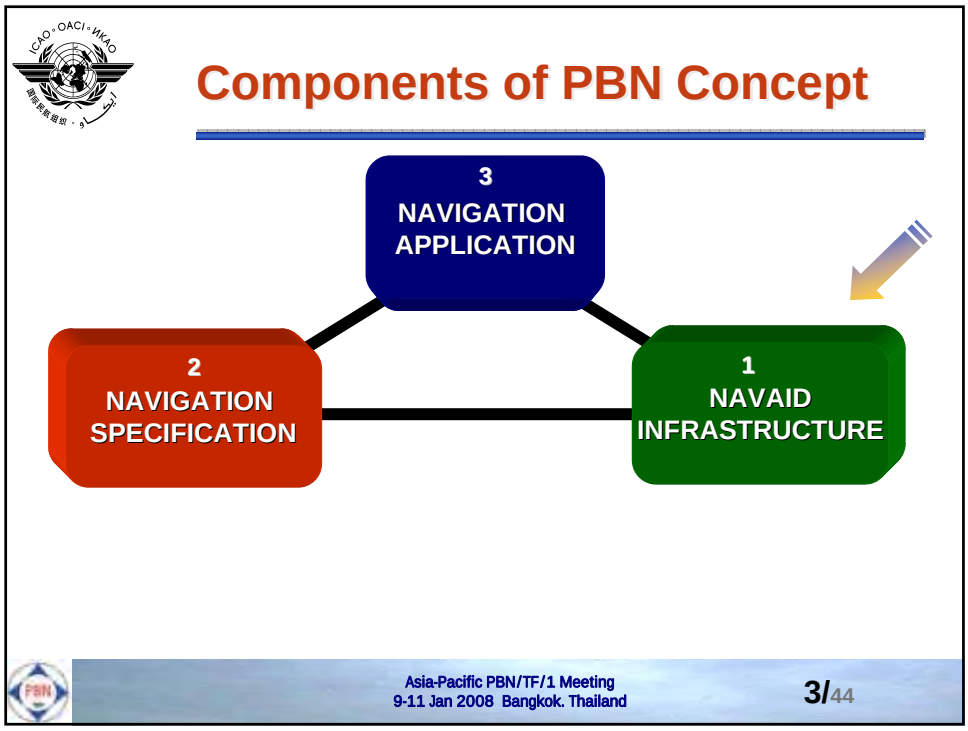
David VanNess

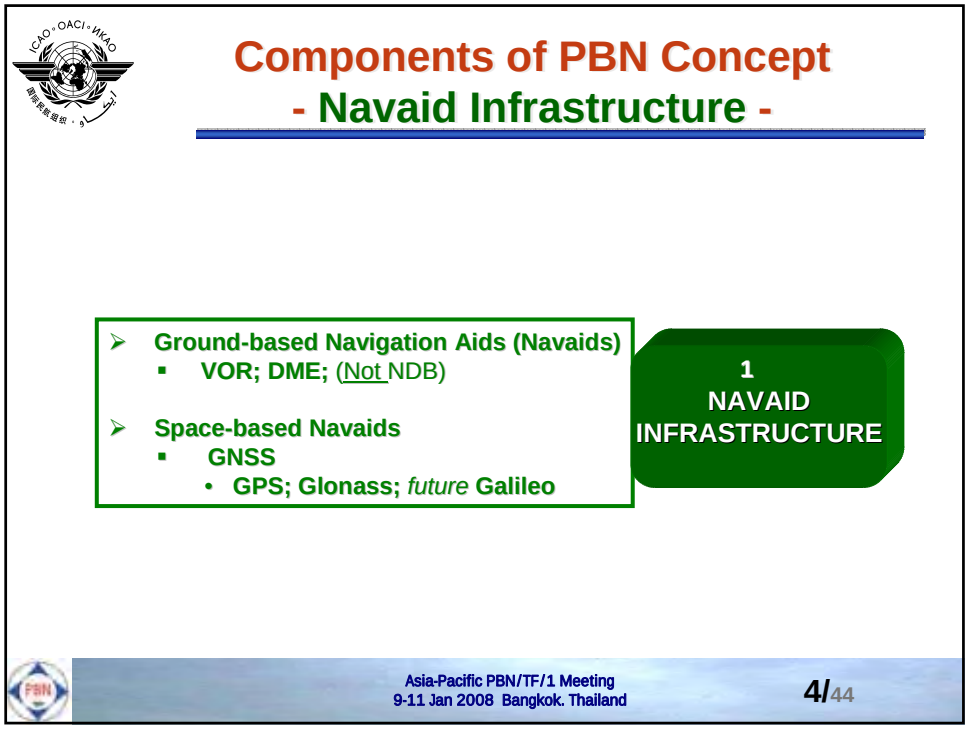
Implementation & Resource Development Coordinator

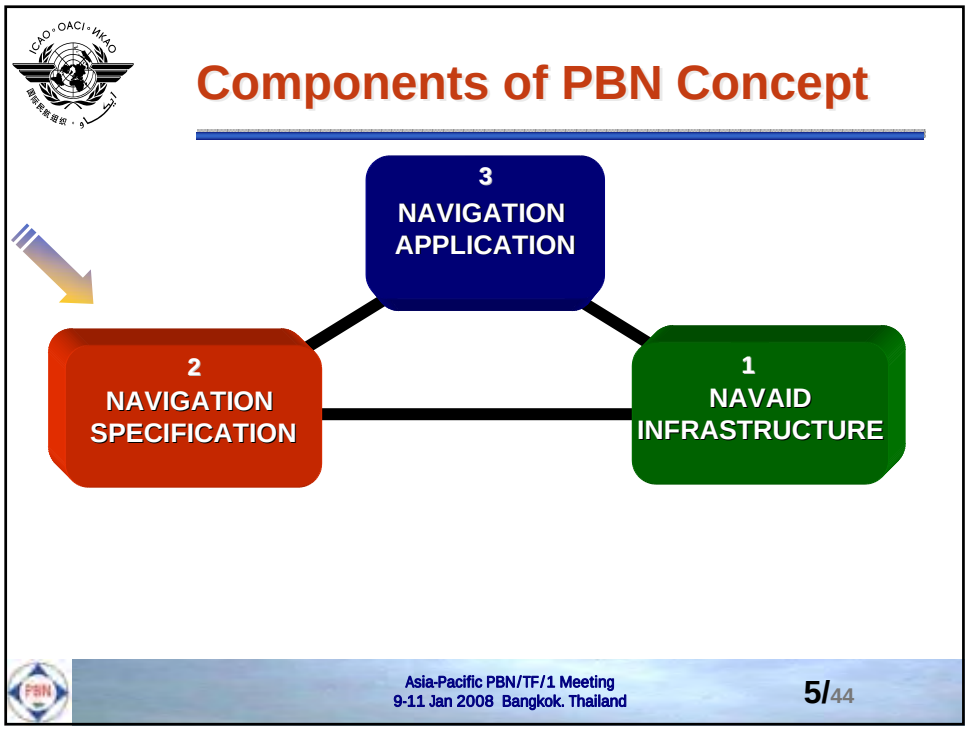
ICAO PBN Programme

Components of PBN Concept




Components of PBN Concept
3
NAVIGATION
APPLICATION
2
NAVIGATION
SPECIFICATION
1
NAVAID
INFRASTRUCTURE
Asia-Pacific PBN/TF/1 Meeting
9-11 Jan 2008 Bangkok. Thailand
3/44


Components of PBN Concept
- Navaid Infrastructure -
Ground-based Navigation Aids (Navaids)
VOR; DME; (Not NDB)
Space-based Navaids
GNSS
GPS; Glonass; future Galileo
1
NAVAID
INFRASTRUCTURE
Asia-Pacific PBN/TF/1 Meeting
9-11 Jan 2008 Bangkok. Thailand
4/44


Components of PBN Concept
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NAVIGATION
APPLICATION
2
NAVIGATION
SPECIFICATION
1
NAVAID
INFRASTRUCTURE
Asia-Pacific PBN/TF/1 Meeting
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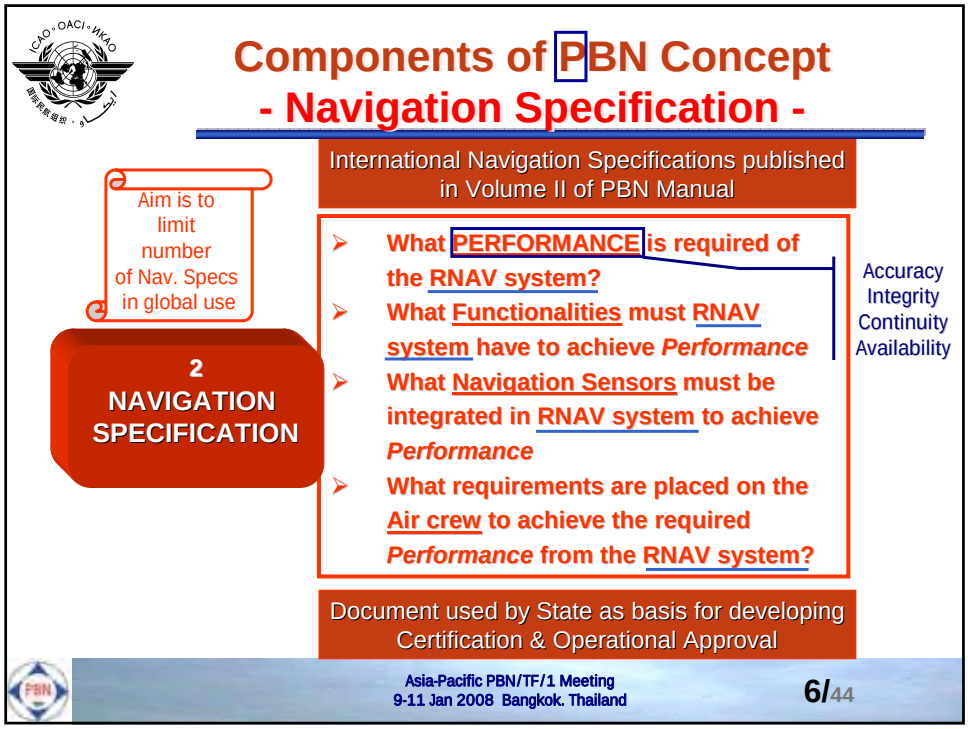
Components of PBN Concept
- Navigation Specification -
International Navigation Specifications published in Volume II of PBN Manual
Aim is to limit number of Nav. Specs in global use
2
NAVIGATION
SPECIFICATION
What PERFORMANCE is required of the RNAV system?
What Functionalities must RNAV system have to achieve Performance
What Navigation Sensors must be integrated in RNAV system to achieve Performance
What requirements are placed on the Air crew to achieve the required Performance from the RNAV system?
Accuracy
Integrity
Continuity
Availability
Document used by State as basis for developing Certification & Operational Approval
Asia-Pacific PBN/TF/1 Meeting
9-11 Jan 2008 Bangkok. Thailand
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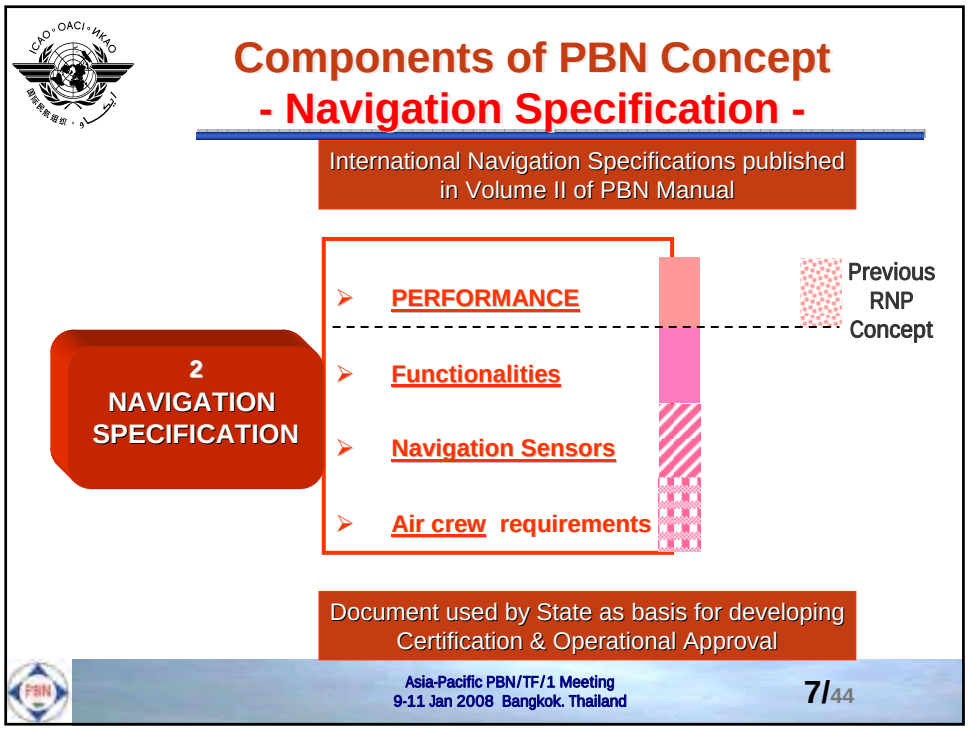
Components of PBN Concept
- Navigation Specification -
International Navigation Specifications published in Volume II of PBN Manual
2 NAVIGATION SPECIFICATION
PERFORMANCE
Functionalities
Navigation Sensors
Air crew requirements
Previous RNP Concept
Document used by State as basis for developing Certification & Operational Approval
Asia-Pacific PBN/TF/1 Meeting
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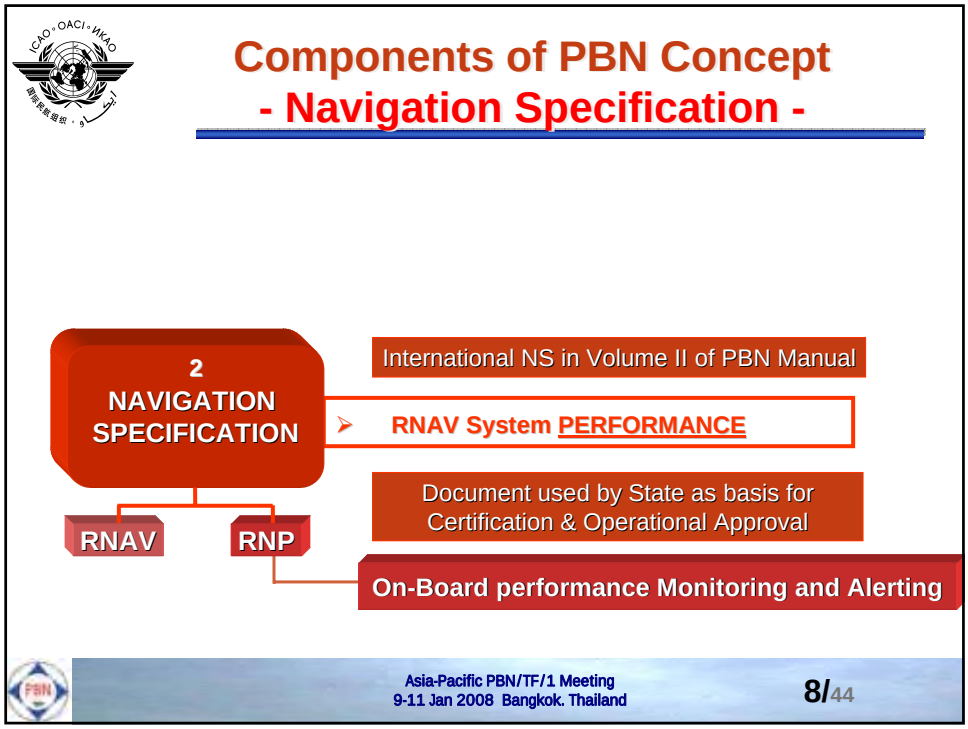
Components of PBN Concept
- Navigation Specification -
2 NAVIGATION SPECIFICATION
International NS in Volume II of PBN Manual
RNAV System PERFORMANCE
RNAV
RNP
Document used by State as basis for Certification & Operational Approval
On-Board performance Monitoring and Alerting
Asia-Pacific PBN/TF/1 Meeting
9-11 Jan 2008 Bangkok. Thailand
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Components of PBN Concept
- Navigation Specification -

RNAV

RNP

On-Board performance Monitoring and Alerting

- On-board performance monitoring and alerting does not only refer to 'containment' in the MASPS; Annex 11 or PANS-OPS.
- On-board performance monitoring and alerting allows the air crew to detect that the RNP system is not achieving the navigation performance required of the RNP system

Components of PBN Concept
- Navigation Specification -

ICAO NAVIGATION SPECIFICATIONS

RNAV SPECIFICATIONS

Designation	Designation
RNAV 10 (RNP10) *For Oceanic and Remote Continental navigation applications*	**RNAV 5** **RNAV 2** **RNAV 1** *For En Route & Terminal navigation applications*

RNP SPECIFICATIONS

Designation	Designation	Designation
RNP 4 *For Oceanic & Remote Continental navigation applications*	**Basic-RNP 2*** **Basic-RNP 1** **Advanced-RNP 1*** **RNP APCH** **RNP AR APCH** *for various phases of flight*	**RNP** with additional requirements to be determined (e.g. 3D, 4D etc)

International NS in Volume II of PBN Manual

*Potential Nav Specs

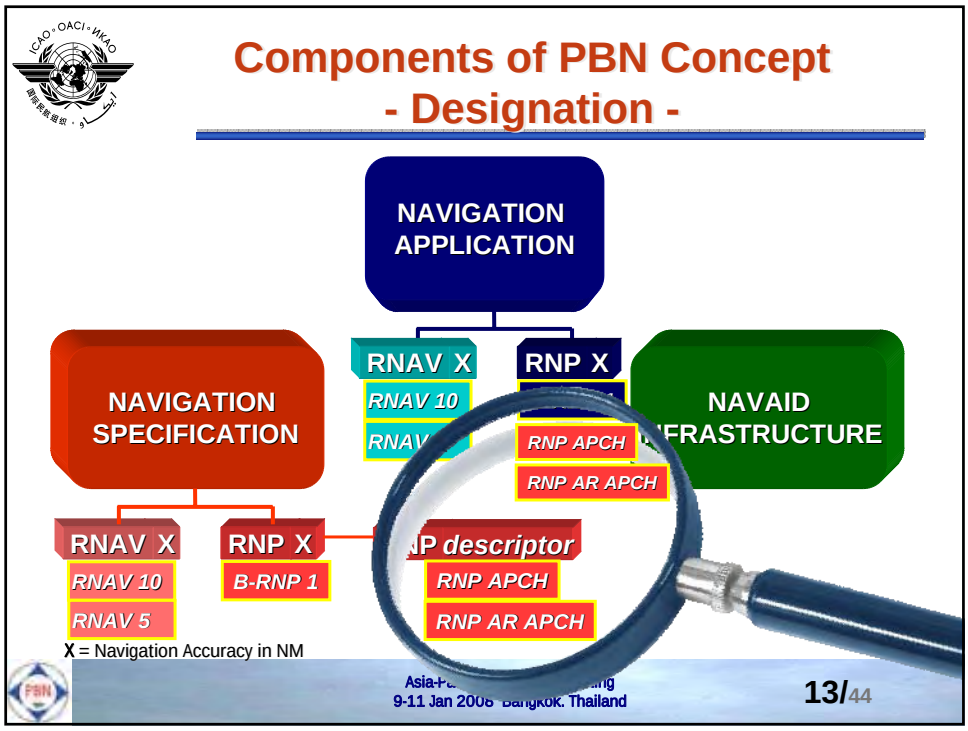
Components of PBN Concept
- Navigation Specification -

Simplification results in lower costs for Operators and ANSP

Area of Application	Nav accuracy	Designation of navigation standard: *Current situation*	Designation of navigation specification: PBN concept *(new)*
Oceanic/ Remote	10	RNP 10	**RNAV 10 (RNP 10 label)**
	4	RNP 4	**RNP 4**
EnRoute- Continental	5	RNP 5 Basic RNAV	**RNAV 5**
En Route - Continental and Terminal	2	USRNAV type A	**RNAV 2**
Terminal	1	USRNAV type B and P-RNAV	**RNAV 1**

Components of PBN Concept
- Navigation Specification -

Area of Application	Nav accuracy (NM)	Designation of navigation standard: *Current situation*	Designation of navigation specification: PBN concept *(new)*
Terminal	1	Basic-GNSS SBAS	**Basic-RNP 1**
Approach	1-0.3	Basic-GNSS (Baro-VNAV) SBAS	**RNP APCH**
Approach	1-0.1	RNP SAAAR (US)	**RNP AR APCH**


Components of PBN Concept
- Designation -
NAVIGATION APPLICATION
NAVIGATION SPECIFICATION
RNAV X
RNAV 10
RNAV
RNP X
RNP APCH
RNP AR APCH
NAVAID
FRASTRUCTURE
RNAV X
RNAV 10
RNAV 5
RNP X
B-RNP 1
NP descriptor
RNP APCH
RNP AR APCH
X = Navigation Accuracy in NM
9-11 Jan 2008 Bangkok. Thailand
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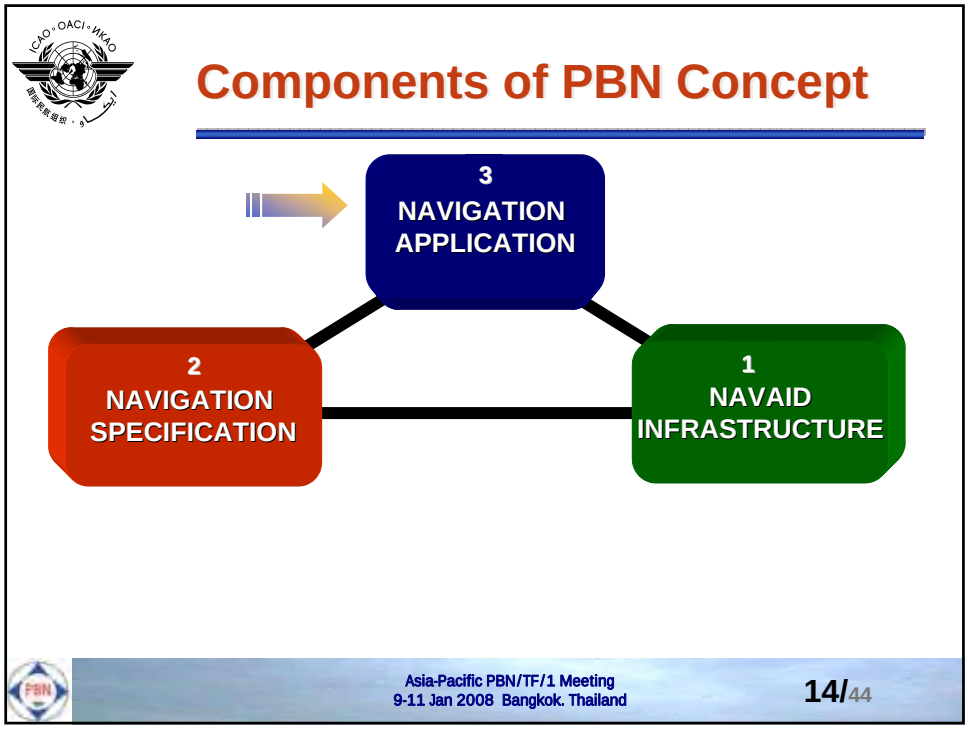
Components of PBN Concept
3
NAVIGATION APPLICATION
2
NAVIGATION SPECIFICATION
1
NAVAID INFRASTRUCTURE
Asia-Pacific PBN/TF/1 Meeting
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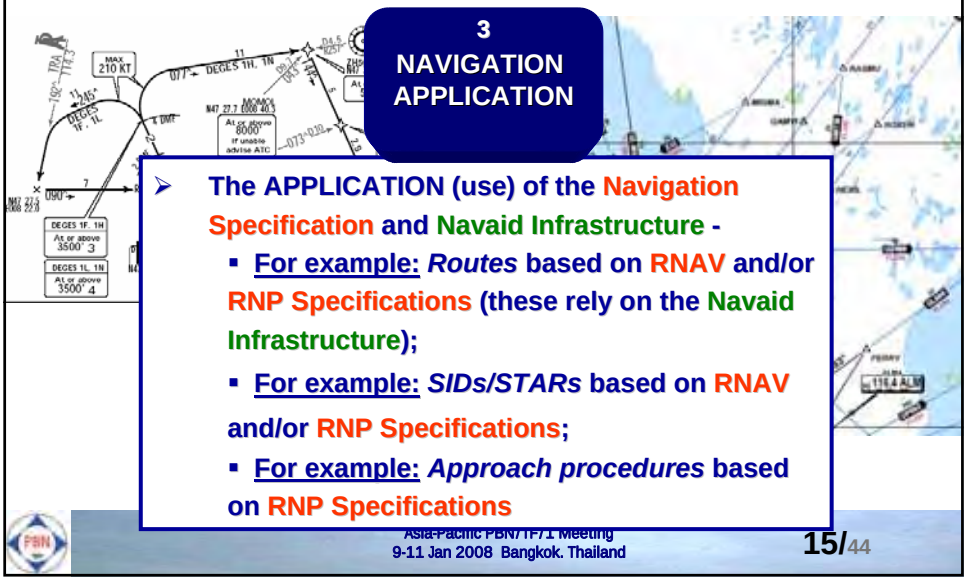
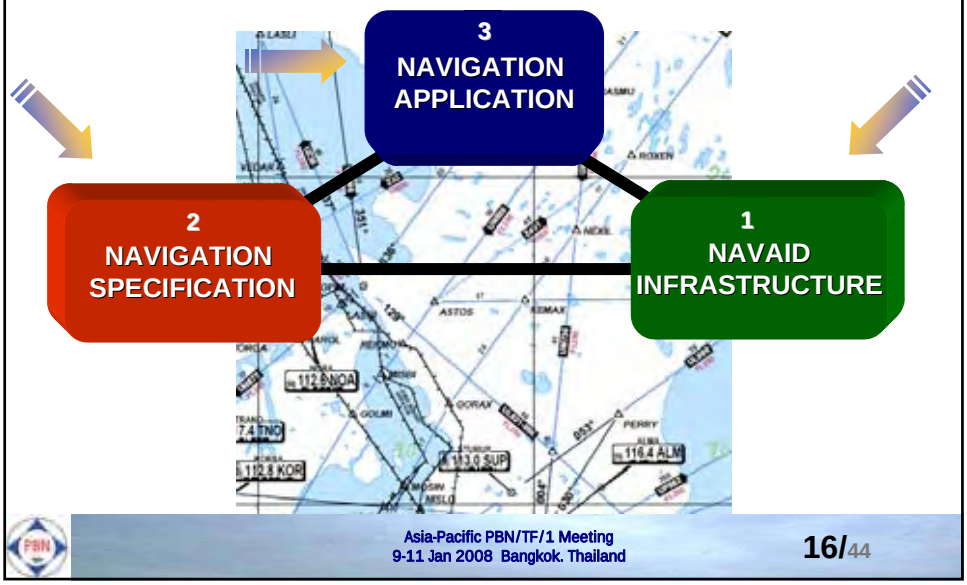
Components of PBN Concept
- Navigation Application -

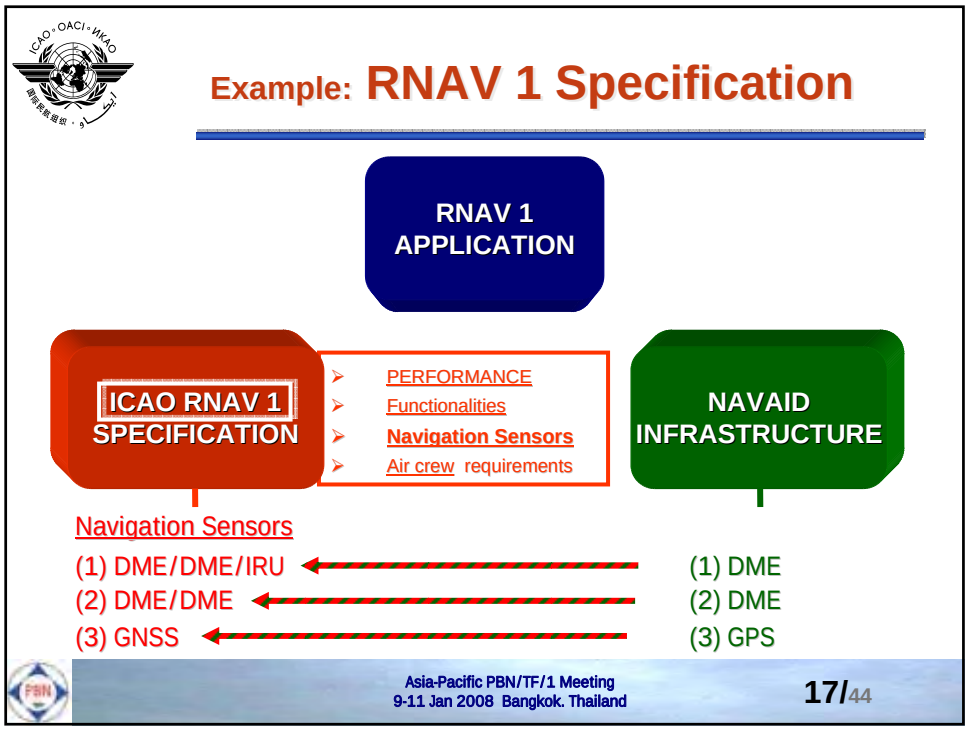


3 NAVIGATION APPLICATION

- The APPLICATION (use) of the Navigation Specification and Navaid Infrastructure -
  - For example: *Routes* based on RNAV and/or RNP Specifications (these rely on the Navaid Infrastructure);
  - For example: *SIDs/STARs* based on RNAV and/or RNP Specifications;
  - For example: *Approach procedures* based on RNP Specifications

Components of PBN Concept




Example: RNAV 1 Specification
RNAV 1 APPLICATION
ICAO RNAV 1 SPECIFICATION
PERFORMANCE
Functionalities
Navigation Sensors
Air crew requirements
NAVAID INFRASTRUCTURE
Navigation Sensors
(1) DME/DME/IRU
(2) DME/DME
(3) GNSS
(1) DME
(2) DME
(3) GPS
Asia-Pacific PBN/TF/1 Meeting
9-11 Jan 2008 Bangkok. Thailand
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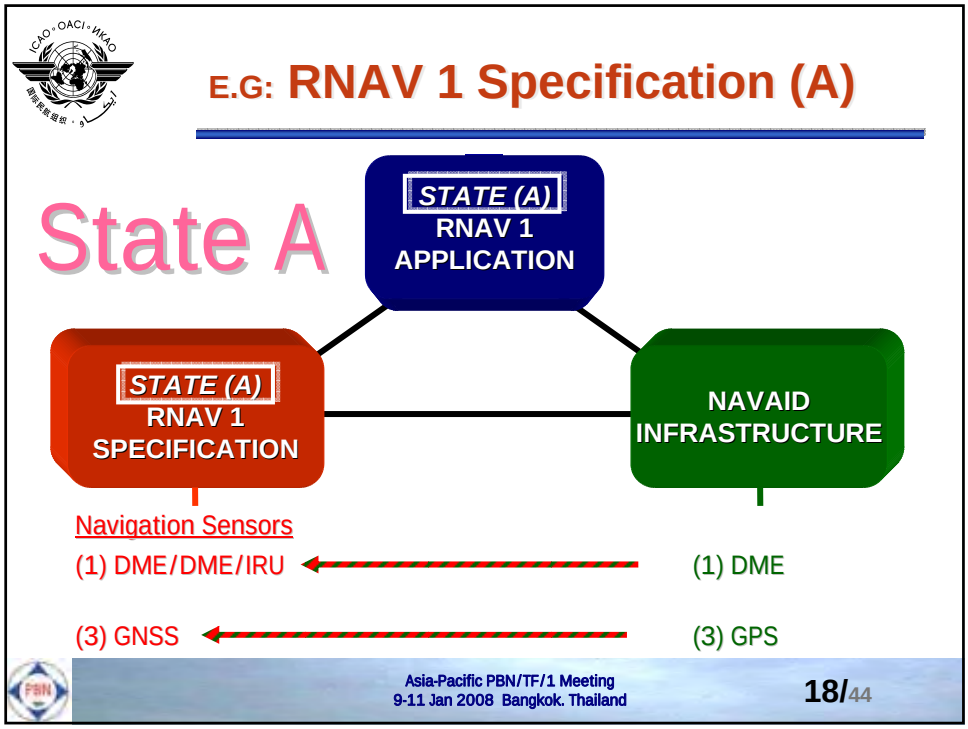
E.G: RNAV 1 Specification (A)
State A
STATE (A) RNAV 1 APPLICATION
STATE (A) RNAV 1 SPECIFICATION
NAVAID INFRASTRUCTURE
Navigation Sensors
(1) DME/DME/IRU
(3) GNSS
(1) DME
(3) GPS
Asia-Pacific PBN/TF/1 Meeting
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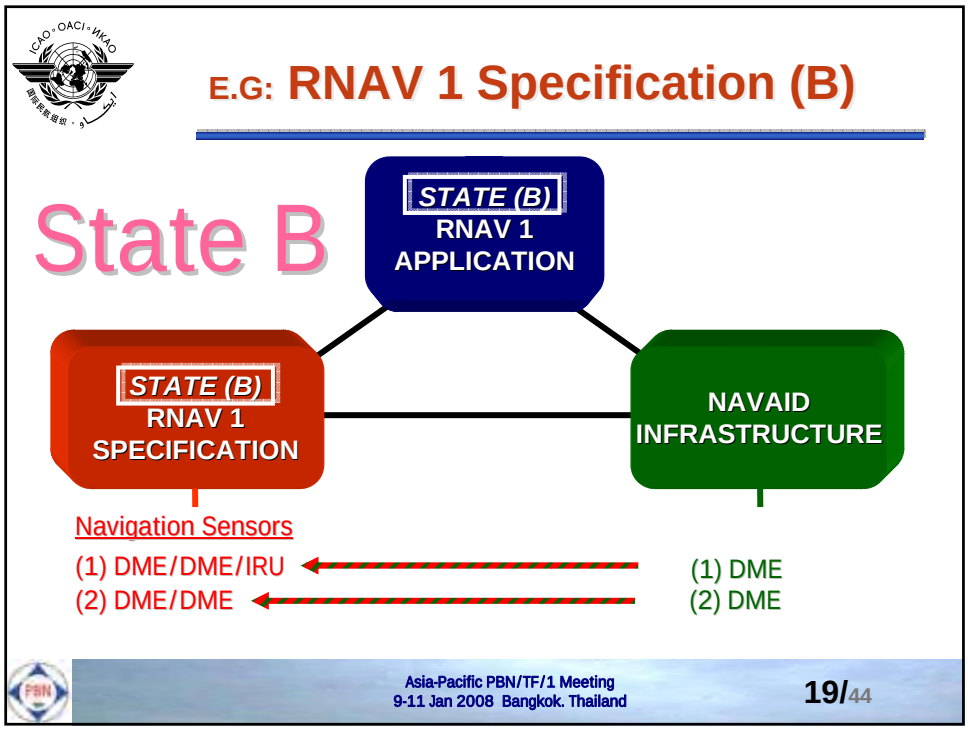
18/44


E.G: RNAV 1 Specification (B)
State B
STATE (B)
RNAV 1
APPLICATION
STATE (B)
RNAV 1
SPECIFICATION
NAVAID
INFRASTRUCTURE
Navigation Sensors
(1) DME/DME/IRU
(2) DME/DME
(1) DME
(2) DME
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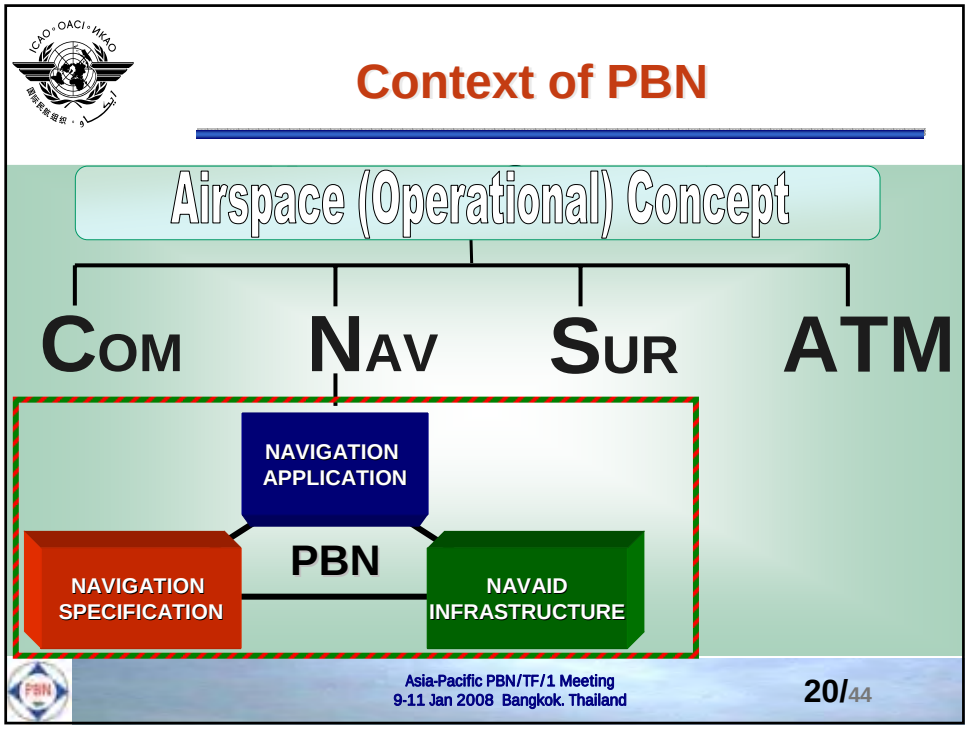
Context of PBN
Airspace (Operational) Concept
COM
NAV
SUR
ATM
NAVIGATION
APPLICATION
PBN
NAVIGATION
SPECIFICATION
NAVAID
INFRASTRUCTURE
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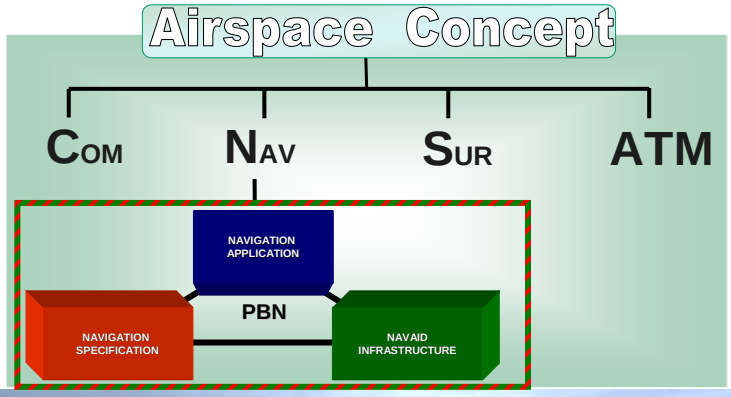
Context of PBN

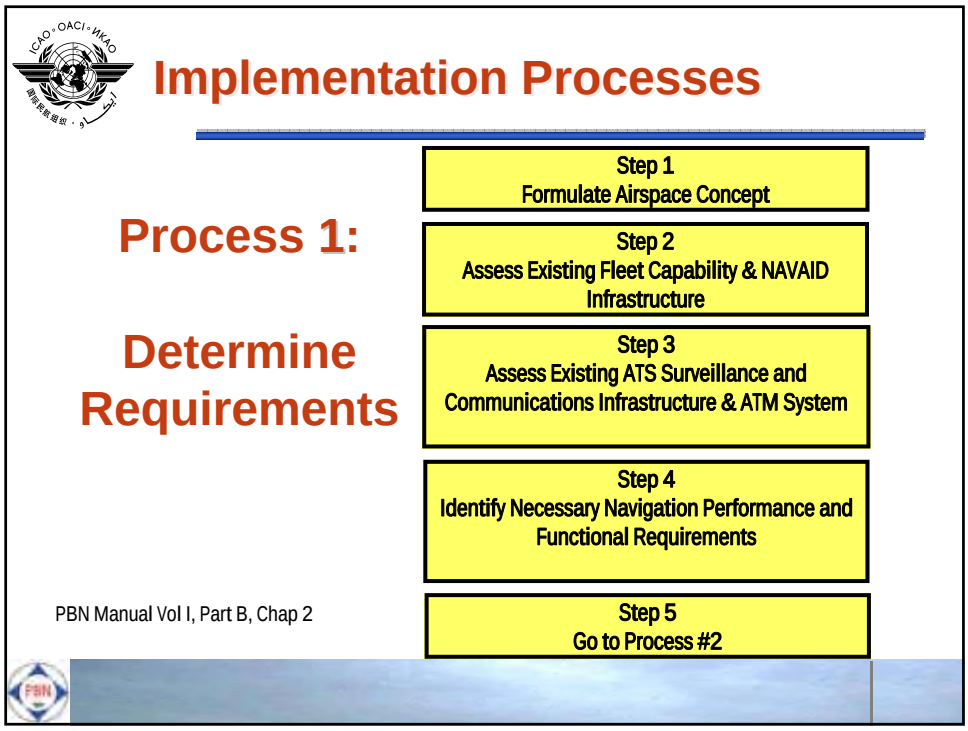
ICAO GLOBAL ATM CONCEPT

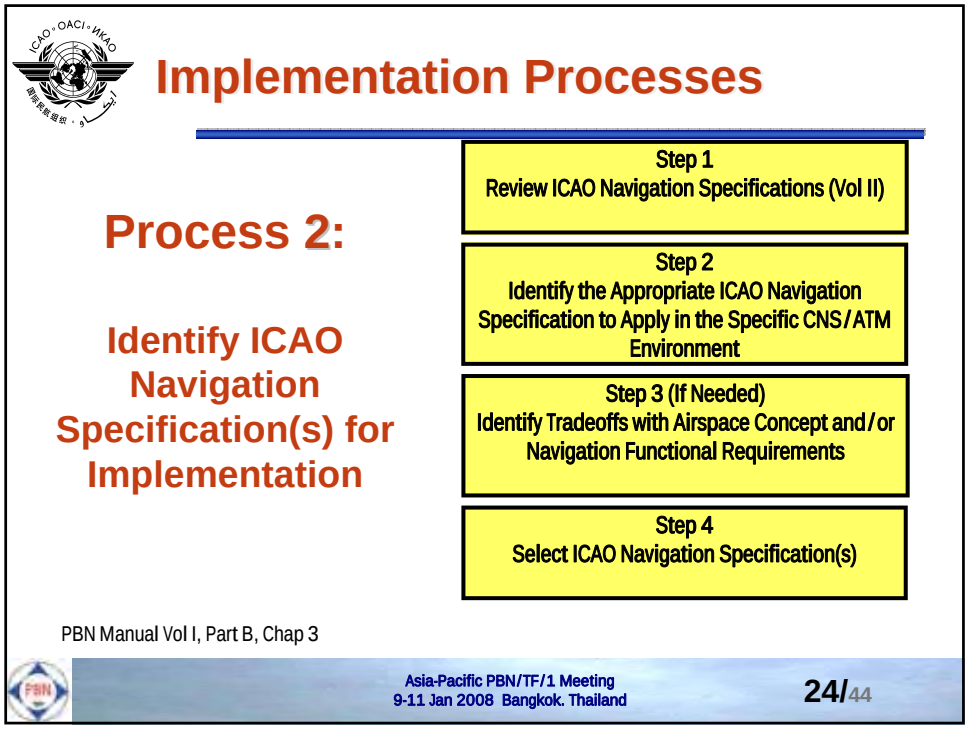


Implementation Processes

- **#1: Determine requirements**
  - **#2 Identify an ICAO Navigation Specification for Implementation**
    - **#3 Planning and Implementation**

PBN Manual Volume I, Part B


Implementation Processes
Process 1:
Determine Requirements
Step 1
Formulate Airspace Concept
Step 2
Assess Existing Fleet Capability & NAVAID Infrastructure
Step 3
Assess Existing ATS Surveillance and Communications Infrastructure & ATM System
Step 4
Identify Necessary Navigation Performance and Functional Requirements
Step 5
Go to Process #2
PBN Manual Vol I, Part B, Chap 2


Implementation Processes
Process 2:
Identify ICAO Navigation Specification(s) for Implementation
Step 1
Review ICAO Navigation Specifications (Vol II)
Step 2
Identify the Appropriate ICAO Navigation Specification to Apply in the Specific CNS/ATM Environment
Step 3 (If Needed)
Identify Tradeoffs with Airspace Concept and/or Navigation Functional Requirements
Step 4
Select ICAO Navigation Specification(s)
PBN Manual Vol I, Part B, Chap 3
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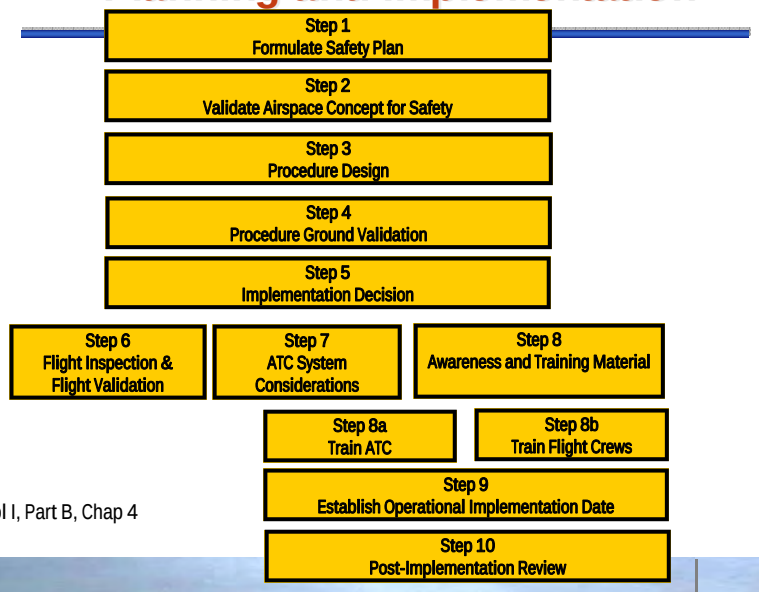
Implementation Process #3:
Planning and Implementation



PBN Manual Vol I, Part B, Chap 4

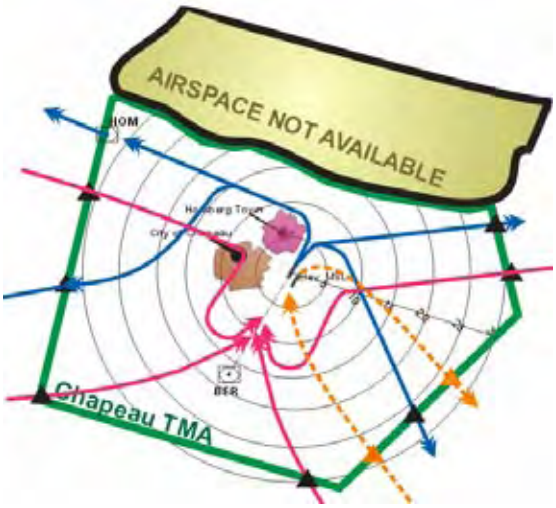
Notes on Process 3

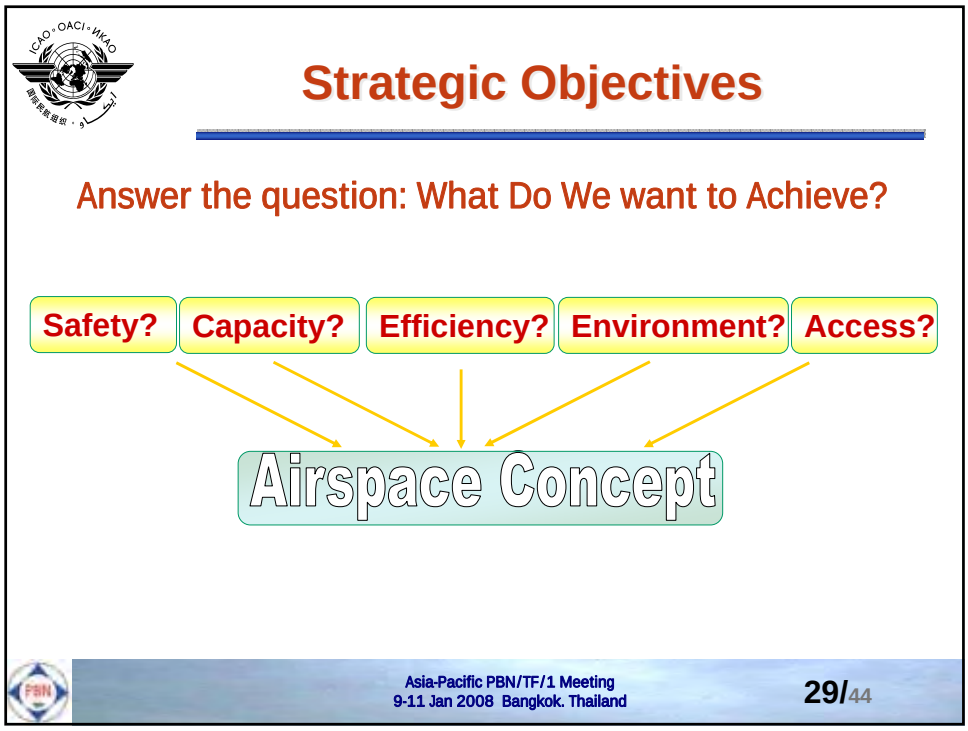
- The activities in Process 3 would be followed for any level of PBN implementation
  - A single instrument approach procedure
  - A set of terminal arrival and departure routes
  - An entire airspace redesign
- The activities described in Process 3 are not new – undertaken with any implementation

What is an Airspace Concept?

- General Vision or Master Plan for an airspace
  - Geared towards Strategic Objectives
    - Covers all air traffic system "Enablers"

What is an Airspace Concept?




Strategic Objectives
Answer the question: What Do We want to Achieve?
Safety?
Capacity?
Efficiency?
Environment?
Access?
Airspace Concept
Asia-Pacific PBN/TF/1 Meeting
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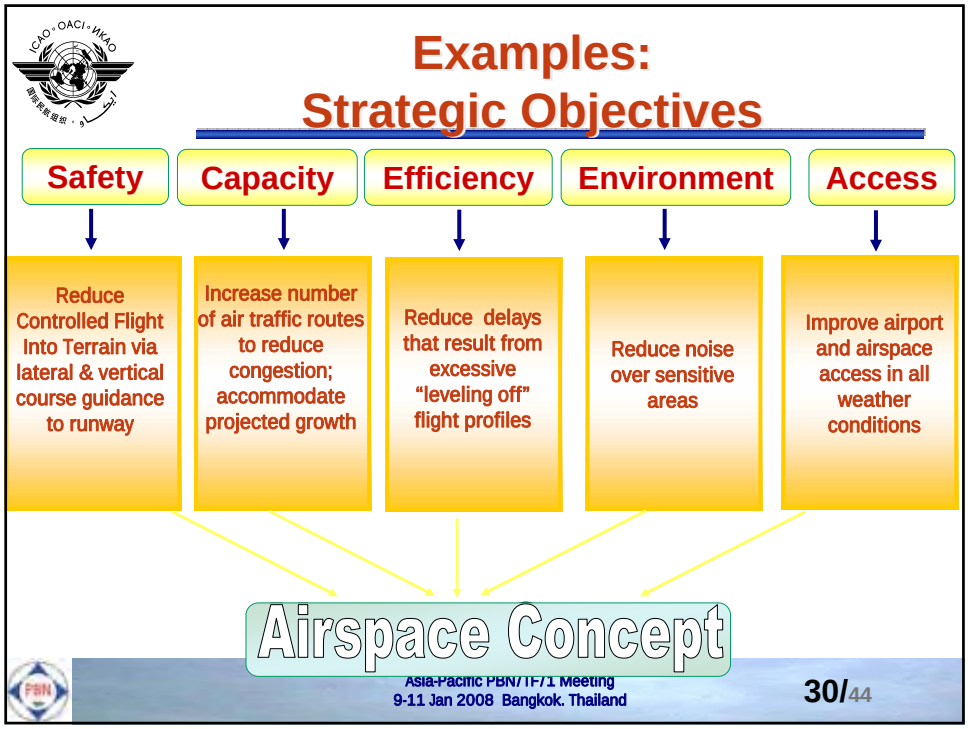
Examples:
Strategic Objectives
Safety
Capacity
Efficiency
Environment
Access
Reduce Controlled Flight Into Terrain via lateral & vertical course guidance to runway
Increase number of air traffic routes to reduce congestion; accommodate projected growth
Reduce delays that result from excessive "leveling off" flight profiles
Reduce noise over sensitive areas
Improve airport and airspace access in all weather conditions
Airspace Concept
Asia-Pacific PBN/TF/1 Meeting
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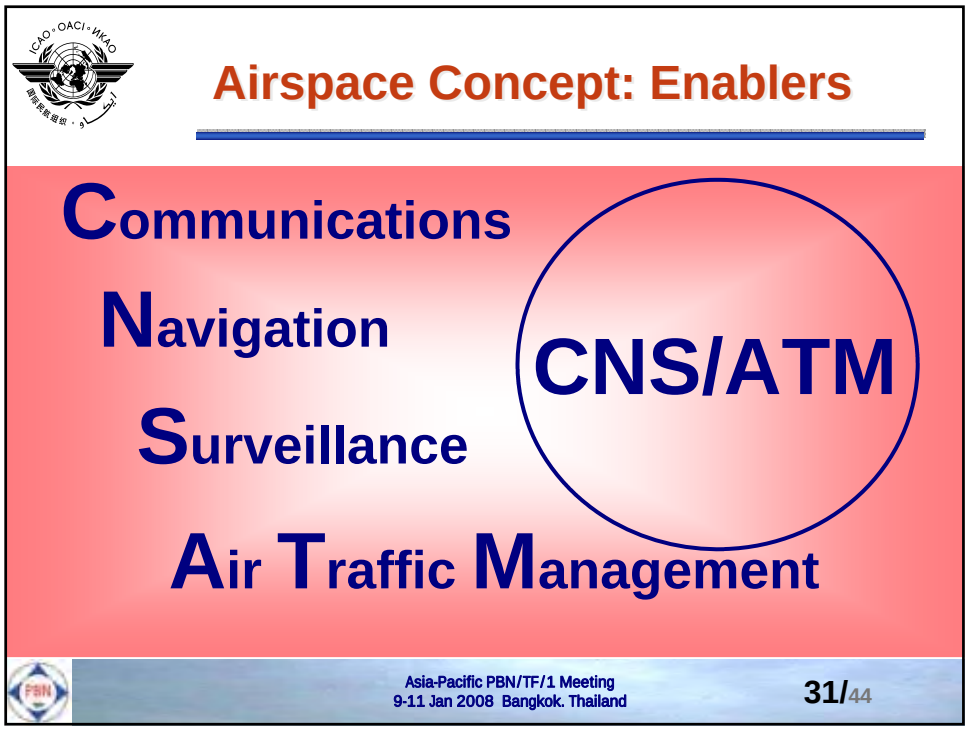
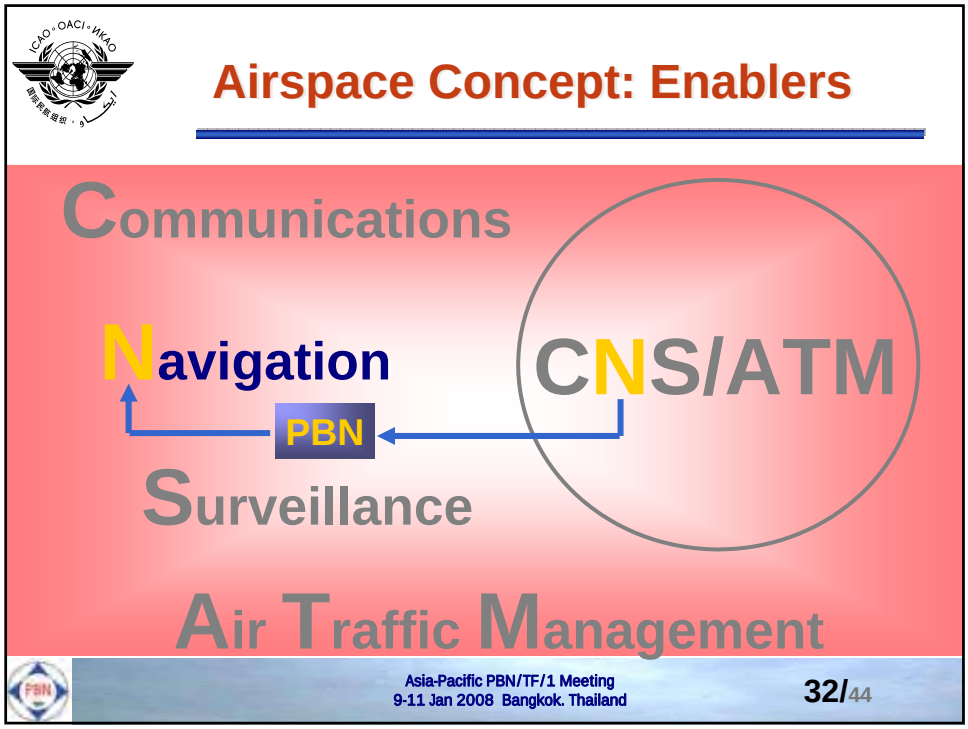

Airspace Concept: Enablers
Communications
Navigation
Surveillance
CNS/ATM
Air Traffic Management
Asia-Pacific PBN/TF/1 Meeting
9-11 Jan 2008 Bangkok. Thailand
31/44


Airspace Concept: Enablers
Communications
Navigation
PBN
Surveillance
CNS/ATM
Air Traffic Management
Asia-Pacific PBN/TF/1 Meeting
9-11 Jan 2008 Bangkok. Thailand
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Airspace Concept Development

Airspace Concept development requires the combined efforts of:

- ✈ Air Navigation Service Providers ("Air Traffic")
- ✈ Regulators
- ✈ System Users
- ✈ PANS-OPS specialist(s)

"STAKEHOLDERS"

To Do What?

Airspace Concept: Stakeholder Roles

Air Traffic Service Providers, Regulators and System Users:

1. **Identify** strategic objectives

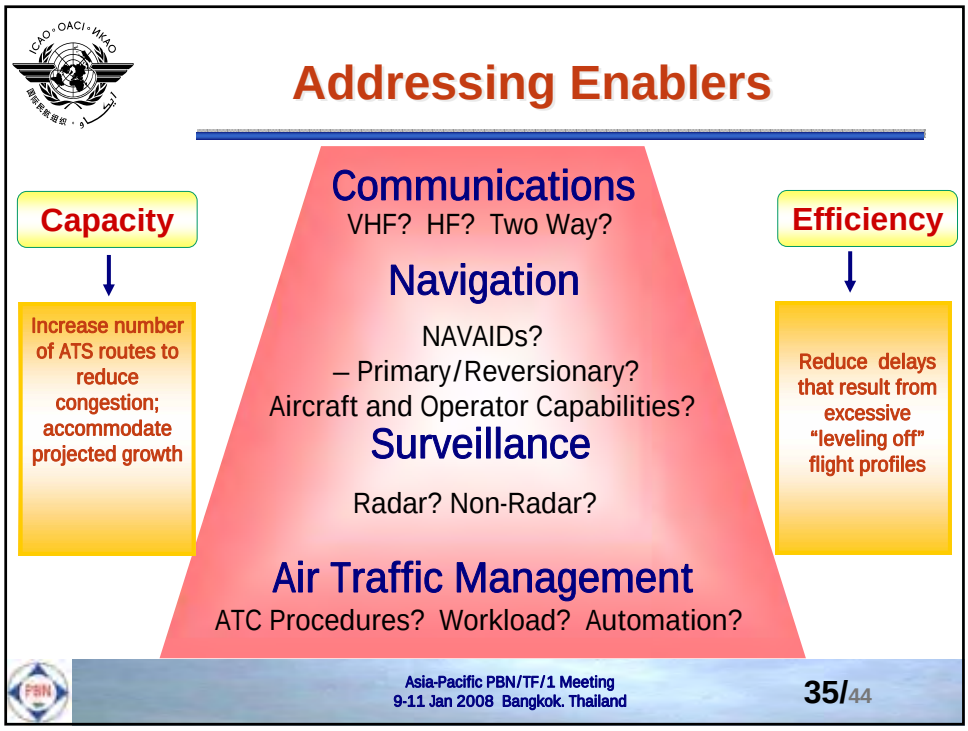
Safety? Efficiency? Capacity? Environment? Access?

2. **Prioritise** strategic objectives

Safety? Capacity? Access? Efficiency? Environment?

3. **Address** enablers

CNS/ATM


Addressing Enablers
Capacity
Increase number of ATS routes to reduce congestion; accommodate projected growth
Communications
VHF? HF? Two Way?
Navigation
NAVAIDs?
– Primary/Reversionary?
Aircraft and Operator Capabilities?
Surveillance
Radar? Non-Radar?
Air Traffic Management
ATC Procedures? Workload? Automation?
Efficiency
Reduce delays that result from excessive "leveling off" flight profiles
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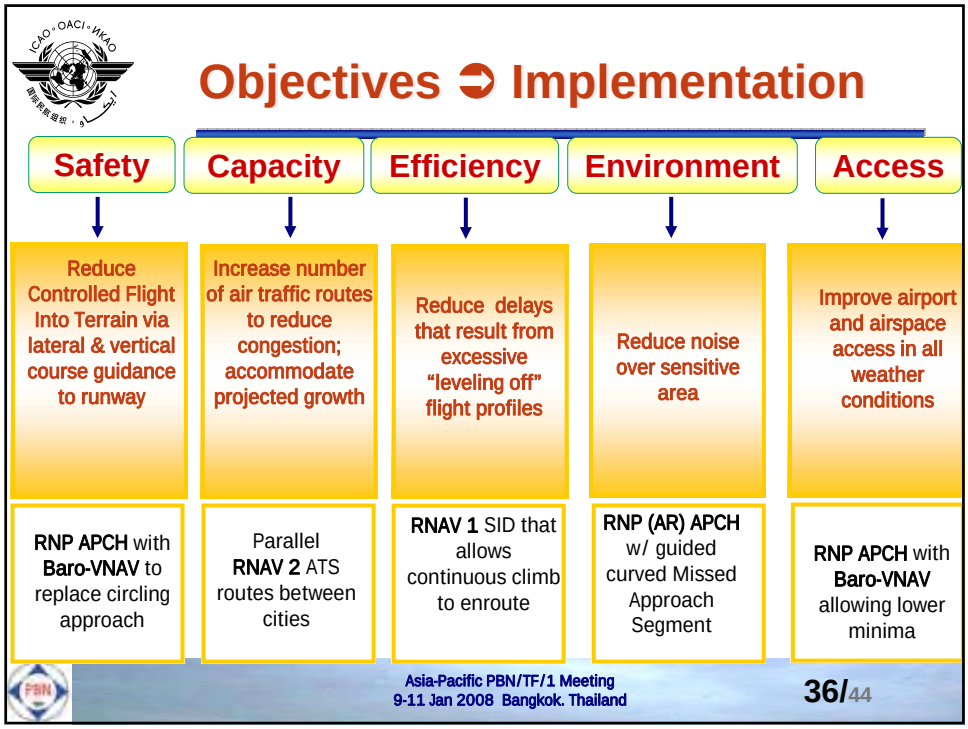
Objectives ➲ Implementation
Safety
Reduce Controlled Flight Into Terrain via lateral & vertical course guidance to runway
RNP APCH with Baro-VNAV to replace circling approach
Capacity
Increase number of air traffic routes to reduce congestion; accommodate projected growth
Parallel RNAV 2 ATS routes between cities
Efficiency
Reduce delays that result from excessive "leveling off" flight profiles
RNAV 1 SID that allows continuous climb to enroute
Environment
Reduce noise over sensitive area
RNP (AR) APCH w/ guided curved Missed Approach Segment
Access
Improve airport and airspace access in all weather conditions
RNP APCH with Baro-VNAV allowing lower minima
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Airspace Concept Use

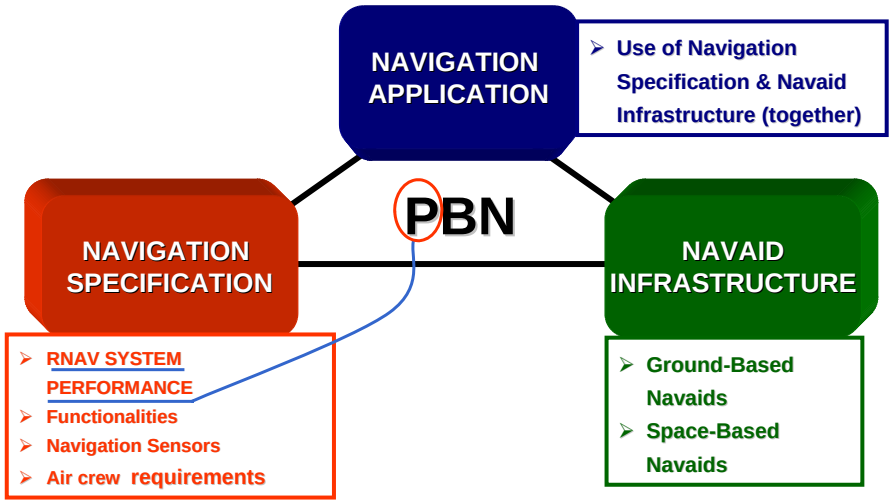
Airspace Concept development requires the combined efforts of:

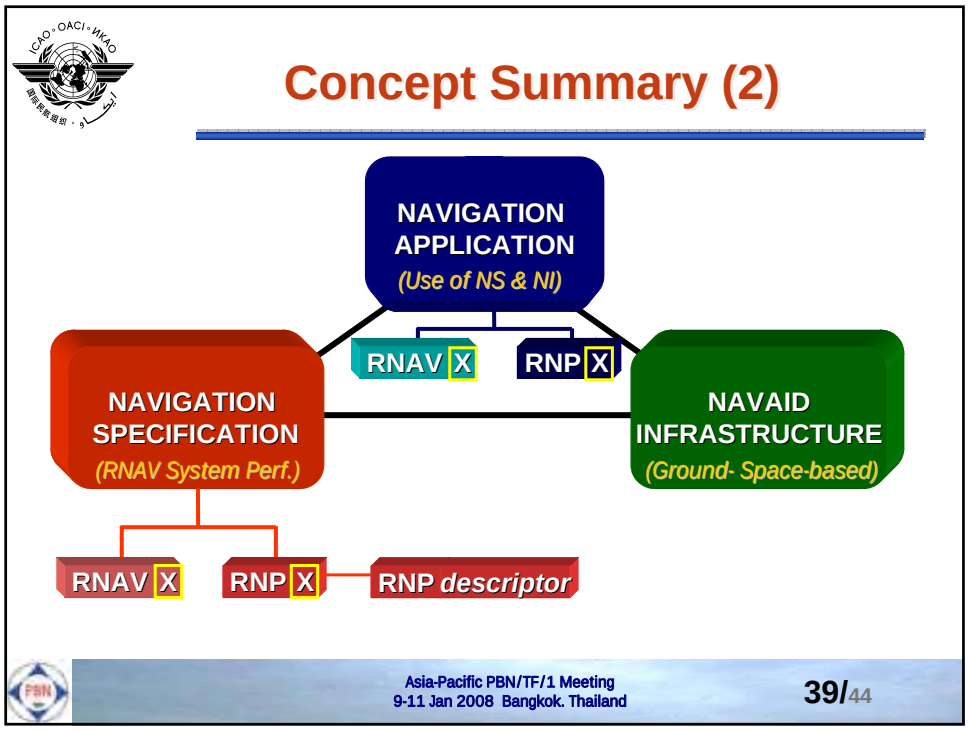
- ✈ Air Navigation Service Providers ("Air Traffic")
- ✈ Regulators
- ✈ System Users
- ✈ PANS-OPS specialist

"STAKEHOLDERS"

To identify and prioritise **Strategic Objectives**, considering the entire CNS/ATM environment

Concept Summary (1)




Concept Summary (2)
NAVIGATION APPLICATION
(Use of NS & NI)
RNAV X
RNP X
NAVIGATION SPECIFICATION
(RNAV System Perf.)
NAVAID INFRASTRUCTURE
(Ground- Space-based)
RNAV X
RNP X
RNP descriptor
Asia-Pacific PBN/TF/1 Meeting
9-11 Jan 2008 Bangkok. Thailand
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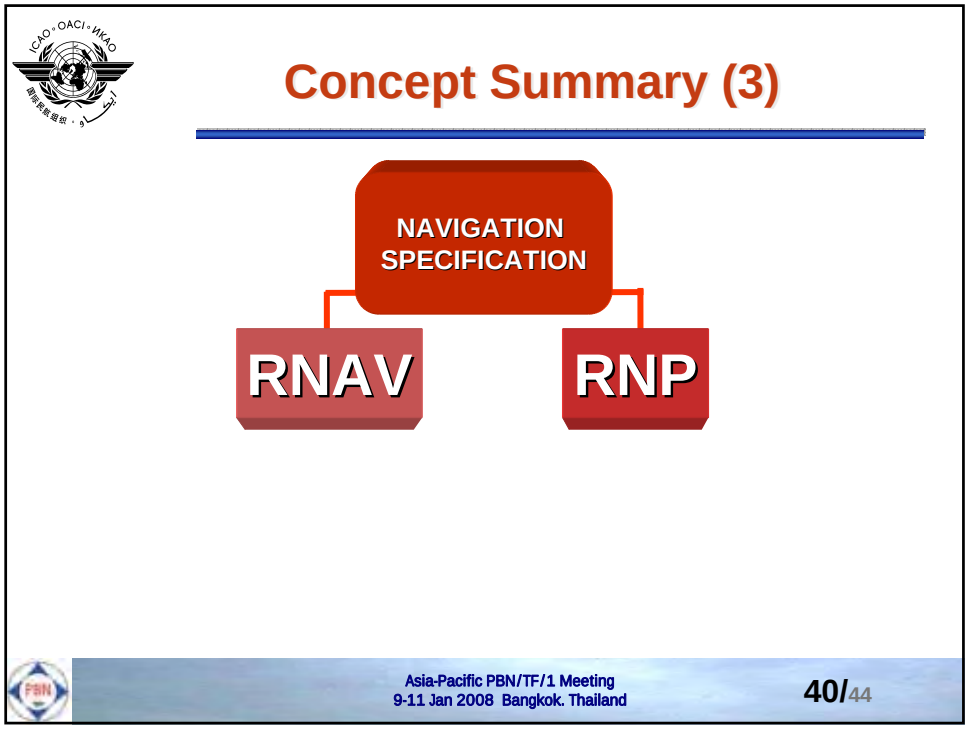
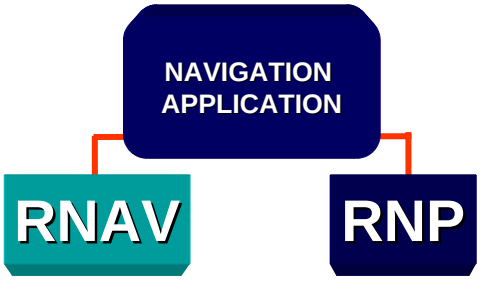
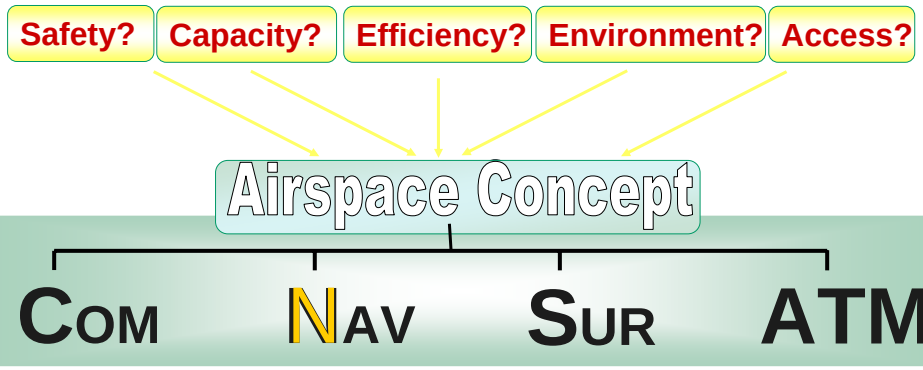

Concept Summary (3)
NAVIGATION SPECIFICATION
RNAV
RNP
Asia-Pacific PBN/TF/1 Meeting
9-11 Jan 2008 Bangkok. Thailand
40/44

Concept Summary (3)

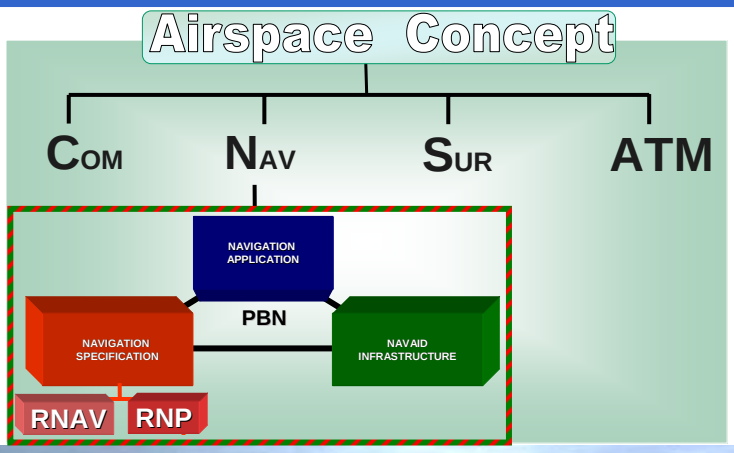


Airspace Concept Summary (1)



Airspace Concept Summary (2)

ICAO GLOBAL ATM CONCEPT



Implementation Processes Summary

- **#1: Determine requirements**
  - **#2 Identify an ICAO Navigation Specification for Implementation**
    - **#3 Planning and Implementation**

Implementation Summary: Additional Considerations

- Possible regional or inter-regional agreements
  - For connectivity and continuity between airspaces
- If considering mandating a navigation specification, the decision needs to consider many factors, including:
  - Proportion of aircraft fleet capable of meeting requirements
  - Cost to operators to equip aircraft to meet requirements
  - Operational Impacts on
    - Operators
    - Flight crews
    - Air traffic services

7 Steps for Safety Assessment

- System description
- Hazard identification
- Estimation of hazard severity
- Estimation of the likelihood of the hazard occurring
- Evaluation of the risk
- Risk mitigation
- Development of safety assessment documentation

ICAO Doc 9859, *Safety Management Manual*, Chapter 13

Aircraft Performance

- Normal performance
  - Lateral accuracy is expressed in terms of nautical miles either side of a desired track centerline
  - Aircraft is expected to be within the lateral value of the desired track centerline at least 95% of the time
- Non-Normal Errors:
  - Some non-normal errors are addressed by on-board performance monitoring and alerting requirements
  - "Blunder" type errors (e.g. selection of wrong route) are not included in on-board performance monitoring and alerting requirements
    - Handled through training, surveillance detection or additional separation

RNAV System Failures (1)

- Aircraft having single navigation systems (where allowed) must be considered in the safety assessment
- Potential mitigations are identified by considering:
  - Nature of aircraft system failure
  - Availability of alternate navigation
  - Available CNS/ATM environment

RNAV System Failures (2)

- In a Surveillance environment
  - One aircraft with failure of navigation capability could be handled
- In an Non-surveillance environment
  - Complete navigation system failure and unreported position errors must be considered
  - Potential mitigations are identified by considering:
    - Nature of aircraft system failure
    - Availability of alternate navigation and CNS/ATM environment

Failure of Navigation Aid Environment

- NAVAID infrastructure and the degree of redundancy needs study
  - Inertial navigation should be considered as a mitigation for areas with sparse NAVAID infrastructure
- Where GNSS is the predominant positioning source:
  - Likelihood of GNSS outage must be considered
  - If mitigation is ATS surveillance
    - ATC workload must be considered
    - Aircraft carriage of alternate navigation capability must be considered if ATS surveillance not feasible

ATS Surveillance and Communication

- Consider the contribution of ATS surveillance and communications as mitigation to achieve TLS for a desired route or spacing
- Availability of ATS surveillance along route to support TLS
- Effectiveness of ATC intervention when aircraft fail to maintain route center line should be considered
- ATS communication requirement is VHF
  - Exception in remote and oceanic airspace (HF, SATCOM, CPDLC)
  - Consider Reception Strength

ECAC Example

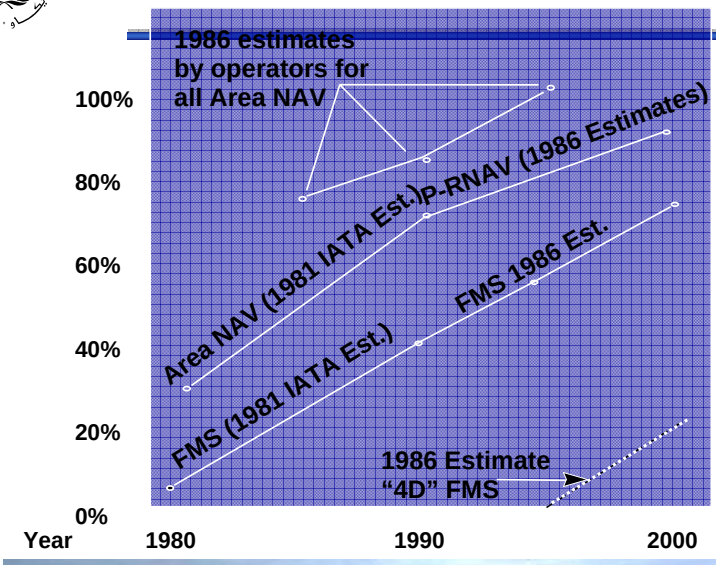
ECAC Strategy for 90s

- RNAV mandate en-route
- RNAV enable in TMA

- Target Date 1998

Identified RNAV 1 (P-RNAV) as required

EQUIPAGE FORECAST



Implementation

Identified:

- RNAV 1 (P-RNAV) equipage rates much slower than predicted
- Reviewed Airspace Concept –
  - Main capacity benefits could be achieved with RNAV 5 (B-RNAV)

Result

- Mandated RNAV 5
- Enabled RNAV 1 to provide TMA capabilty

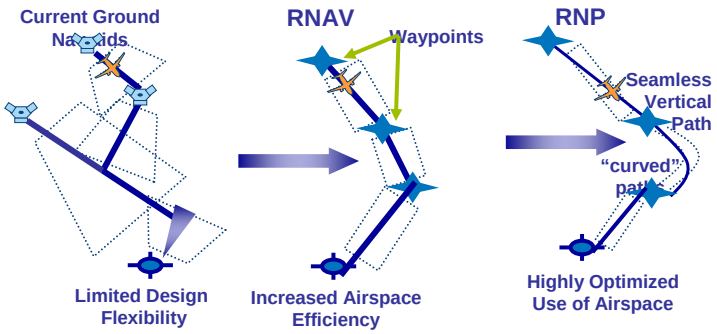

IATA
Performance Based Navigation
Doug Michael - Assistant Director ATM


IATA
ICAO • OACI • ИКАО
IATA
2

To promote safe, secure, efficient and economical air transport

3

The use of satellite technology has allowed the aviation industry to move away from its dependence upon ground based navigation systems.



4

- Airlines continue to acquire or equip existing aircraft with improved and more capable avionics.

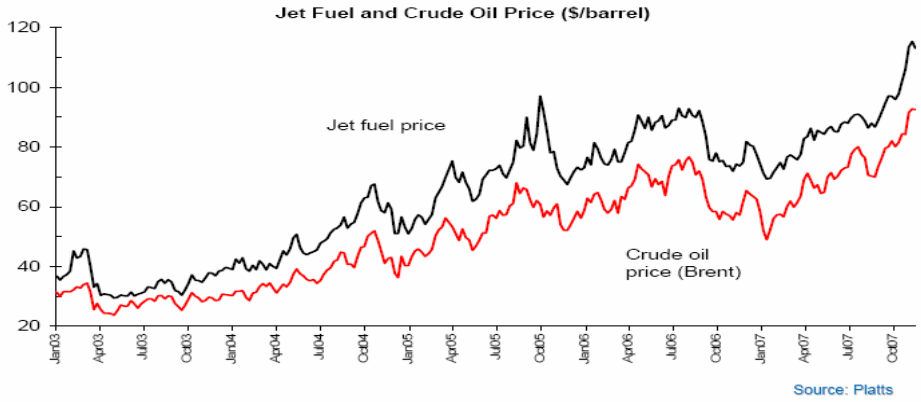
5

- Traffic growth forecast

6

Jet Fuel Prices

Jet fuel prices above $110 / barrel…



Source: Platts

7

PBN benefits for airlines

- At the end of the third quarter 2007 the accident rate was 0.83 hull losses per million departures.
- **Safety benefits of PBN:**
  - CFIT reduction
  - Stabilized Approaches
  - Safer Missed Approaches
  - Safer Non-normal Procedures
  - Less stress on flight crews
  - More consistency
  - No ILS Signal distortion

8

PBN benefits for airlines

- Performance Based Navigation promises to increase capacity while enhancing safety.
- Benefits of RNAV/RNP technology include:
  - SAFETY – Controlled Flight into Terrain (CFIT)
  - RELIABILITY – GNSS virtually always operational
  - EFFICIENCY – optimized approach routing
  - REMOTE AREAS – accurate guidance in remote and oceanic areas

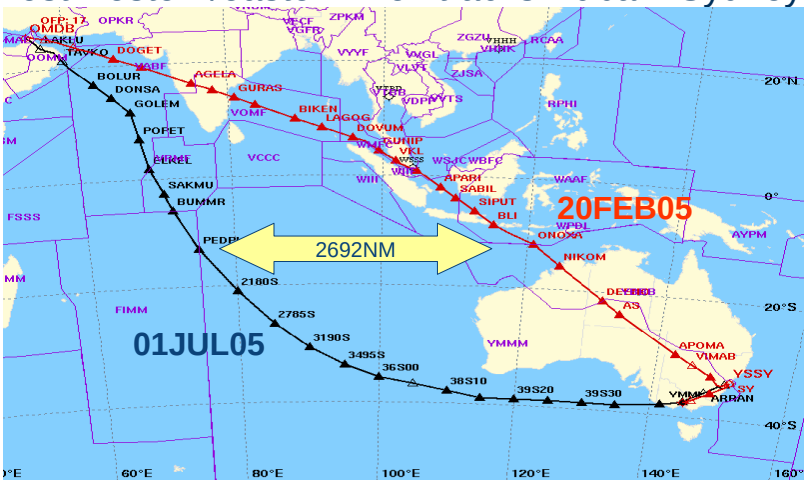
9

PBN benefits for airlines

- Benefits of RNAV/RNP technology include:
  - ACCURATE APPROACH GUIDANCE – improved accessibility and with vertical guidance
  - GLOBAL APPLICATION – seamless global navigation system
  - ROUTE FLEXIBILITY – supports efficient noise abatement
  - ENVIRONMENTAL BENEFITS – reduced fuel emissions

10

Most western/eastern Flex tracks Dubai - Sydney



11

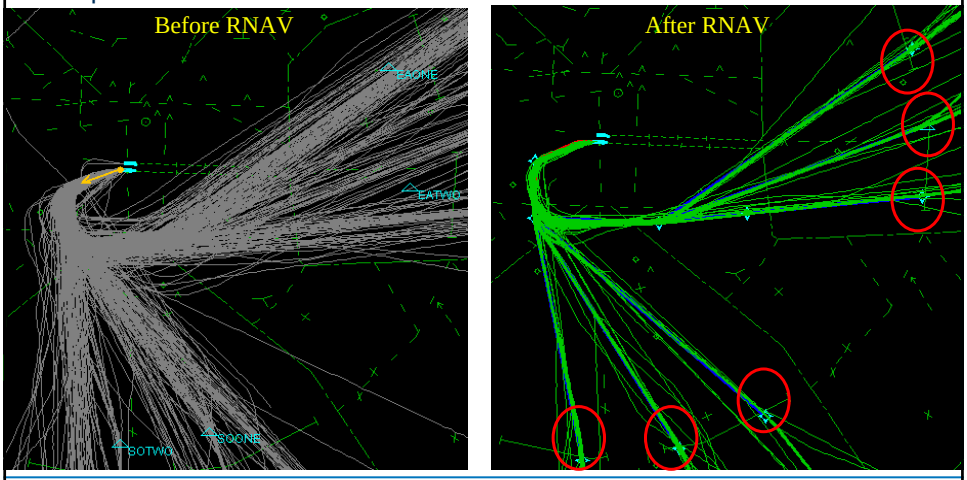
Panama Approach Procedures

Fuel Savings 2007:

- ↗ US$7 million
- ↗ 31,000 tons CO_2

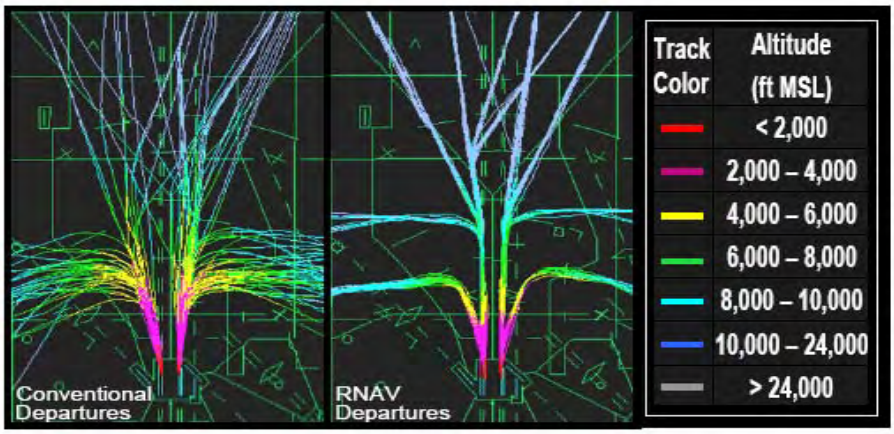
12

Atlanta RNAV Departure Procedures
April 2005



13

DFW before and after implementation of RNAV procedures.



14

PBN benefits for airlines

- Performance Based Navigation is green.
  - It saves fuel.
  - It relieves congestion, alleviates choke points and reduces delays.
  - It increases efficiency by providing smoother traffic flow.
  - Flying straight down the middle of a flight path means that people on the ground perceive less jet noise and experience fewer engine emissions.

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PBN benefits for airlines

- Summary
  - Safety – 2007 accident trend rising
  - Efficiency – traffic growth rising
  - Economy – fuel prices rising
  - Environment – global concern growing

16

PBN in 2008

- IATA PBN Workshops to support implementation as an industry priority
- First held 23 November 2007
- Plan to be held every 2-3 months
- IATA to fund TMA for implementation of PBN

17

PBN benefits for airlines

- The End

Thank you.

18




Qantas RNP-AR Activities

Captain Alex Passerini

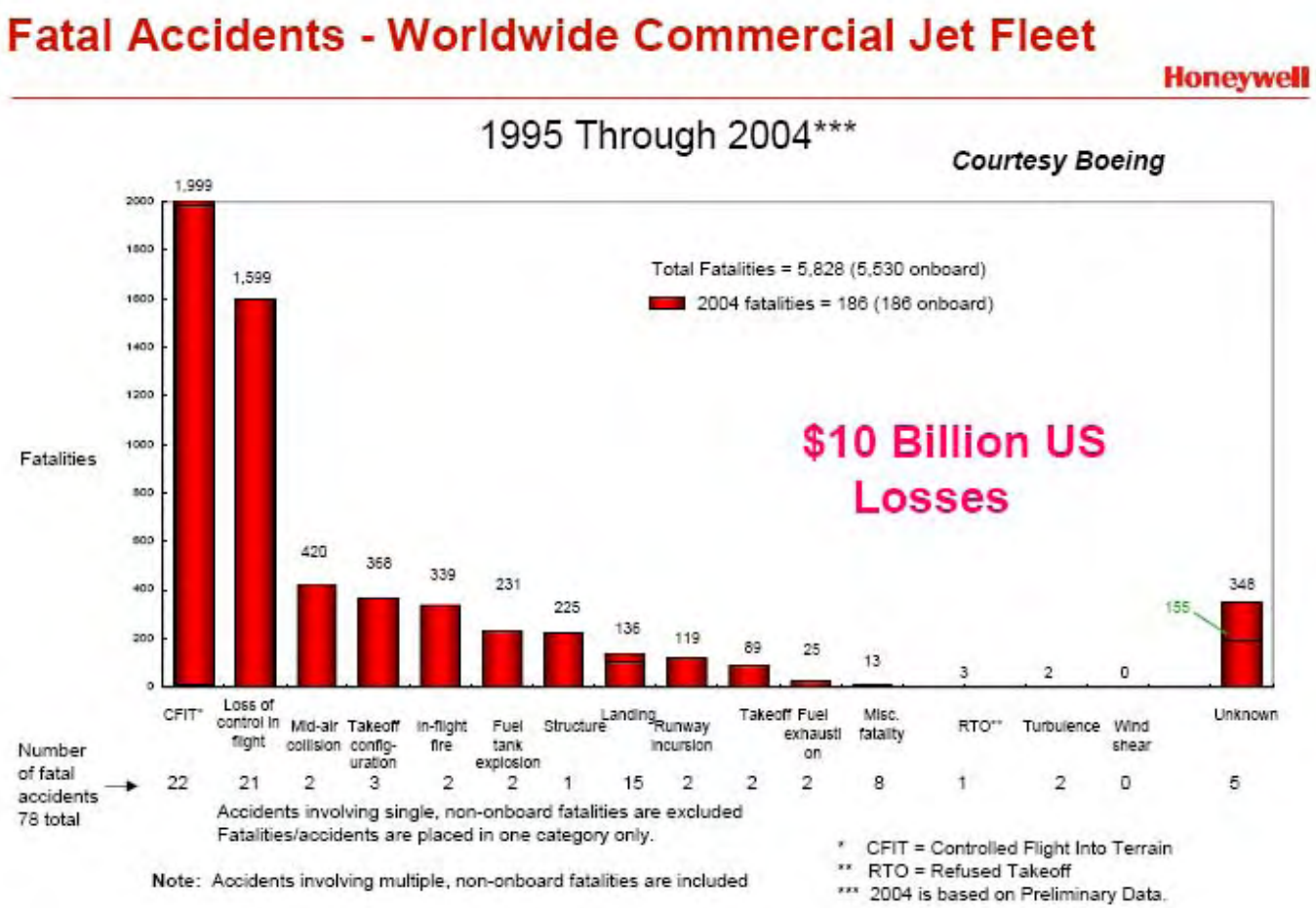
Flight Operations

QANTAS

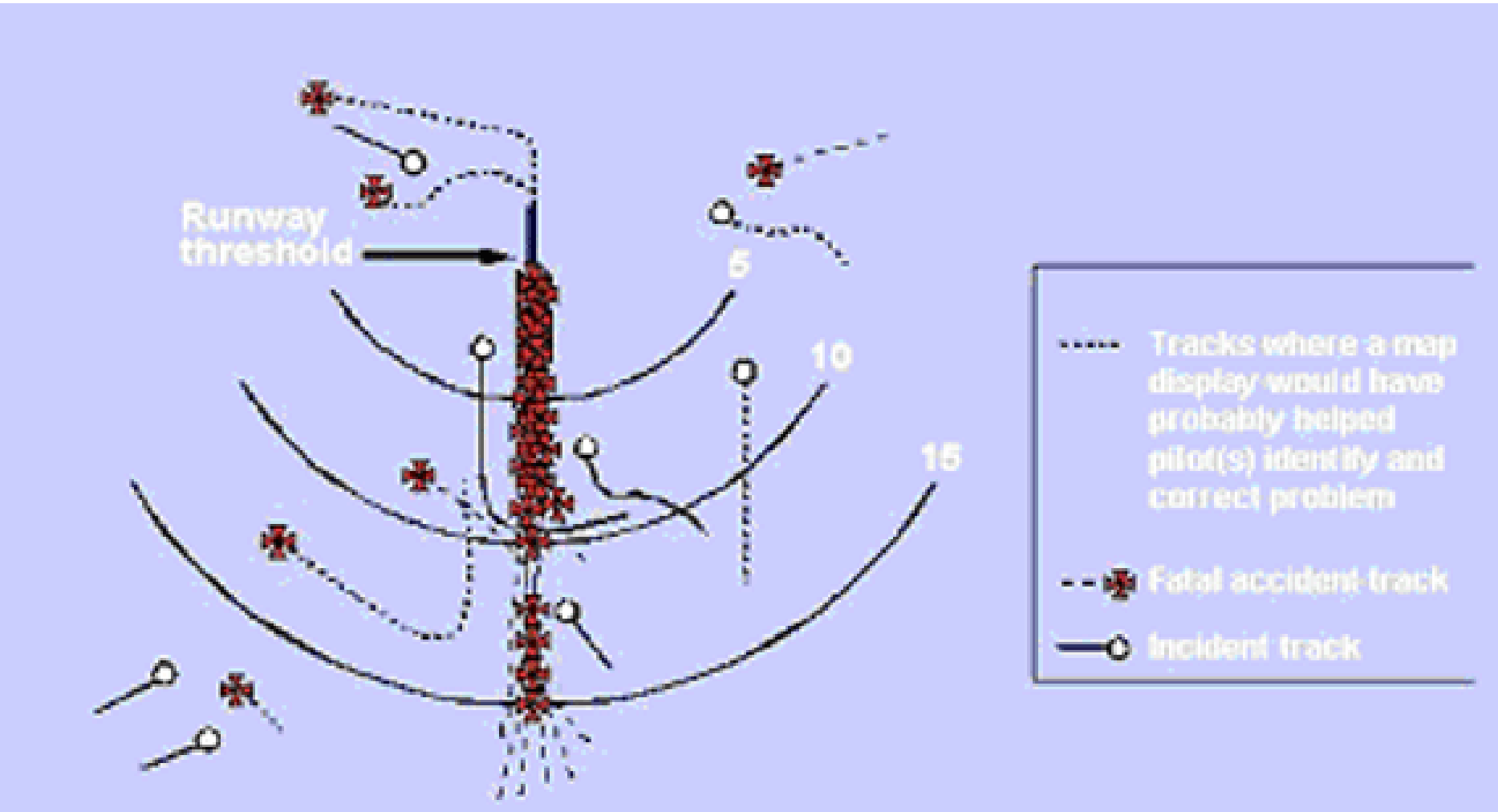
Overview

- Project History
- Current Operations
- Fuel & Emissions
- Future Activities
- Summary

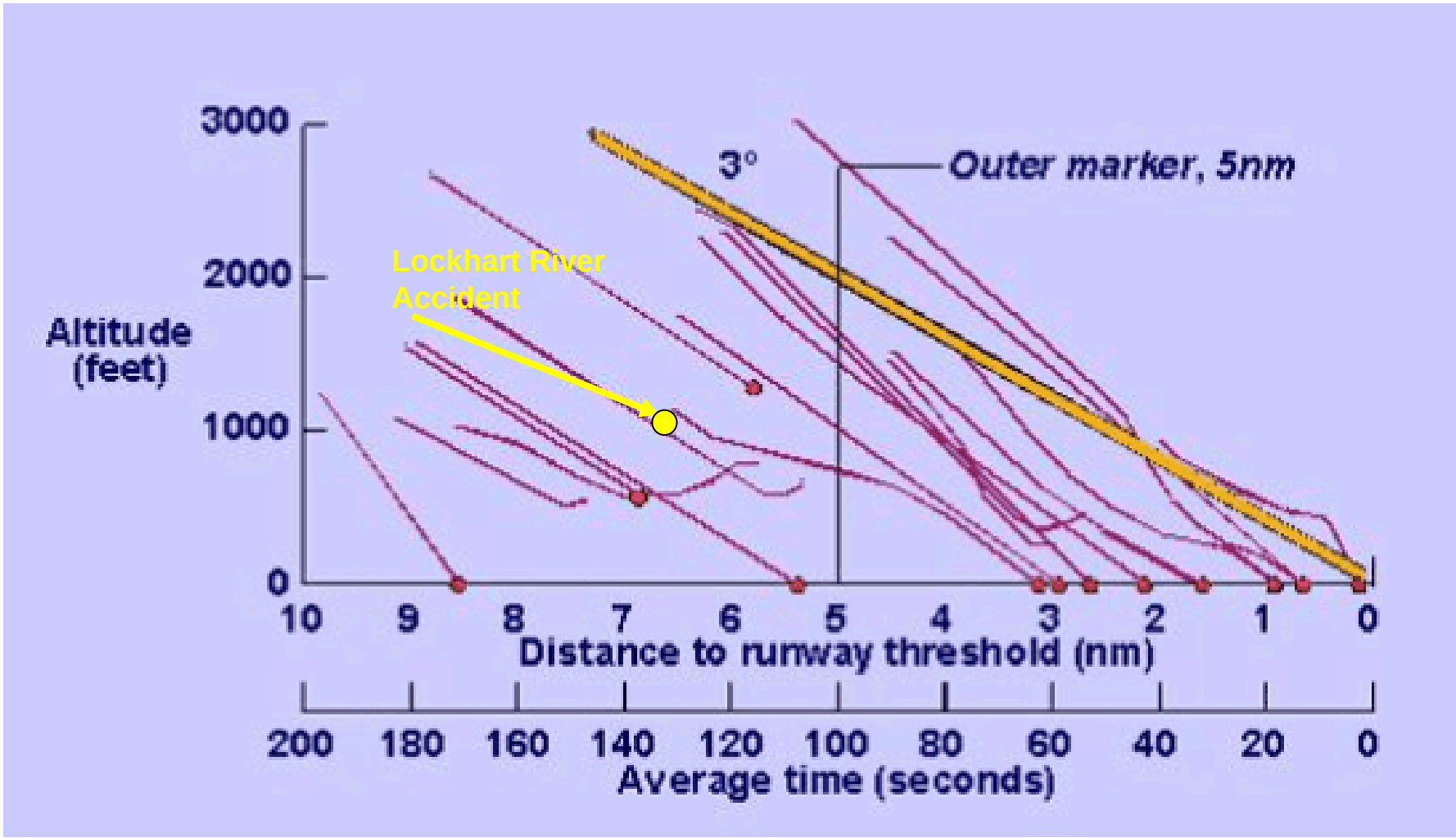
Fatal Accident History



CFIT Accident Locations



Relative Locations Of CFIT Events



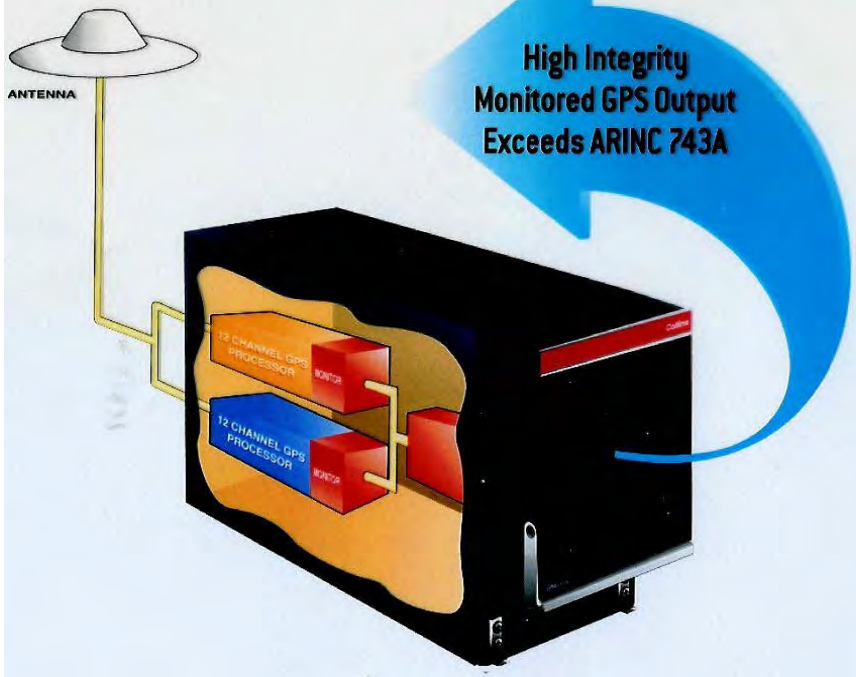
SWA Midway Airport

Technology advancements

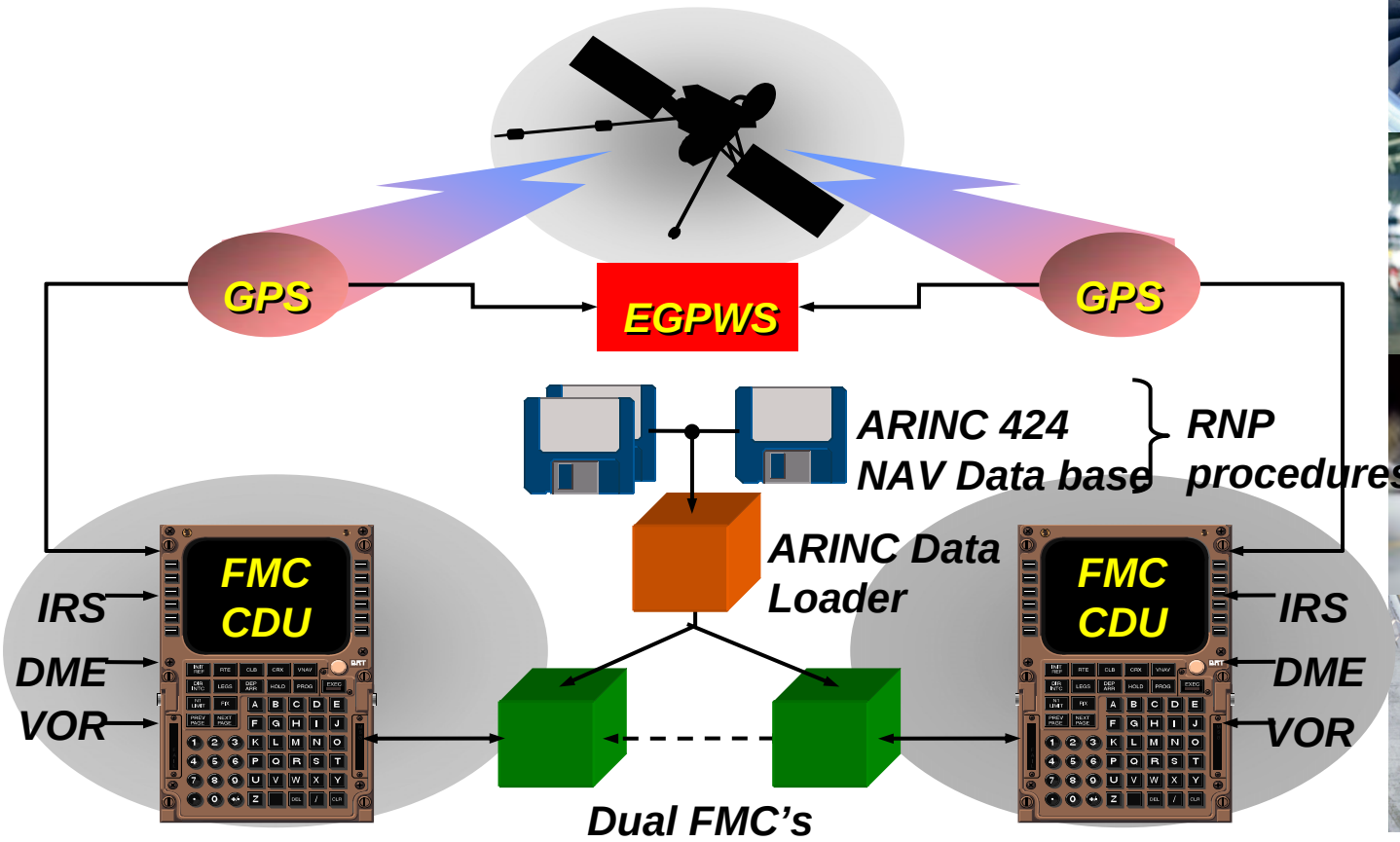
- GPS
  - Average 15 metre accuracy
  - At 9 Standard Deviations, still well within 36 m wingspan of the B737 NG
  - Worldwide coverage

DUAL MONITORED DESIGN

- Collins Unique MMR Architecture
- Providing 10^{-8} Integrity
- Greater Confidence with fewer false alarms

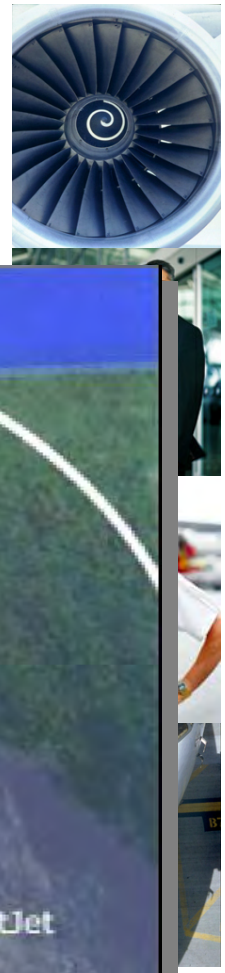


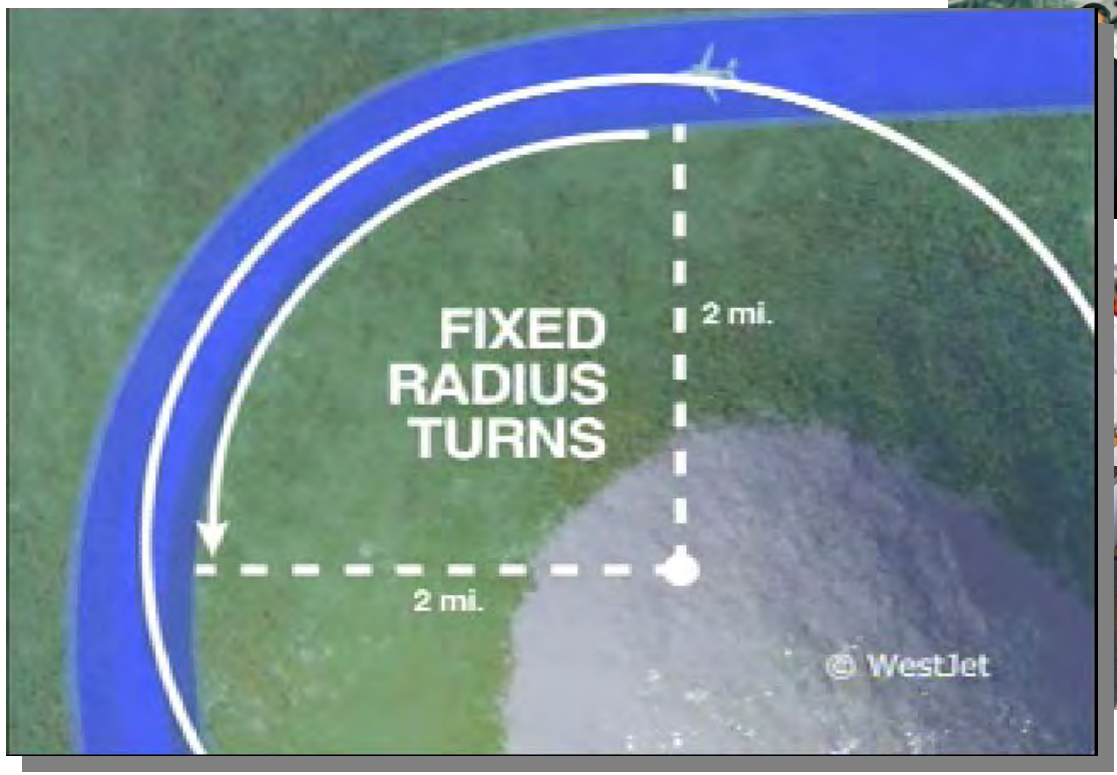
B737NG System Architecture



Technology advancements

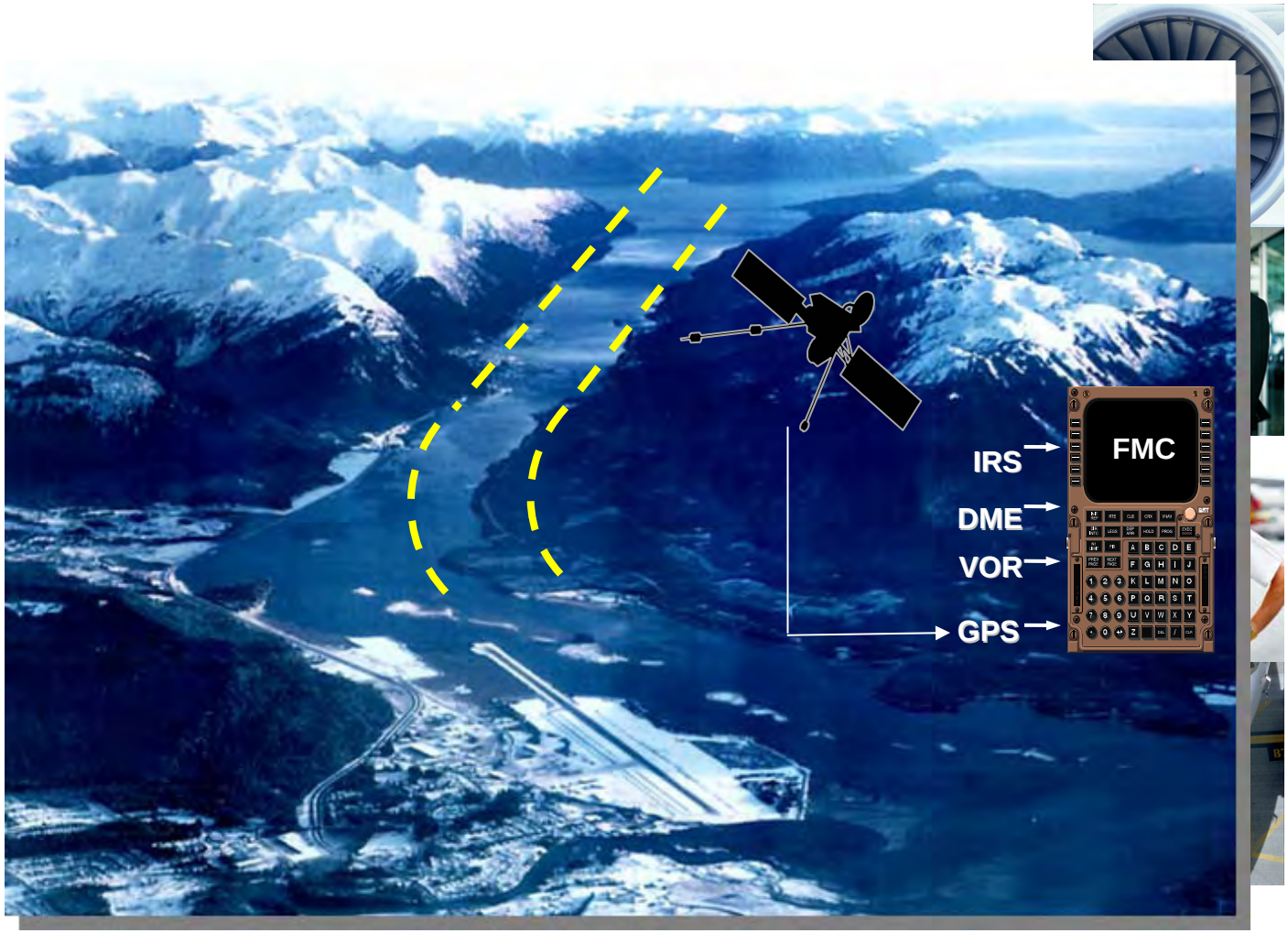
- Flight Management Computer
  - Fixed Radius Turn (RF) capability





Position fixing

- Accuracy
- Integrity
- Availability
- Continuity

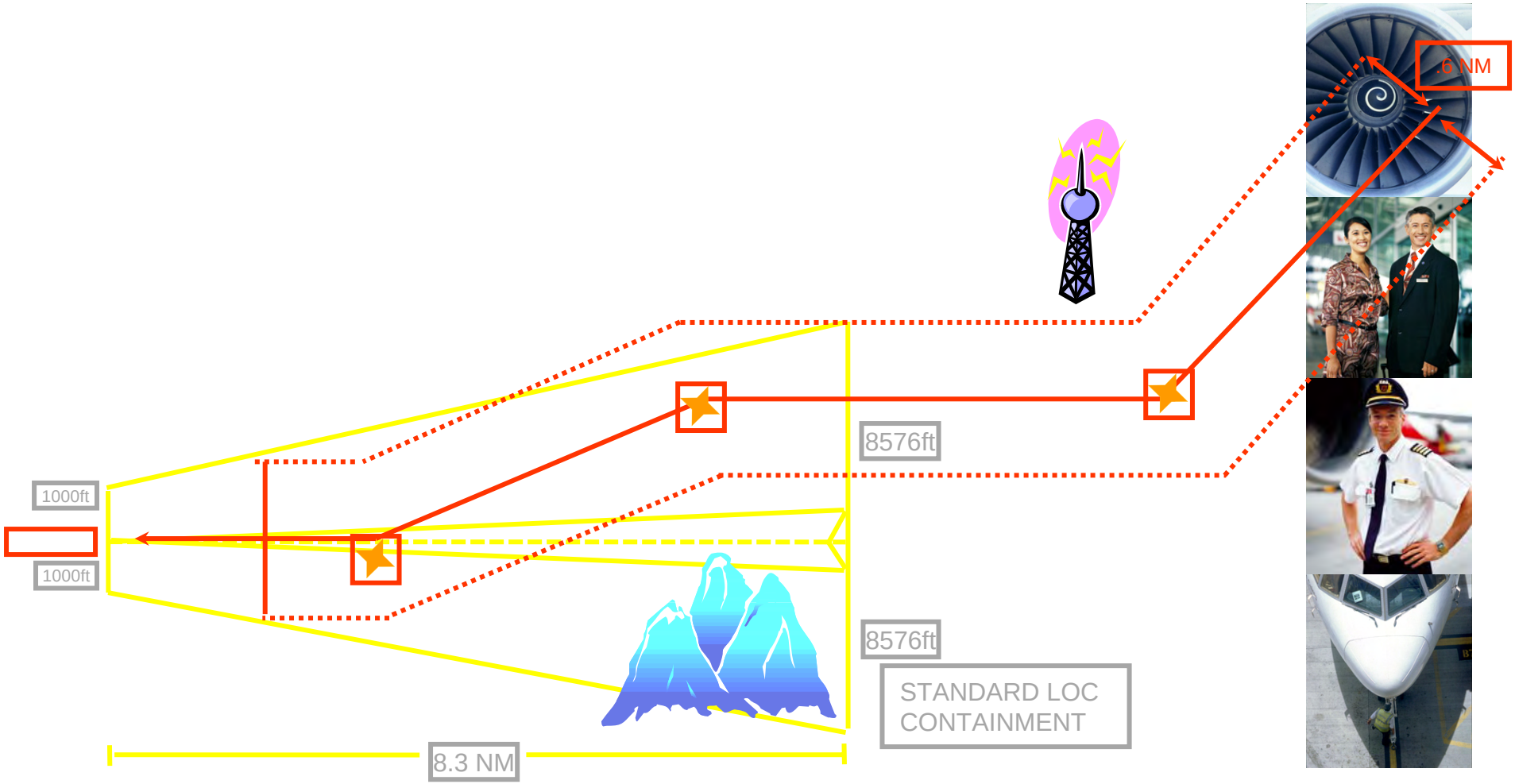


Project History

- Australia is an earlier adopter of GNSS based capabilities
  - RNAV (GNSS) approach procedures
  - Primary Means GNSS
  - ADS-B (5nm lateral separation standard in place TODAY)

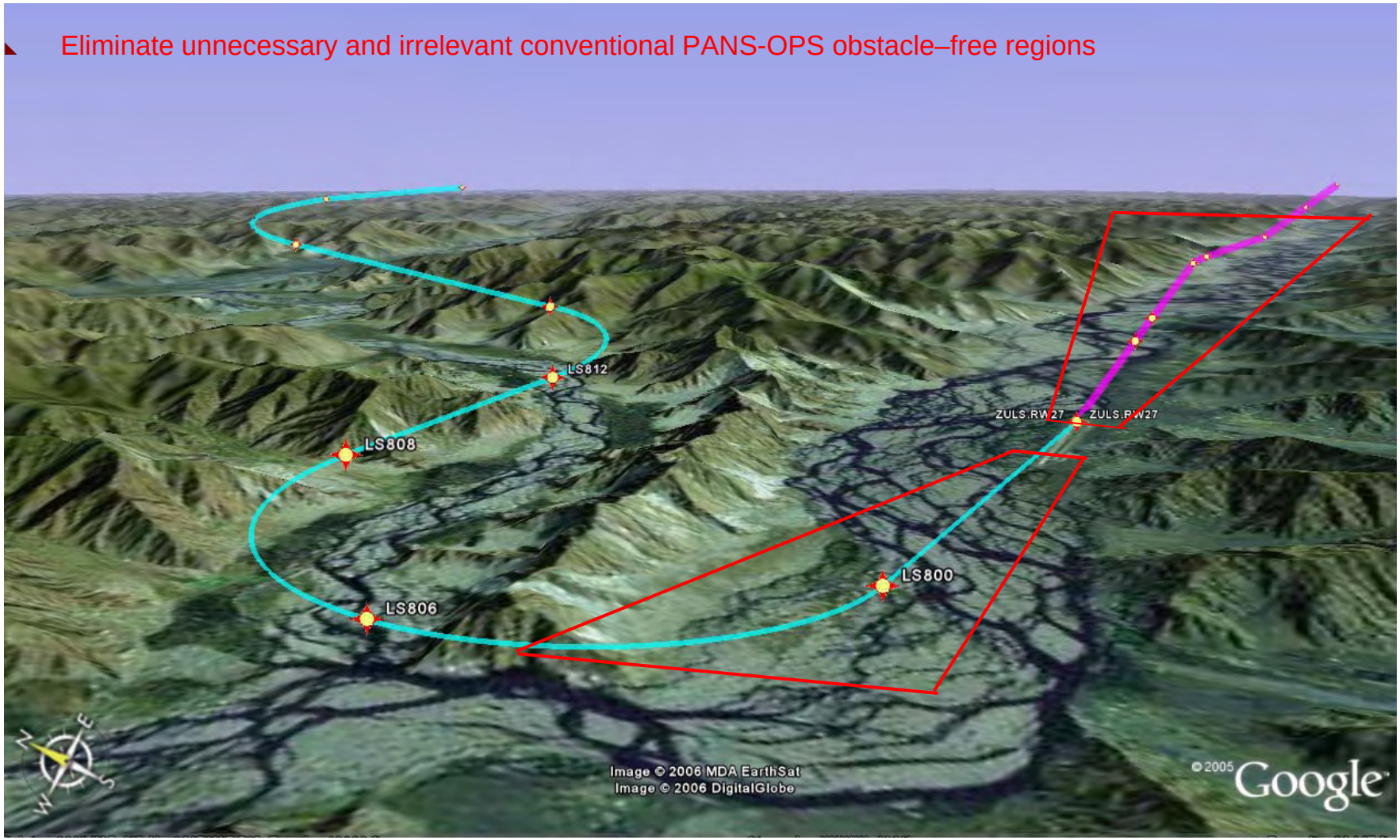
- RNAV (RNP) was the next logical progression

Tailored lateral path example



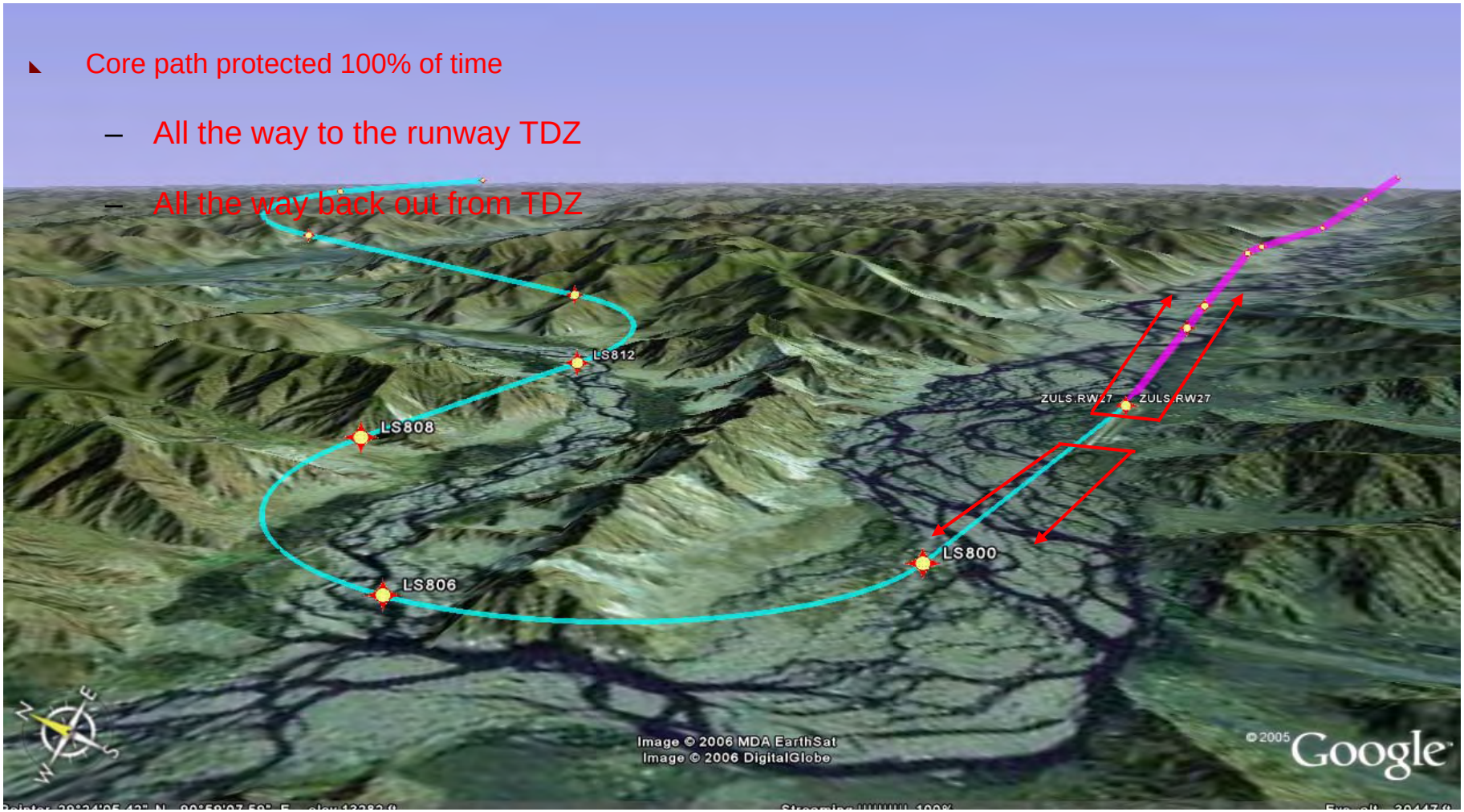
RNP Design – Normal Performance

- Eliminate unnecessary and irrelevant conventional PANS-OPS obstacle–free regions



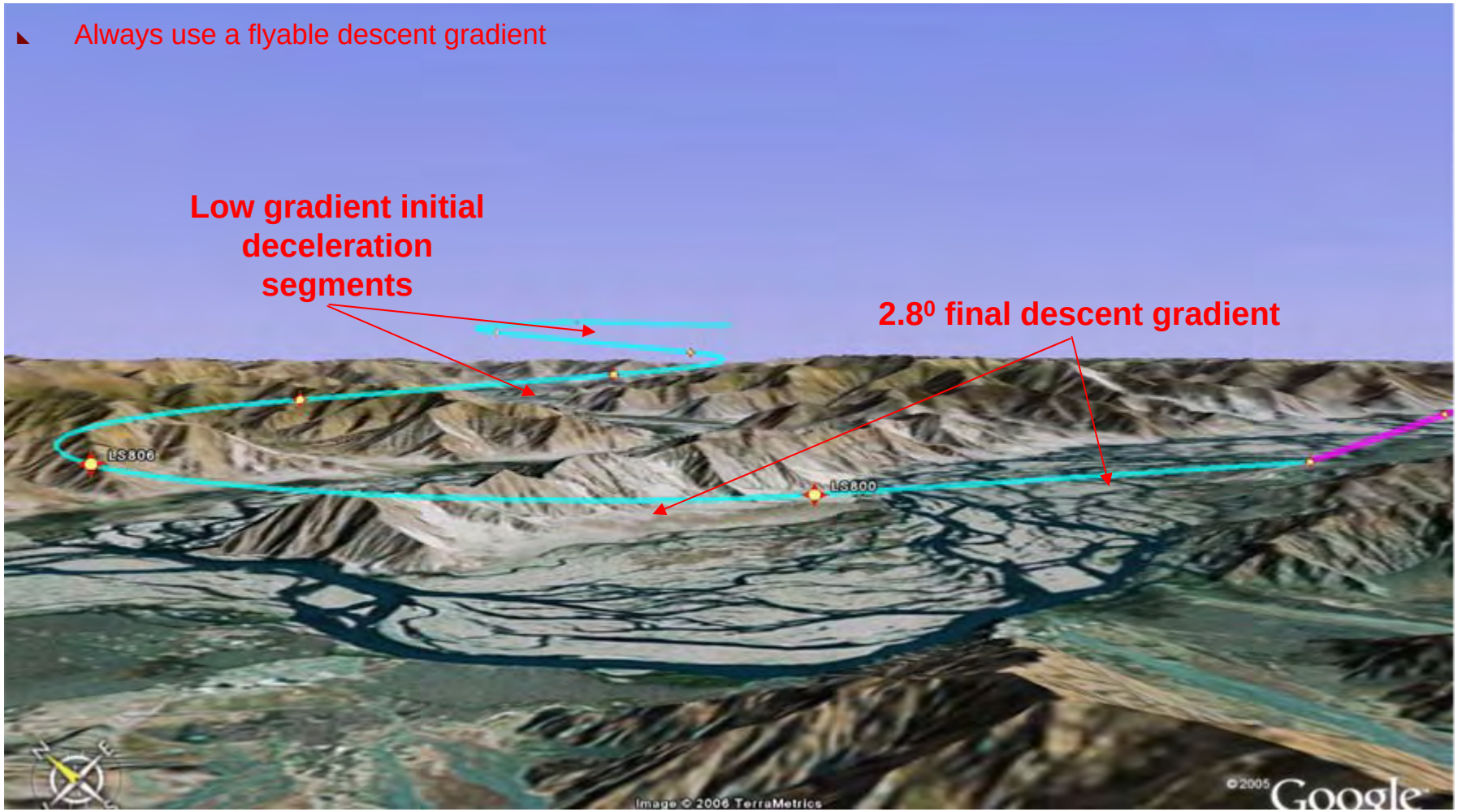
RNP Design – Normal Performance

- Core path protected 100% of time
  - All the way to the runway TDZ
  - All the way back out from TDZ



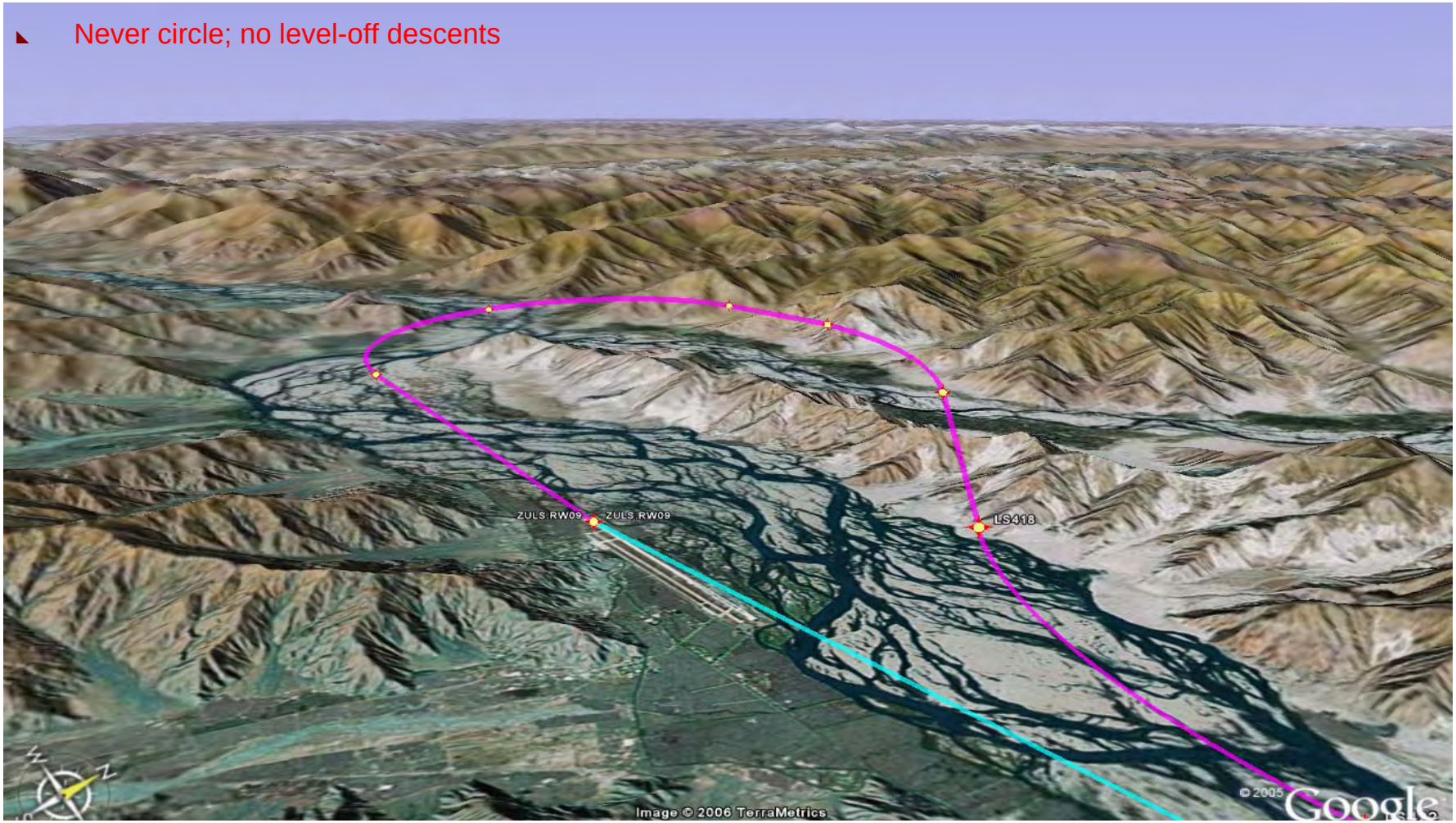
RNP Design – Normal Performance

- Always use a flyable descent gradient

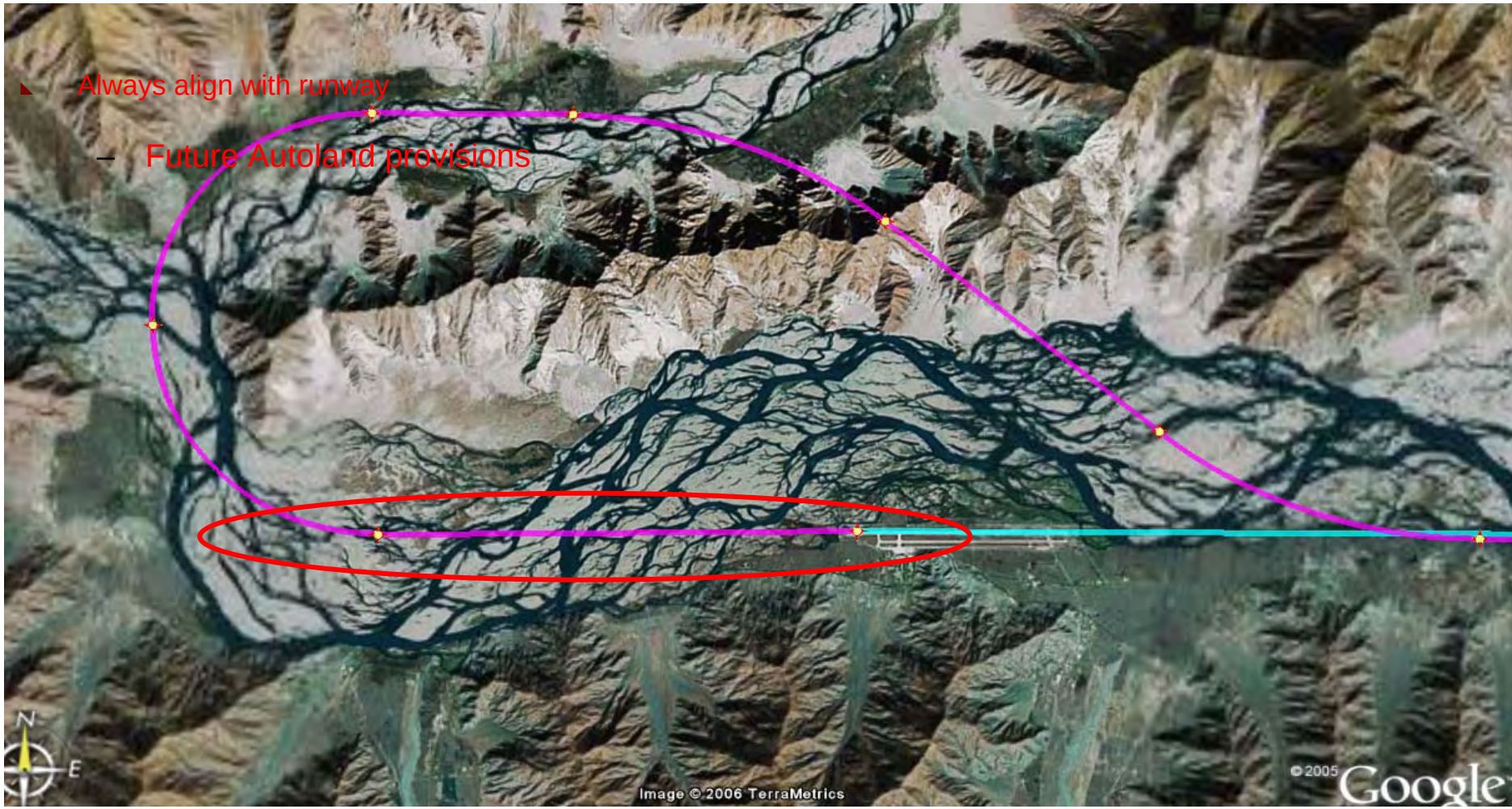


RNP Design – Normal Performance

- Never circle; no level-off descents

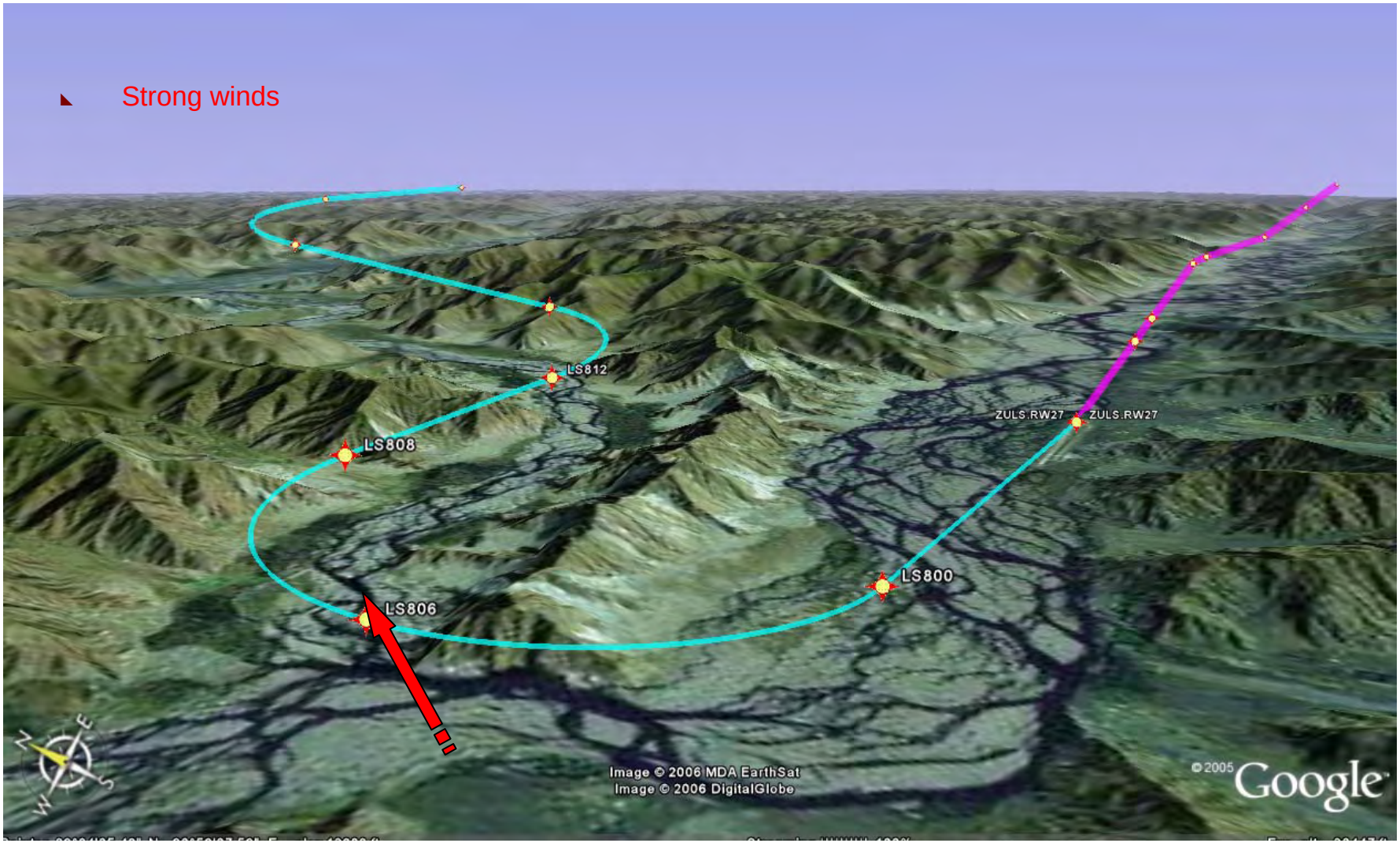


RNP Design – Normal Performance



RNP Design – Rare Normal Performance

- Strong winds



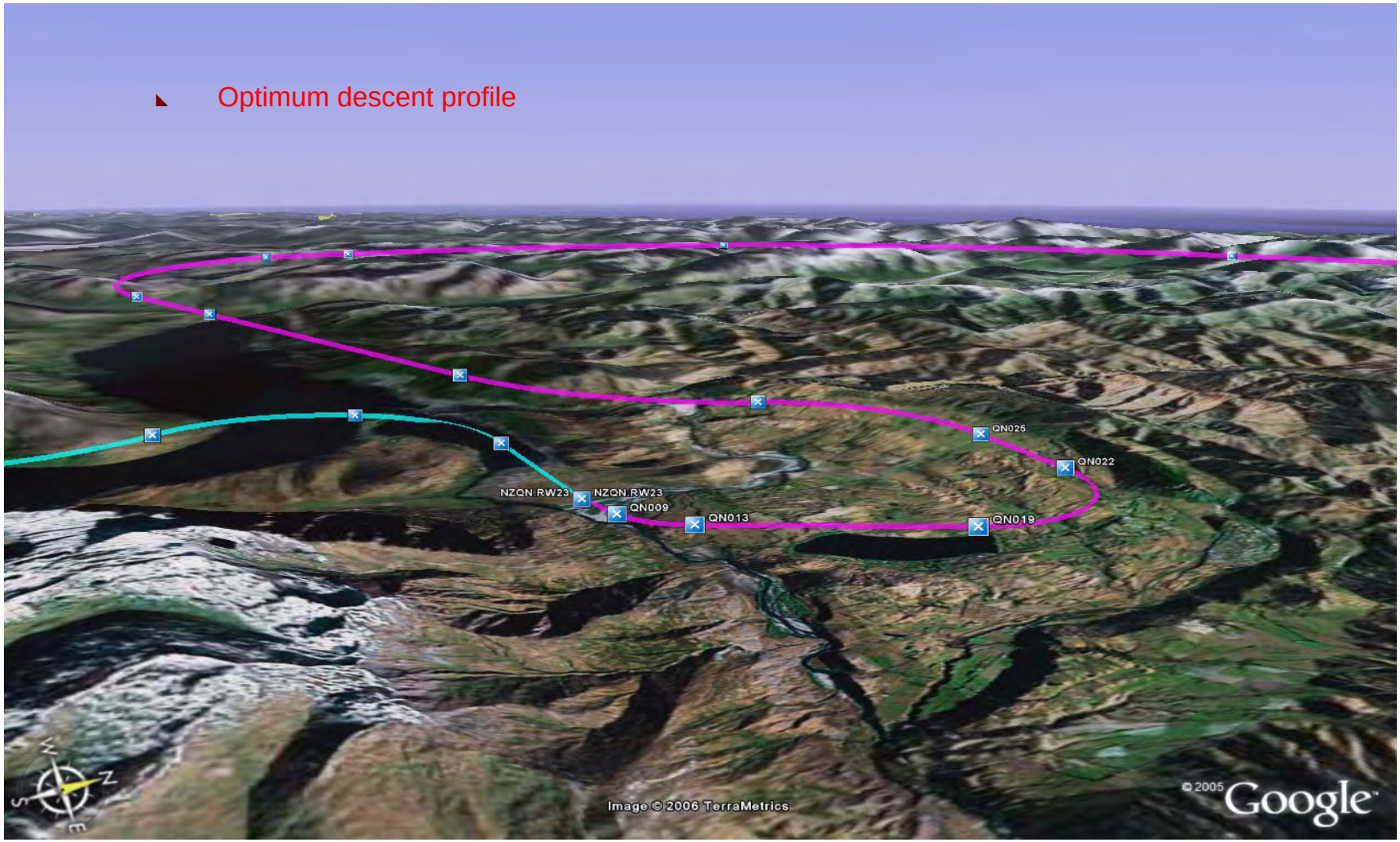
RNP Design –
Non-Normal Performance

- Failure conditions
  - Engine failure
  - GPS failure
  - Other systems failure

RNP Design - Efficiency

RNP Design - Efficiency

- Optimum descent profile



Queenstown, New Zealand

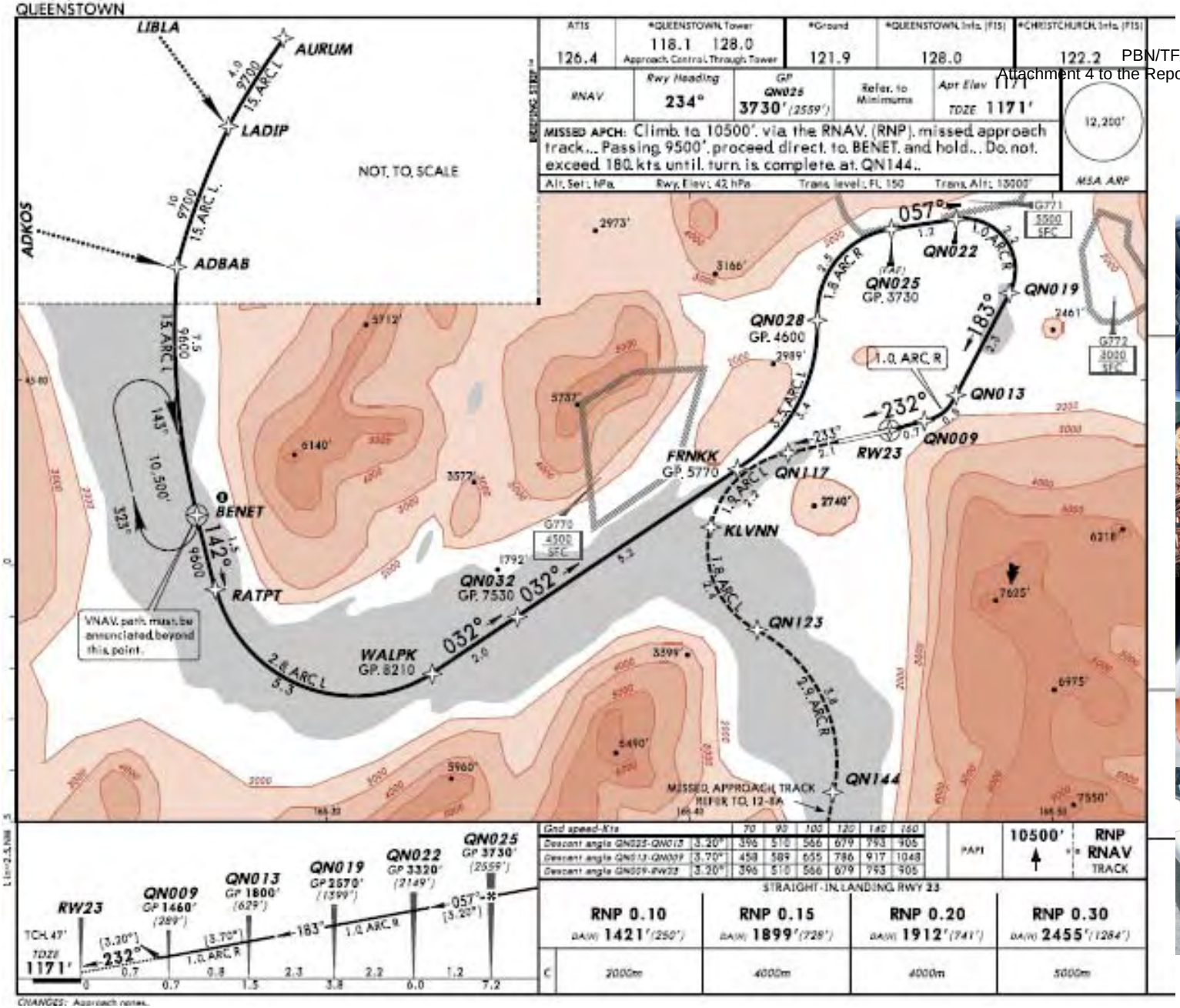

208

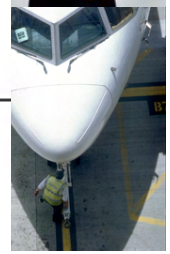

MAN
AUTO
HUD BRT
FUEL PUMPS
OFF
L
R
ON
CTR
AFT
FWD
FUEL PUMPS
FWD
AFT
L WIPER
PARK
INT
LOW
RUNWAY TURNOFF
TAXI
COURSE
234
A/T ARM
IAS/MACH
V NAV
HEADING
234
L NAV
ALTITUDE
10500
FIRE WARN
MAIN PANEL DU
LOWER DU
YAW DAMPER
AUTO BRAKE
FUEL FLOW

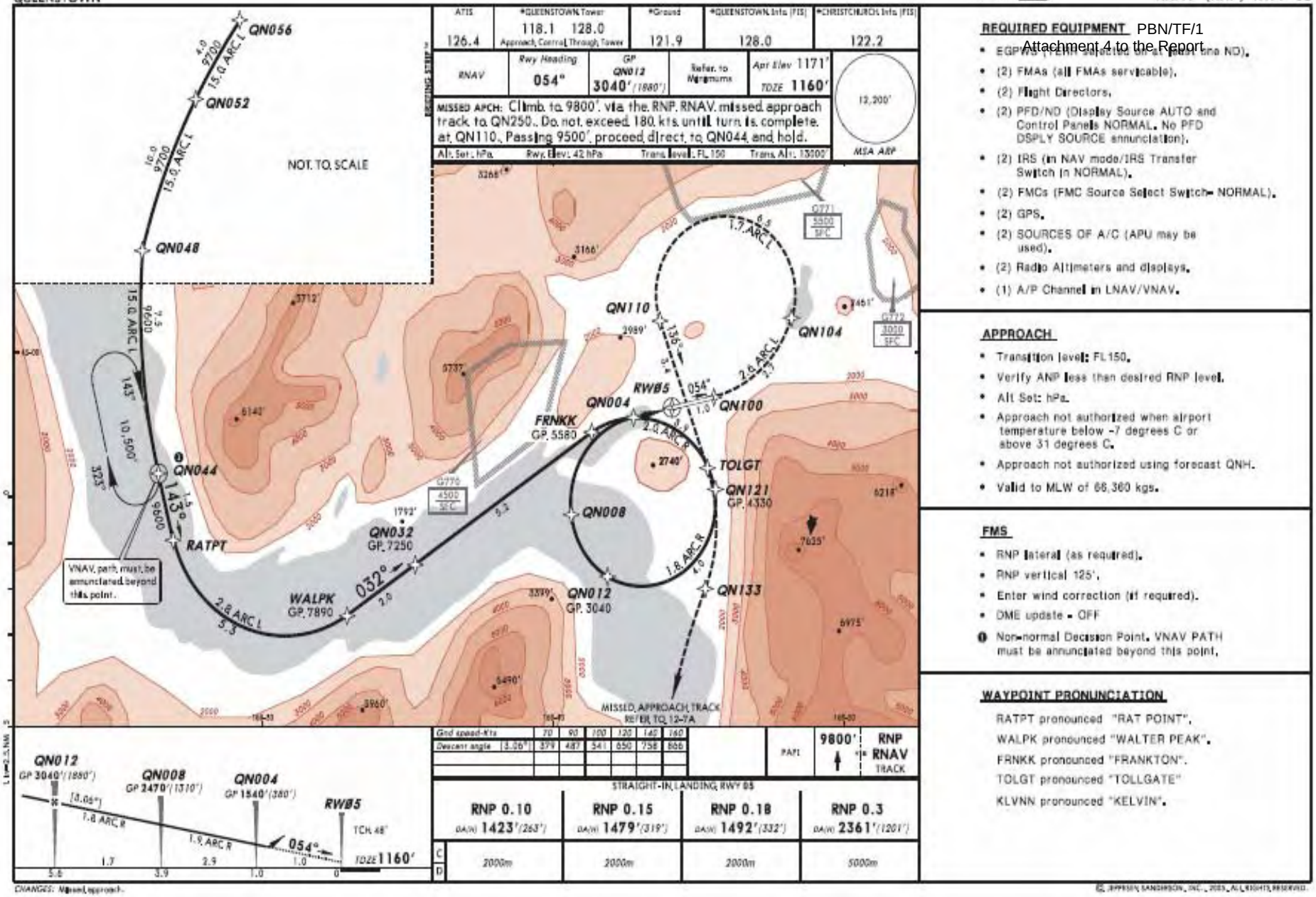
Project History

- Commenced RNP Operations into Queenstown NZ in September 2004
  - Approach and Departure Procedures
  - No conventional procedures authorised
  - World's first RNP 0.10 approach

NZQN/ZQN
QUEENSTOWN







REQUIRED EQUIPMENT

PBN/TF/1

- EGPWS (TERR selected ON at least one ND).
- (2) FMAs (all FMAs serviceable).
- (2) Flight Directors.
- (2) PFD/ND (Display Source AUTO and Control Panels NORMAL. No PFD DSPLY SOURCE annunciation).
- (2) IRS (in NAV mode/IRS Transfer Switch in NORMAL).
- (2) FMCs (FMC Source Select Switch= NORMAL).
- (2) GPS.
- (2) SOURCES OF A/C (APU may be used).
- (2) Radio Altimeters and displays.
- (1) A/P Channel in LNAV/VNAV.

APPROACH

- Transition level: FL150.
- Verify ANP less than desired RNP level.
- Alt Set: hPa.
- Approach not authorized when airport temperature below -7 degrees C or above 31 degrees C.
- Approach not authorized using forecast QNH.
- Valid to MLW of 66,360 kgs.

FMS

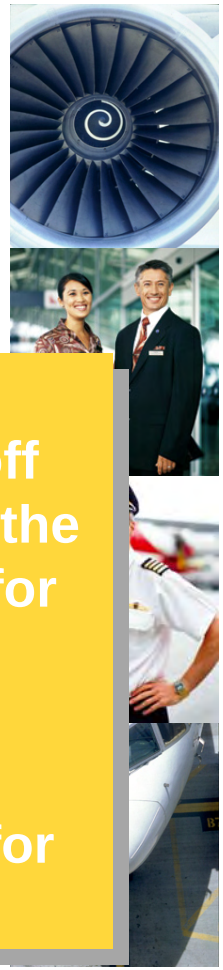
- RNP lateral (as required).
- RNP vertical 125'.
- Enter wind correction (if required).
- DME update - OFF
- ❶ Non-normal Decision Point. VNAV PATH must be annunciated beyond this point.

WAYPOINT PRONUNCIATION

RATPT pronounced "RAT POINT".
WALPK pronounced "WALTER PEAK".
FRNKK pronounced "FRANKTON".
TOLGT pronounced "TOLLGATE"
KLVNN pronounced "KELVIN".

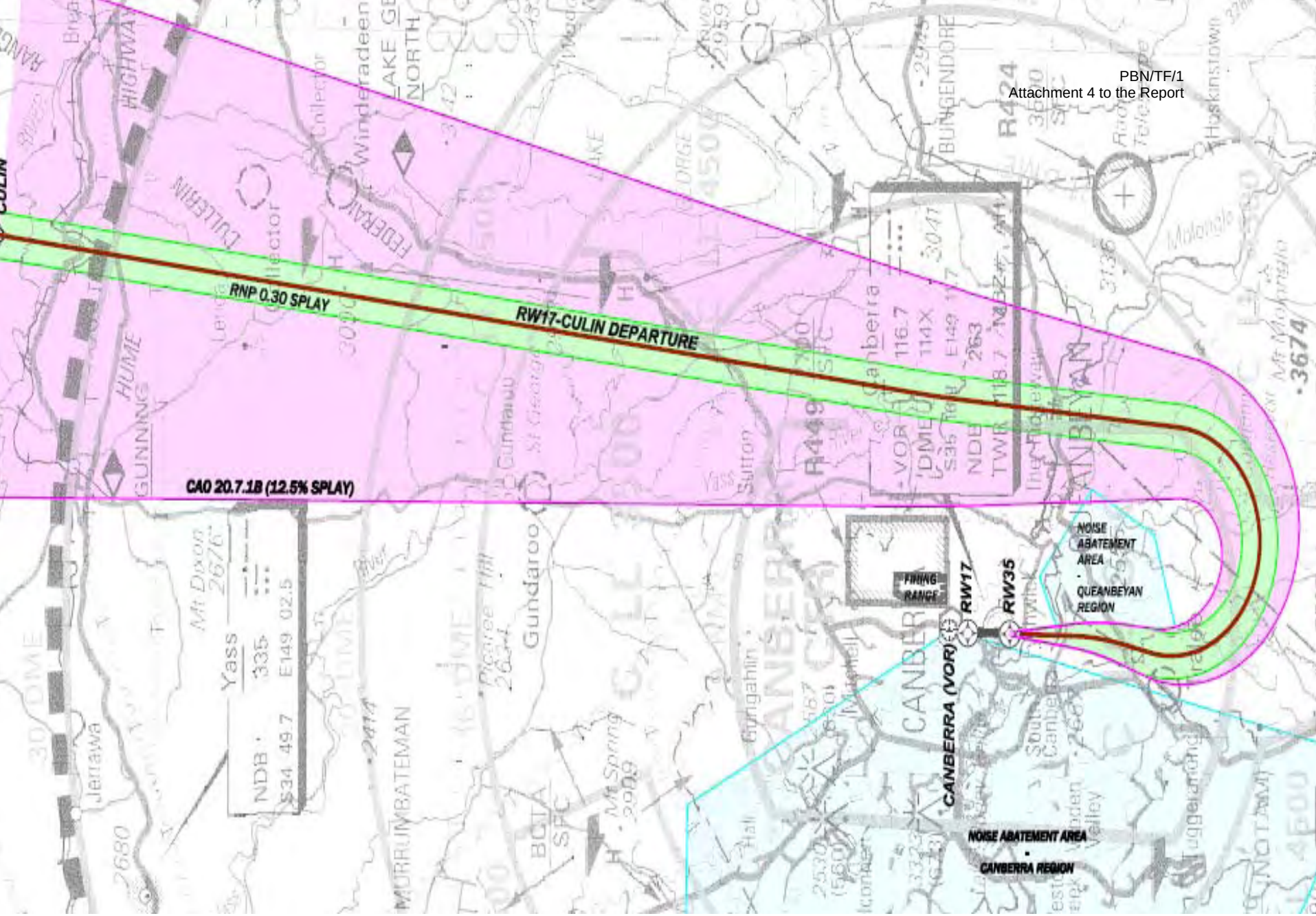
Takeoff Performance Improvements

- Aeroplane Weight and Performance Limitations -
  Specified Aeroplanes Above 5,700 kg -
  All Operations (Turbine and Piston-Engined)



…However, for an RNP-capable aeroplane engaged in an approved RNP operation, the lateral expansion of the takeoff area may be discontinued when the takeoff area intersects the RNP containment specified in the approval as appropriate for the RNP type that is:

(i) selected in the FMS by the flight crew; and
(ii) within the RNP capability specified in the flight manual for an operation of that kind.


RNP 0.30 SPLAY
RW17-CULIN DEPARTURE
CA0 20.7.1B (12.5% SPLAY)
NOISE ABATEMENT AREA - QUEANBEYAN REGION
FIRING RANGE
RW17
RW35
CANBERRA (VOR)
NOISE ABATEMENT AREA - CANBERRA REGION
Yass
NDB
335
S34 49.7 E149 02.5

NZQN/ZQN
QUEENSTOWN

QANTAS
1 JUL 05 (10-3K-1) QUEENSTOWN, NEW ZEALAND
RNP RNAV DEPARTURE

ATIS	*QUEENSTOWN Ground	*Tower	*QUEENSTOWN Info (FIS)	Apt Elev 1171'	Trans. alt: 13000' Trans. level: FL 150
126.4	121.9	118.1 128.0	128.0		Safe Altitude within 100 NM of Queenstown Apt 13,400'.

RNP BOWEN ONE RNP RNAV DEPARTURE (RNPBN1.QN124)

QANTAS B737-800 w/26K ONLY

RNP 0.18
(RWY 23)

Required weather minima:
Reported ceiling -2300'
Visibility -5000m

This departure requires a minimum climb gradient of 500' per NM to 9800'.

Gnd speed-Kts	100	150	200	250	300
500' per NM	833	1250	1667	2083	2500

MSA SH VOR

RW23 RNP RNAV ENGINE FAILURE DEPARTURE PROCEDURE

RNP 0.18

For engine failure prior to TOLGT:

1. EXECute ENG OUT SID MOD.
2. Fly RNP RNAV track to QN250. Do not exceed 180 kts until 360° turn is complete at QN123.

For engine failure after TOLGT:

1. Fly the RNP RNAV track to QN188 (LIBLA Trans.) or QN132 (ADKOS Trans.).

NOT TO SCALE

QN188 (LIBLA)
QN184
QN180
QN132 (ADKOS)
QN128
QN124
QN118
QN122
QN119
QN123
QN144
RW23
TOLGT
At or above 6300'
(All Departures)
SLOPE HILL
SH
See Engine Failure Procedure

NOT TO SCALE

QN118
QN122
QN119
QN123
QN144
QN148
QN152
QN156
QN170
QN174
QN178
QN250
RW23
TOLGT
Note: QN250 is co-located with NV VOR

ROUTING

Rwy 23: Climb to 9800' via RNP RNAV track to TOLGT and cross TOLGT at or above 6300'. Do not exceed 180 kts until turn is completed at TOLGT. Set climb thrust at 2130' AGL. Thence:

TRANSITIONS:

LIBLA (RNPBN1_LIBLA): Fly the RNP RNAV track to QN188.

ADKOS (RNPBN1_ADKOS): Fly the RNP RNAV track to QN132.

REQUIRED EQUIPMENT

- FMS.
  RNP lateral (as required).
  Inhibit VOR and DME updating.
  ARM LNAV prior to departure.
- EGPWS (TERR selected on at least one ND).
- (2) FMAs (all FMAs serviceable).
- (2) Flight Directors.
- (2) PFD/ ND (Display Source AUTO and Control Panels NORMAL. No PFD DSPLY SOURCE annunciation).
- (2) IRS (In NAV mode/IRS Transfer Switch in NORMAL).
- (2) FMCs (FMC Source Select Switch-NORMAL).
- (2) GPS.
- (2) SOURCES OF A/C (APU may be used).
- (2) Radio Altimeters and displays.

Waypoint Pronunciation

TOLGT pronounced "TOLLGATE".

CHANGED: Procedure

RNP Procedure Queenstown NZ

Project History

- Safety Improvements
  - Guidance through to touchdown/missed approach
  - Non-normal & rare-normal accountability
  - EO departure procedures
- Access Improvements
  - Lower takeoff & landing minima
- Economic Improvements
  - Payload
  - Reduced diversion
  - Schedule integrity
- Technology Leader – Qantas seen by community as an “innovator”

RNP Network Deployment

- Additional ports currently online
  - Alice Springs (Class D non-radar)
  - Ayers Rock (CTAF-R/Class G/uncontrolled)
  - Brisbane (Class C radar/busy environment)
  - Canberra (Class C radar)
  - Cairns (Class C radar)
  - Sydney (Class C radar/ very busy & complex environment)
  - Townsville (Class C radar/military)
  - Gold Coast (Class C radar)
  - Hobart (Class D non-radar)
- Complete Domestic Network Rollout approved March 2007

YBTL/TSV
TOWNSVILLE INTL

QANTAS

FOR CASA APPROVED OPERATORS ONLY

DRAFT 12-8
QANTAS B737-800 ONLY

TOWNSVILLE, QLD, AUSTRALIA
RNAV (RNP) Z RWY 19

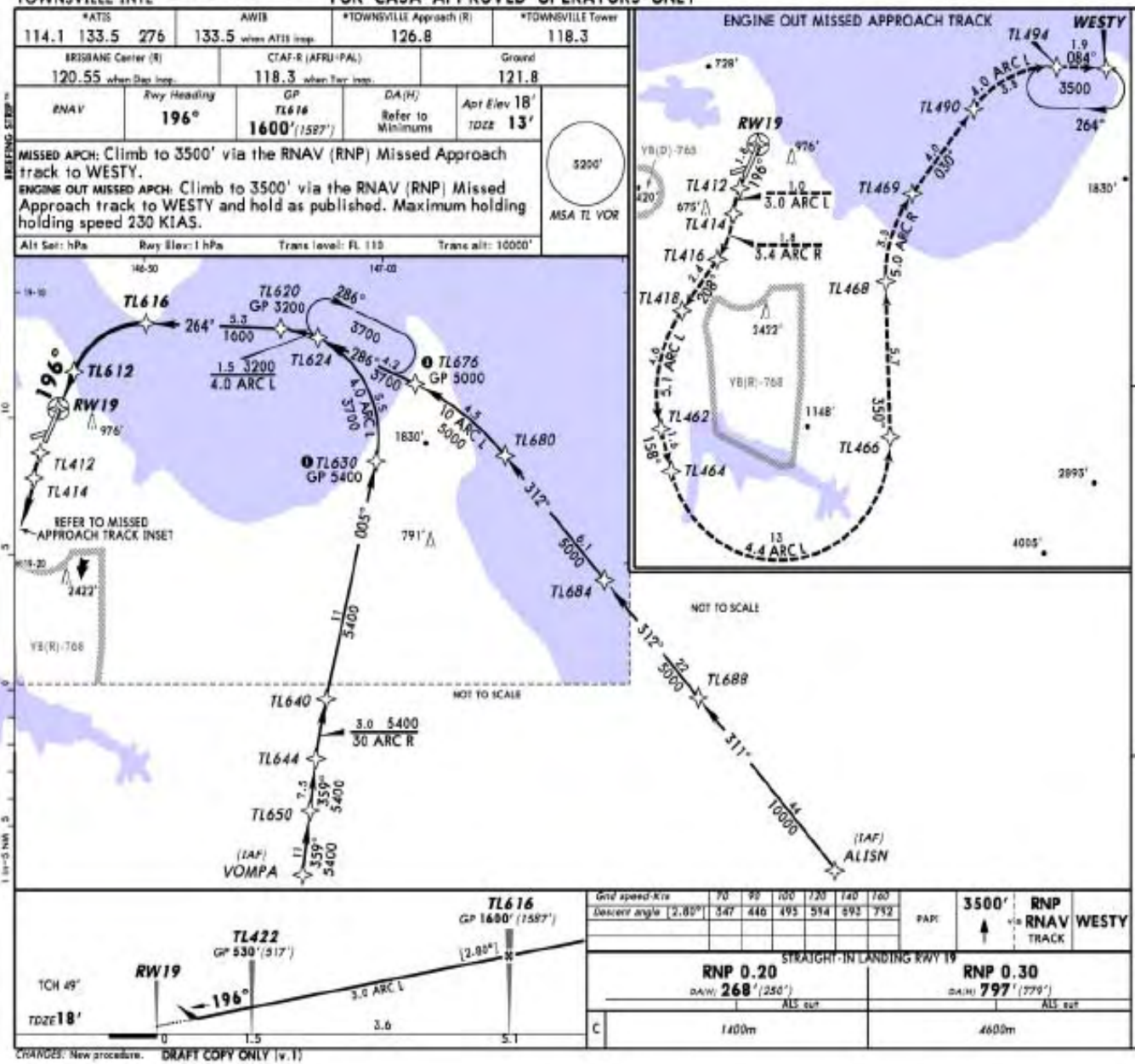
*ATIS	AWIB	*TOWNSVILLE Approach (R)	*TOWNSVILLE Tower
114.1 133.5 276	133.5 when ATIS inop.	126.8	118.3
BRISBANE Center (R)	CTAF-R (AFRU-PAL)		Ground
120.55 when Dep inop.	118.3 when Twr inop.		121.8

RNAV	Rwy Heading	GP	DA(H)	Apt Elev 18'
	196°	TL616 1600'(1587')	Refer to Minimums	TDZE 13'

MISSED APCH: Climb to 3500' via the RNAV (RNP) Missed Approach track to WESTY.
ENGINE OUT MISSED APCH: Climb to 3500' via the RNAV (RNP) Missed Approach track to WESTY and hold as published. Maximum holding holding speed 230 KIAS.

5200'
MSA TL VOR

Alt Set: hPa | Rwy Elev: I hPa | Trans level: FL 110 | Trans alt: 10000'



Grid speed-Kts	70	90	100	120	140	160
Descent angle 2.80°	347	446	495	594	693	792

PAPI | 3500' | RNP RNAV TRACK | WESTY

STRAIGHT-IN LANDING RWY 19

	RNP 0.20	RNP 0.30
DA(H)	268'(256')	797'(779')
	ALS out	ALS out
C	1400m	4600m

CHANGES: New procedure. DRAFT COPY ONLY (v.1)

REQUIRED EQUIPMENT PBN/TF/1

Attachment 4 to the Report

EGPWS (Terrain selected on at least one ND).

(2) FMAs (all FMAs servicable).

(2) Flight Directors.

(2) PFD/ND (Display Source AUTO and Control Panels NORMAL. No PFD DSPLY SOURCE annunciation).

(2) IRS (in NAV mode/IRS Transfer Switch in NORMAL).

(2) FMCs (FMC Source Select Switch- NORMAL).

(2) GPS.

(2) Source of A/C power (APU may be used).

(2) Radio Altimeters and displays.

(1) A/P Channel in LNAV/VNAV.

APPROACH

Verify ANP less than desired RNP level.

Alt Set: hPa.

Approach not authorized when airport temperature below X degrees C or above XX degrees C.

Approach not authorized using forecast QNH.

Valid to MLW of 66,360 kgs.

Initiate a missed approach unless suitable visual reference can be established and maintained with any of the following.
- Loss of LNAV or VNAV information.
- ANP exceeds RNP, VERIFY POSITION or FMC DISAGREE messages.
- Unable to maintain NPS limits inside NNDP.

FMS

RNP lateral (as required).

RNP vertical 125'.

Enter wind correction (if required).

❶ Non-normal Decision Point. VNAV PATH must be annunciated beyond this point.

YMHB/HBA
HOBART

QANTAS

FOR CASA APPROVED OPERATORS ONLY

DRAFT 12-8
QANTAS B737-800 ONLY

HOBART, TAS, AUSTRALIA
RNAV (RNP) Z RWY 30

*ATIS	*HOBART Tower	CTAF-R (APRU+PAL)
112.7 128.45	118.1	118.1 when Twr inop.

RNAV	Rwy Heading	GP	DA(H)	Apt Elev 13'
	300°	HB720 1700' (1687')	Refer to Minimums	TDZE 13'

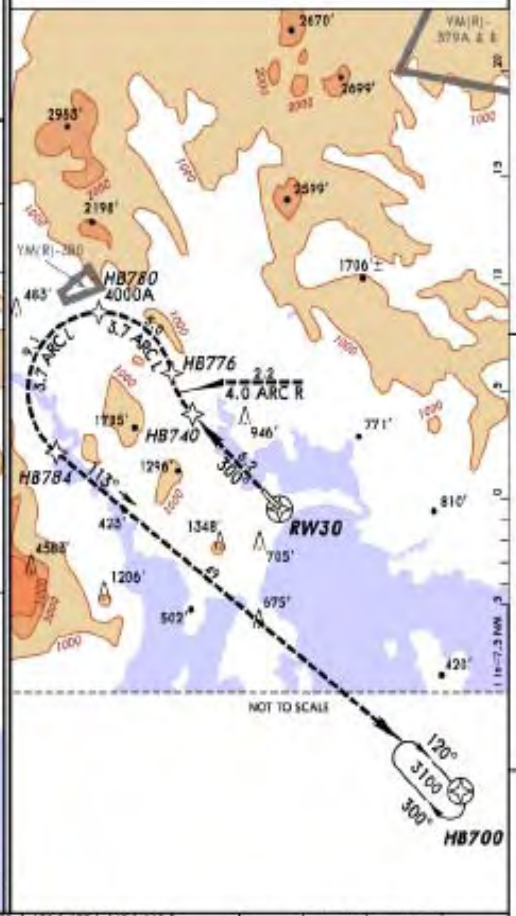
MISSED APCH: Climb to 4000' via the RNAV (RNP) Missed Approach track to HB780. Acceleration altitude 1500' QNH.
ENGINE OUT MISSED APCH: If unable to cross HB780 at 4000', advise ATC, and climb to 3100' via the RNAV (RNP) Engine Out Missed Approach track to HB700 and hold as published. Maximum holding speed 230 KIAS.

Alt Set: hPa | Rwy Elev: 0 hPa | Trans level: FL 110 | Trans alt: 10000'

5600'

AISA HB VOR

ENGINE OUT MISSED APPROACH TRACK



REQUIRED EQUIPMENT PBN/TF/1

Attachment 4 to the Report

EGPWS (TERR selected on at least one ND).

(2) FMAs (all FMAs servicable).

(2) Flight Directors.

(2) PFD/ND (Display Source AUTO and Control Panels NORMAL. No PFD DSPLY SOURCE annunciation).

(2) IRS (in NAV mode/IRS Transfer Switch in NORMAL).

(2) FMCs (FMC Source Select Switch- NORMAL).

(2) GPS.

(2) Sources of A/C power (APU may be used).

(2) Radio Altimeters and displays.

(1) A/P Channel in LNAV/VNAV.

APPROACH

Verify ANP less than desired RNP level.

Alt Set: hPa.

Approach not authorized when airport temperature below -1 degrees C or above 32 degrees C.

Approach not authorized using forecast QNH.

Valid to MLW of 66,360 kgs.

Initiate a missed approach unless suitable visual reference can be established and maintained with any of the following.
- -Loss of LNAV or VNAV information.
- -ANP exceeds RNP, VERIFY POSITION or FMC DISAGREE messages.
- -Unable to maintain NPS limits inside NNDP.

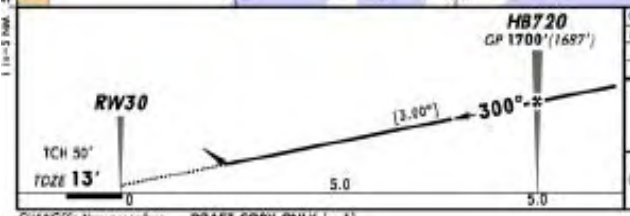
FMS

RNP lateral (as required).

RNP vertical 125'.

Enter wind correction (if required).

❶ Non-normal Decision Point. VNAV PATH must be annunciated beyond this point.



Grid speed-Kts	70	90	100	120	140	160
Descent angle 3.00°	372	478	531	637	743	849

T-VASI | 4000' | RNP RNAV TRACK | HB780

STRAIGHT-IN LANDING RWY 30
RNP 0.30
DA(H) 263' (250')

C 1200m

CHANGES: New procedure. DRAFT COPY ONLY (v.1)

YSSY/SYD QANTAS
-(KINGSFORD SMITH), INTL

"FOR CASA APPROVED OPERATORS ONLY"

7 APR 06 12-7
QANTAS B737-800 ONLY

SYDNEY, NSW, AUSTRALIA
RNAV (RNP) RWY 16R

ATIS 112.1..118.55..126.25..428 | SYDNEY Approach (R) North 124.4 South 128.3 | Director West 126.1 East 125.3
SYDNEY Tower Rwy 16R/34L & 07/25 120.5 Rwy 16L/34R 124.7 | Ground West of Rwy 16R/34L 126.5 East of Rwy 16R/34L 121.7

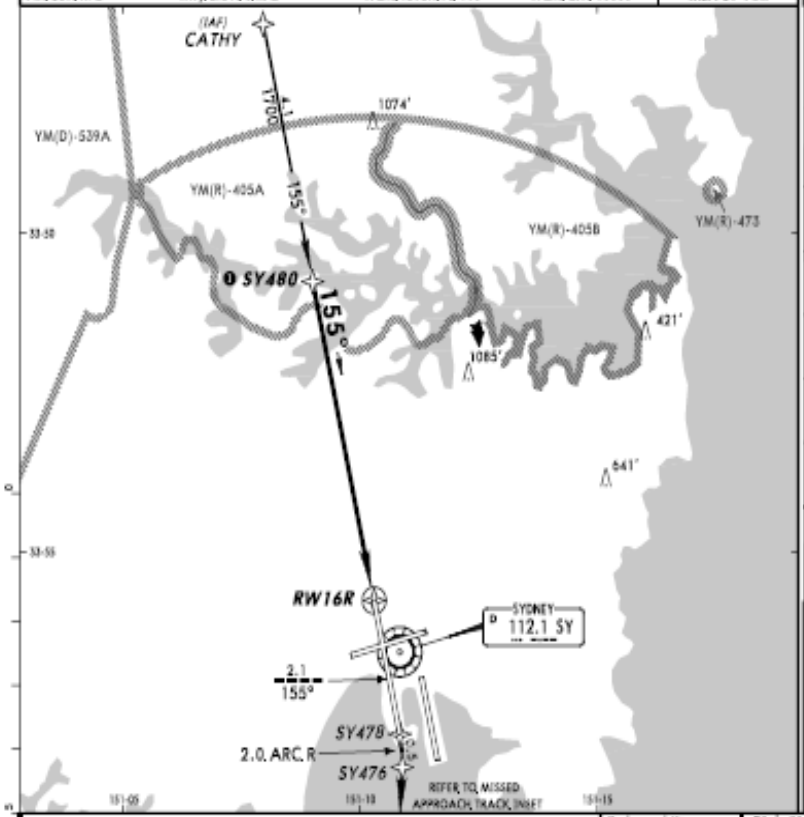
RNAV	Rwy Heading 155°	GP SY480 1700'(1692')	DA(H) Refer to Minimums	Apt Elev 21' TDZE 8'

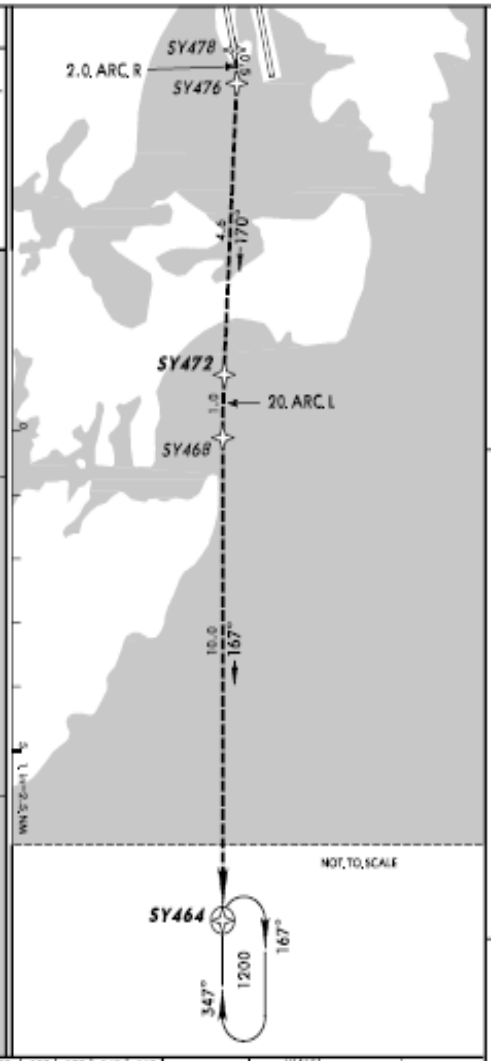
BRIEFING STRIP

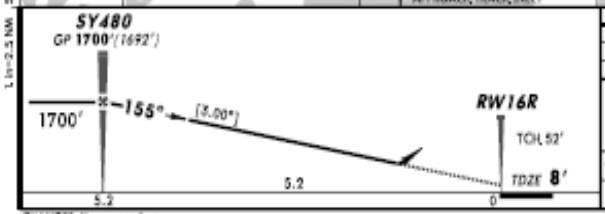
MISSED APCH: Climb to 3000', via the RNAV (RNP) Missed Approach track to SY472.
ENGINE OUT MISSED APCH: If unable to cross SY472 at 3000', advise ATC, and climb 1200', via the RNAV (RNP) Engine Out Missed Approach track to SY464 and hold as published. Maximum holding speed 230 KIAS.

Alt Set: hPa | Rwy Elev: 0 hPa | Trans level: FL 110 | Trans alt: 10000'

2600'
MSA SY VOR







Grid speed-Kts	70	90	100	120	140	160
Descent angle (3.00°)	372	478	531	637	743	849

HIALS T-VASI 3000' via RNP RNAV TRACK

STRAIGHT-IN LANDING, RWY 16R

	RNP 0.10 DA(H) 406'(398')		RNP 0.30 DA(H) 439'(431')	
	HIALS OUT		HIALS OUT	
C	1200m	2100m	1400m	2300m
D				

CHANGES: New procedure.

REQUIRED EQUIPMENT

EGPWS (TERR selected on at least one ND).
(2) FMAs (all FMAs servicable).
(2) Flight Directors.
(2) PFD/ND (Display Source AUTO and Control Panels NORMAL. No PFD DSPLY SOURCE annunciation).
(2) IRS (in NAV mode/IRS Transfer Switch in NORMAL).
(2) FMCs (FMC Source Select Switch- NORMAL).
(2) GPS.
(2) SOURCES OF A/C power (APU may be used).
(2) Radio Altimeters and displays.
(1) A/P Channel in LNAV/VNAV.

APPROACH

Verify ANP less than desired RNP level.
Alt Set: hPa.
Approach not authorized when airport temperature below 0 degrees C or above 36 degrees C.
Approach not authorized using forecast QNH.
Valid to MLW of 66,360 kgs.
Initiate a missed approach unless suitable visual reference can be established and maintained with any of the following.
- Loss of LNAV or VNAV information.
- ANP exceeds RNP, VERIFY POSITION or FMC DISAGREE messages.
- Unable to maintain NPS limits inside NNDP.

Valid to MLW of 66,360 kgs.
A GLS Channel must not be selected in the active display of any Navigation Control Panel during this approach.

FMS

RNP lateral (as required).
RNP vertical 125'.
Enter wind correction (if required).

❶ Non-normal Decision Point. VNAV PATH must be annunciated beyond this point.

YBBN/BNE
BRISBANE INTL

QANTAS

FOR CASA APPROVED OPERATORS ONLY

26 JAN 07 | 12-10

QANTAS B737-800 ONLY

BRISBANE, QLD, AUSTRALIA
RNAV (RNP) P RWY 19

Attachment 4 to the Report

ATIS	BRISBANE Approach [R] Northwest of, extended C/L Rwy 01-19	BRISBANE Approach [R] Southeast of, extended C/L Rwy 01-19	BRISBANE Tower	Ground
113.2 125.5	124.7	125.6	120.5	121.7

RNAV	Rwy Heading	GP	DA(H)	Apt Elev 13'
	196°	YB748 1500'(1489')	Refer to Minimums	TDZE 11'

MISSED APCH: Climb to 3000', via the RNAV (RNP) Missed Approach track to YB874. Acceleration altitude 1100' QNH (1000' AGL).

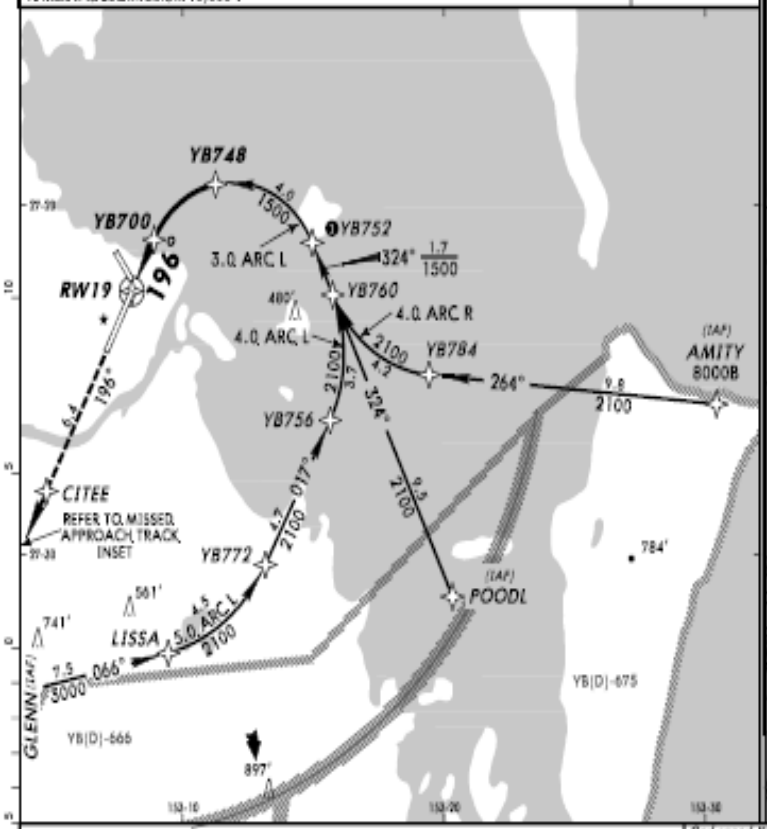
ENGINE OUT MISSED APCH: Climb to 1900', via the RNAV (RNP) Missed Approach track to YB760 and hold as published. Acceleration altitude 1100' QNH (1000' AGL). Maximum holding speed 230 KIAS.

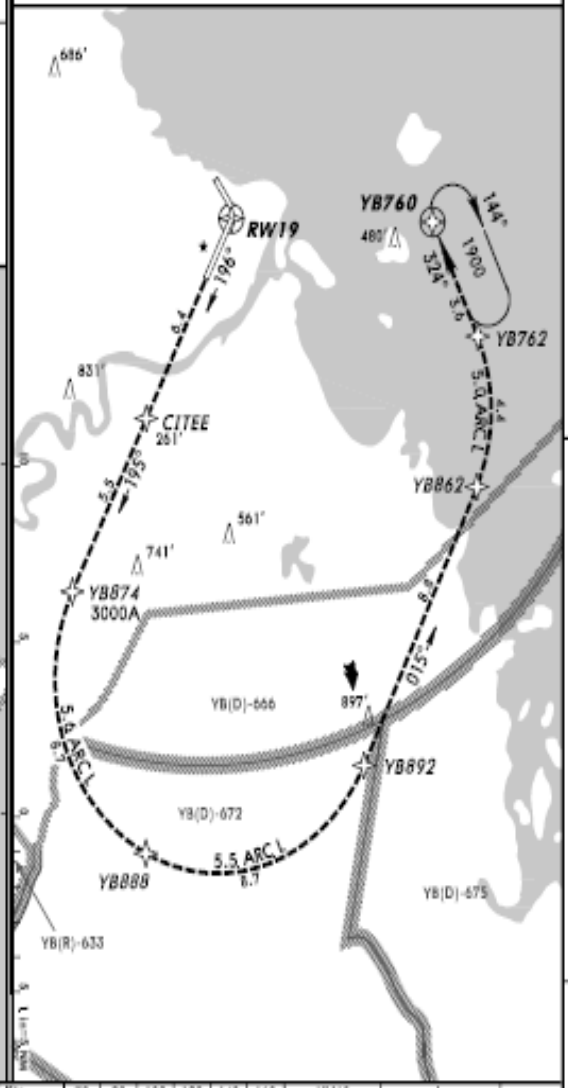
3700'

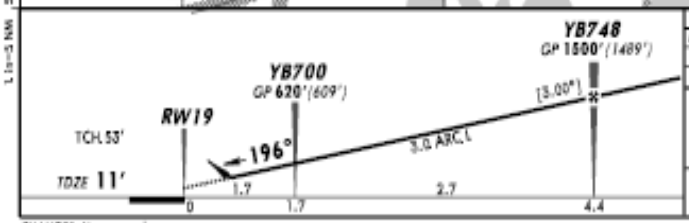
MSA BN VOR

Alt Set: hPa | Rwy Elev: 0 hPa | Trans level: FL 110 | Trans alt: 10000'

1. Max IAS 250 kt below 10,000'.







Grid spead-Kts	70	90	100	120	140	160
Descent angle 3.00°	372	478	531	637	743	849

HEALS T-VASI T-VASI

3000' RNP RNAV TRACK YB874

STRAIGHT-IN LANDING RWY 19

RNP 0.30

DA(H) 261'(250')

HEALS out

C 800m 1200m

REQUIRED EQUIPMENT PBN/TF/1

EGPWS (TERR selected on at least one ND).

(2) FMAs (all FMAs servicable).

(2) Flight Directors.

(2) PFD/ND (Display Source AUTO and Control Panels NORMAL. No PFD DSPLY SOURCE annunciation).

(2) IRS (in NAV mode/IRS Transfer Switch in NORMAL).

(2) FMCs (FMC Source Select Switch- NORMAL).

(2) GPS.

(2) Sources of A/C power (APU may be used).

(2) Radio Altimeters and displays.

(1) A/P Channel in LNAV/VNAV.

APPROACH

Verify ANP less than desired RNP level.

Alt Set: hPa.

Approach not authorized when airport temperature below 0 degrees C or above 35 degrees C.

Approach not authorized using forecast QNH.

Valid to MLW of 66,360 kgs.

Initiate a missed approach unless suitable visual reference can be established and maintained with any of the following.
- Loss of LNAV or VNAV information.
- ANP exceeds RNP, VERIFY POSITION or FMC DISAGREE messages.
- Unable to maintain NPS limits inside NNDP.

Visual Reference means the runway threshold or approach lights or markings identifiable with the landing runway are clearly visable to the pilot with a flight visibility or RVR not less than that specified.

FMS

RNP lateral (as required).

RNP vertical 125'.

Enter wind correction (if required).

❶ Non-normal Decision Point. VNAV PATH must be annunciated beyond this point.

CHANGES: New procedure.

Other Related RNP Experiences

- **Alaska Airlines** (Juneau, Sitka, Red Dog Mine etc) experience from 1994
  - Includes “deficient” infrastructure ports
  - Extreme cold temperature ports (-30 C)
- Westjet
- **Air China** (Lhasa, Linzhi etc)
  - High elevation airports (11,600 ft AMSL)
  - Extreme terrain challenges

- *These ports use the same or similar equipment and their experiences contribute to the immensely successful world-wide operational deployment of RNP*

Current Operations

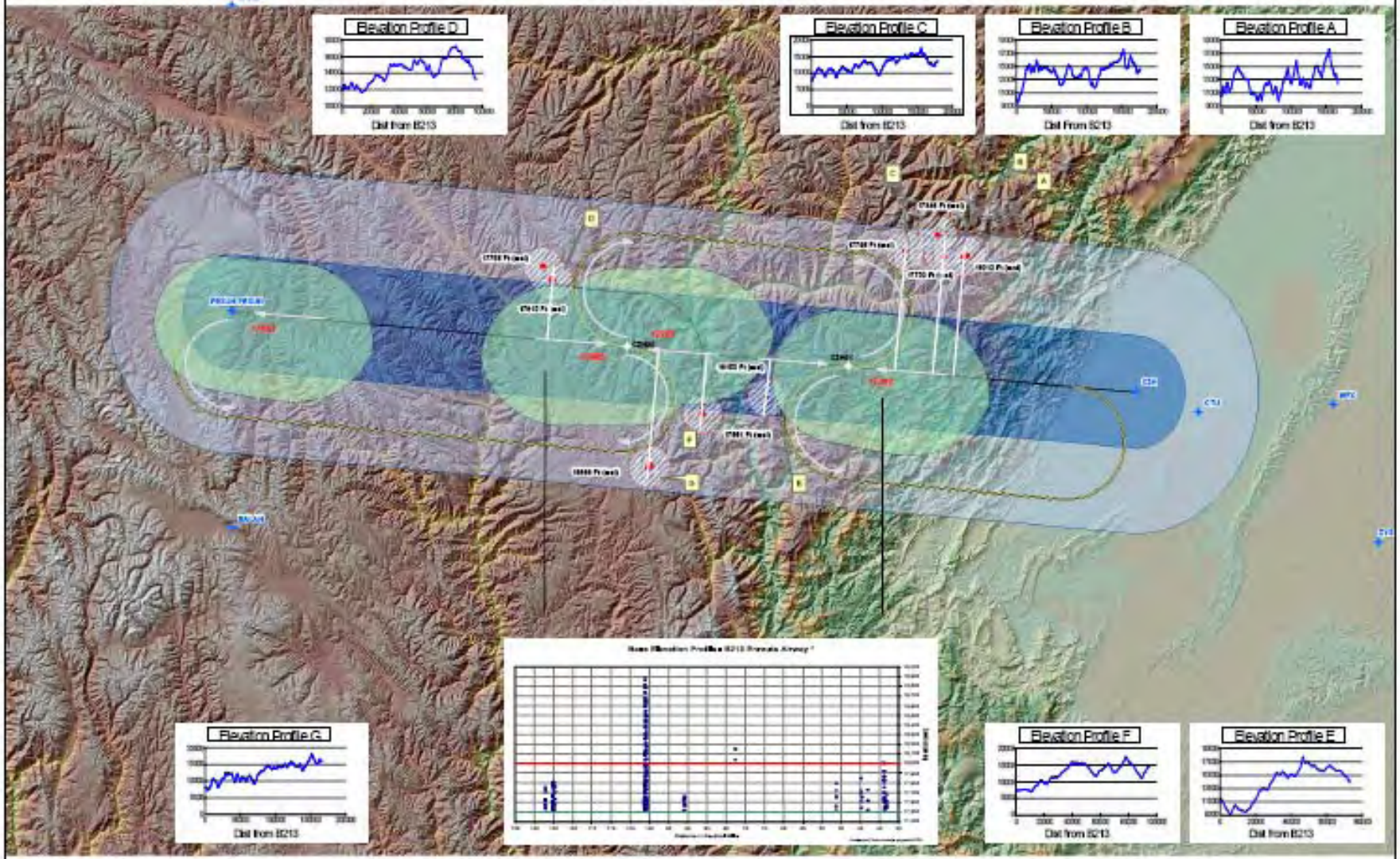
- 580 Flight Crew trained, all authorised to design minima after completion of qualification program
- RNP integrated into recurrent training matrix
- Over 23,000 procedures (approach & departure) flown in revenue service
- Approximately 95 per day

Future Opportunities

- Fuel & Emissions Benefits
  - B767-300 Pegasus & FCC Upgrade
- Takeoff Performance Improvements
  - A330
  - B747-400
- Enroute Alternates for EDTO
  - B787
  - A380
- Enroute Contingency
  - B747-400 L888 & Y1/IATA-1

Qantas China Enroute Analysis

(Airway B213 - Himalayas)



NAVERUS

QANTAS

1:1,000,000

Summary

- RNAV (RNP) Operations improve the safety and efficiency of Flight Operations
- This has been proven during in-service evaluation
- Qantas and its partners (Boeing, Naverus, Honeywell, Rockwell-Collins, Airservices Australia & CASA) are proud to be industry leaders in the deployment of this capability.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Spirit of Australia