Performance Based Navigation Implementation Plan

SINGAPORE

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Summary of Amendments

Date	Amendment #	Name	Signature

Executive Summary

The global air travelling passenger traffic is anticipated to grow by 4.9% annually from 2011 to 2026. Meanwhile airfreight will rise 5.8% annually in the same period. IATA projected that the greatest demand will come from Asia Pacific region, where airlines will take delivery of 31% of new aeroplanes in the next 20 years. Singapore has developed a PBN implementation plan for Singapore FIR to meet this growing demand and also bring about other operational benefits.

As the skies get busier with more aeroplanes, PBN will serve to increase airspace safety, capacity and efficiency. Flight times will also be reduced with optimal flight paths design using PBN specifications resulting in fuel saving and enhanced environmental protection.

Singapore has been implementing PBN procedures in a steady and progressive manner. The Plan adopts a 3-phase approach: Short Term (2008-2012), Medium Term (2013-2017) and Long Term (beyond 2018).

With full support of and close collaboration with the stakeholders in Singapore consisting of local airlines, ANSP, regulators and engineers, Singapore plans to address the impact of air traffic growth by increasing capacity and efficiency while simultaneously improving safety and reducing environmental impacts. To achieve its goals, Singapore is implementing new Performance-Based Navigation (PBN) routes and procedures that leverage emerging technologies and aircraft navigation capabilities.

Glossary of Definitions/Acronyms/Abbreviations

The following table provides definitions and explanations for terms and acronyms relevant to the content presented within this document.

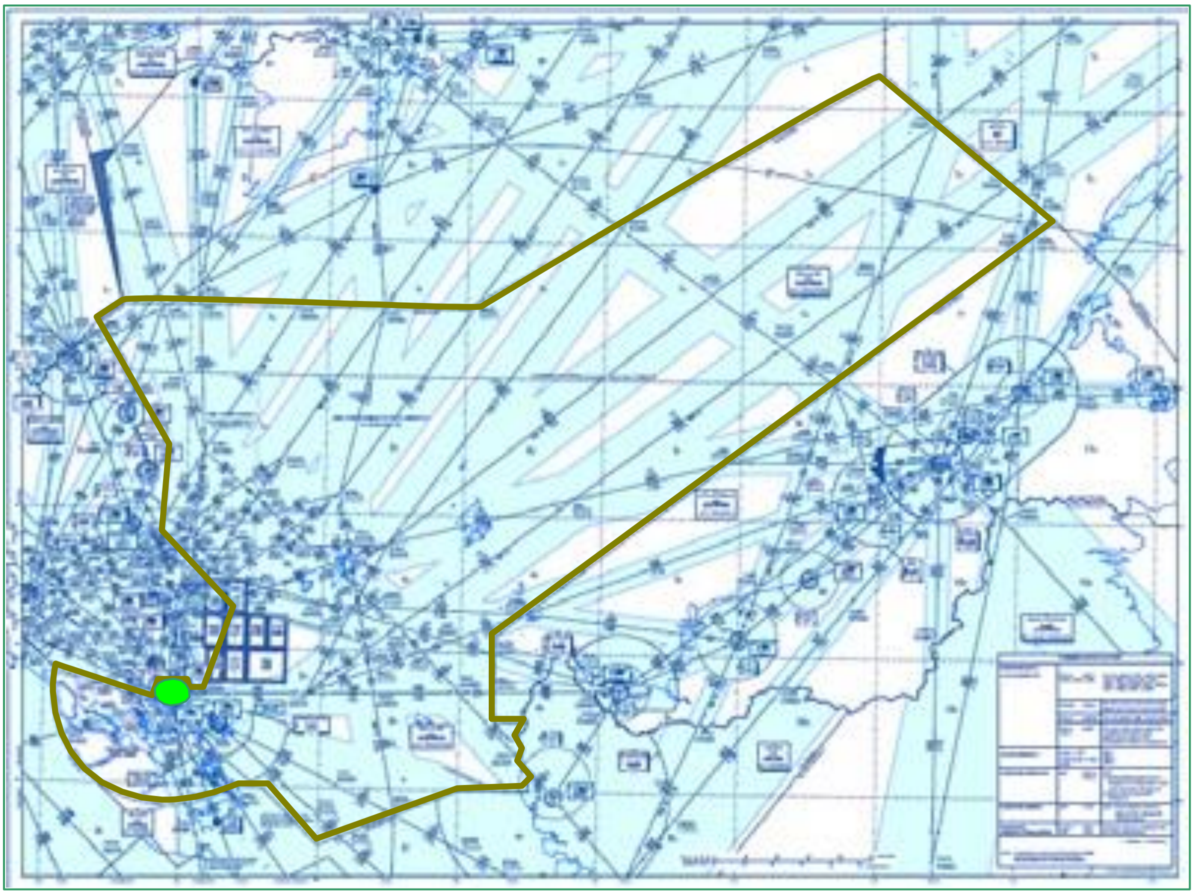
Term	Definition
ACC	Area Control Centre
ADS-B	Automatic Dependent Surveillance - Broadcast
ANSP	Air Navigation Service Provider
APCH	Approach
ASBU	Aviation System Block Upgrades
ATM	Air Traffic Management
CAAS	Civil Aviation Authority of Singapore
CDO	Continuous Descent Operation
CNS	Communication, Navigation, Surveillance
FIR	Flight Information Region
GANP	Global Air Navigation Plan
GASP	Global Air Safety Plan
ICAO	International Civil Aviation Organization
IFP	Instrument Flight Procedure
NAVAID	Navigation Aid
PBN	Performance-based navigation
RNAV	Area Navigation
RNP	Required Navigation Performance
SARPs	Standards and Recommended Practices
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival
TMA	Terminal Area

Chapter 1 – Overview

1.1 Background

1.1.1 The Singapore Flight Information Region (FIR) shares boundaries with five other neighbouring FIRs; namely Ho Chi Minh, Jakarta, Kota Kinabalu, Kuala Lumpur and Manila FIRs. The airspace within the Singapore FIR is largely over the high seas and as such, widespread siting of ground navigational aids is not possible.

1.1.2 Within the airspace around Singapore, high density air traffic movement consisting of international and regional flights into and out of Changi Airport and other airfields within a 40NM radius makes air traffic management a challenge.



1.2 Purpose

1.2.1 This PBN Implementation Plan is published to provide a roadmap for implementation of the ICAO PBN Concept in the Singapore FIR. PBN procedures would be implemented in a steady and progressive manner through a 3-phase approach (short, medium and long term).

1.3 Strategic Objectives

1.3.1 With the application of the ICAO PBN Concept, Singapore aims to achieve the following objectives:

a) Enhance Efficiency
   - Enhanced reliability, repeatability, and predictability of operations to increase air traffic throughput and smoother traffic flow. RNAV departures result in better climb profiles to optimum en-route altitudes thus reducing fuel burn, and reduced track distances. RNAV arrivals result in continuously descending path with minimum level flight segments to enable smooth aircraft deceleration and configuration prior to landing.

b) Enhance Capacity
   - Delays, congestion, and choke points at airports and in crowded airspace may be reduced because of new and parallel offset routes through terminal airspace, additional ingress/egress points around busy terminal areas, more closely spaced procedures for better use of airspace, and reduced or eliminated conflict in adjacent airport flows.

c) Enhance Safety
   - Lateral and vertical track-keeping is much more accurate and reliable due to new three dimensional guided arrival, approach, and departure procedures that cannot be defined by conventional navigational aids. PBN also reduces the flight crew's exposure to operational errors.

d) Reduce Environmental Impact:
   - Utilize PBN to reduce environmental impact from aviation through more efficient operations that result in a less fuel burn and noise emissions. Flying down the middle of a defined flight path means less throttle activity and better avoidance of noise-sensitive areas, so people on the ground perceive less jet noise and are exposed to fewer engine emissions.

Chapter 2 – Performance-based Navigation (PBN)

2.1 PBN Concept

2.1.1 The PBN Concept is based on a shift from sensor-based navigation to performance based. The PBN concept specifies that aircraft area navigation system performance is defined in terms of accuracy, integrity, continuity and functionality. It explains and describes the performance-based RNAV and RNP navigation specifications that can be applied to oceanic, en-route and terminal airspace, to improve safety, efficiency and capacity, as well as reduce the environmental impact. These specifications also detail the navigation sensors and equipment necessary to meet the performance requirement.

2.1.2 The application of a PBN specification depends on many factors – the navigation infrastructure, communications capability, surveillance capability, the operational requirement, the aircraft fleet capability and operational approvals etc. In determining which PBN specification to apply, these factors must be taken into consideration in consultation with all stakeholders.

2.1.3 For Singapore, the application of the PBN concept is important mainly to enhance airspace safety, capacity and efficiency.

2.2 Current Implementation Status

2.2.1 Oceanic, Remote and Continental En-route

2.2.1.1 RNAV en-route operations in the South China Sea area based on RNP10 requirements began as early as November 2001. The six major routes connecting Singapore and the airports in North-east Asia were arranged in a parallel route structure. Back then, the States involved had agreed on a 60NM lateral and 80NM longitudinal separation based on Mach Number Technique as the standard separation minima for the RNP10 routes.

2.2.1.2 In July 2008, reduced horizontal separation down to 50NM lateral / 50NM longitudinal based on RNAV10 operation was implemented on two routes, M771 and L642, which catered for the high air traffic flows between Singapore and Hong Kong as well as the airports in China. A quick glance on the four remaining parallel routes in Singapore FIR suggests RNAV10 as the de-facto standard operations to pursue for these routes as well.

2.2.1.3 In February 2012, restructuring of ATS routes in the south-east portion of Singapore FIR for flights to Jakarta FIR and beyond to Australasia region enabled two routes, M635 and M774, to employ reduced horizontal separation down to 50NM lateral / 50NM longitudinal based on RNAV10 operation.

2.2.1.4 In August 2012, two RNAV5 routes, M630 and Y339, were established to enhance air traffic management safety and efficiency for flights between Singapore and West Malaysia.

2.2.2 Terminal Area (SIDs and STARs)

2.2.2.1 Due to the proliferation of multiple standards for RNAV for use in the TMA by various regions, there were some difficulties encountered when deciding on the standard to adopt for introduction of RNAV SIDs and STARs for Changi Airport. Eventually, Eurocontrol's P-RNAV standard was selected as the model and was implemented in May 2006. The main driver for the new RNAV SIDs and STARs was the need to have a set of TMA routes to better facilitate air traffic management. The introduction of these SIDs and STARs saw some form of segregation between departure and arrival tracks both in the lateral and the vertical dimensions.

2.2.3 Approach

2.2.3.1 There are two parallel runways used by civil aircraft at Changi Airport. Arrivals will typically conduct the approach into Changi Airport on the ILS approach procedures, which are available for the four runway ends as the predominant precision approach procedures. The VOR non-precision approach procedures serve as the backup for Changi Runway 2 operations.

2.2.3.2 PBN facilitates the implementation of instrument approaches with vertical guidance (APV) to all runway ends. This has a significant safety impact, as non-precision approaches (dive and drive) with no vertical guidance can be removed. It has been proven that approach procedures with vertical guidance are 25% safer than procedures with no vertical guidance. Furthermore, PBN facilitates the design and implementation of APV to runways that do not currently have an approach capability, thus improving airport accessibility and flight operations efficiency.

2.2.3.3 Therefore, Singapore in collaboration with the airspace users, places a high priority on the design and implementation of PBN approach procedures with vertical guidance in concert with Assembly Resolution A37-11, to improve both safety and efficiency. In April 2007, Baro-VNAV approaches were introduced as backup procedures to supplement Changi Runway 1 (two ends – Changi 20R/02L). In August 2014, Baro-VNAV approaches were introduced for Changi Runway 2 (two ends – Changi 20C/02C). This improvement is to provide vertical guidance as a safety enhancement over the traditional non-precision approaches.

2.2.3.4 Due to the small volume of air traffic movements and the nature of the type of operations at Seletar Airport, there is currently no instrument procedure in place. However, future developments with the increase in air traffic movements, Seletar Airport would warrant new instrument procedures to be in place to facilitate the increasing air traffic movements coming in and out of Seletar Airport.

2.2.3.5 In March 2012, Continuous Descent Operation (CDO) procedures were implemented for arrivals into Singapore Changi Airport. CDO is an aircraft operating technique which enables the pilot to execute an optimised arrival descend profile utilising the onboard capability of the aircraft. CDO is facilitated by appropriate instrument flight procedure design and air traffic control (ATC) procedures.

2.2.3.6 The vertical profile of CDO takes the form of a continuously descending path with minimum level flight segments to enable smooth aircraft deceleration and configuration prior to an ILS approach. The CDO RNAV STARs were constructed in accordance to ICAO Document 9931 CDO Manual and ICAO Document 8168 Procedures for Air Navigation, Aircraft Operations.

2.3 Aircraft Fleet Capabilities

2.3.1 Currently, most aircraft operating in the Singapore FIR are already basic RNAV-capable. To progress PBN in Singapore, Singapore has developed the Singapore PBN Implementation Plan taking into account fleet readiness, navigation infrastructure and airspace constraints.

2.4 CNS/ATM Capabilities

2.4.1 The Singapore Area Control Centre (ACC) employs a full range of radio communications systems from VHF to HF radios to Controller Pilot Data Link Communications (CPDLC) for air-ground communications. VHF radio supports surveillance control services both within TMA and the En-route sectors within the VHF range. Beyond that, high quality HF radios and CPDLC data-link complete the communications solution.

2.4.2 The largely oceanic airspace inhibits the siting of ground navigational aids. As such, RNAV technology is widely used for en-route navigation. In the TMA however, there is a rich collection of VOR/DMEs and has served as the basis for instrument departure and arrival procedures for the aerodromes within the TMA for many years. With modern aircraft fleets getting equipped with more advance avionics which include satellite navigation capabilities, designing instrument procedures hinged on GNSS will become more and more pragmatic.

2.4.3 As for surveillance, there are the primary and secondary long range radars which provide cover up to about 250NM radius from Changi Airport whereas the two Approach radars are used for surveillance in the TMA. Since 1997, ADS-C has been introduced to augment the surveillance cover for the remaining part of the FIR outside the radar cover.

2.4.4 Since December 2013, ADS-B operations has been implemented in portions of the FIR to enhance surveillance and to bridge parts of the airspace outside radar cover.

2.5 Benefits Of PBN And Global Harmonisation

2.5.1 PBN offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria. For example:

a) It reduces the need to maintain sensor-specific routes and procedures and their associated costs (e.g. VOR, NDB, DME);

b) Enhances safety by allowing for straight-in approach procedures with vertical guidance as a primary approach or back up to existing precision approach procedures;

c) Improves airport accessibility under all weather conditions;

d) Allows for more efficient use of airspace, thus increasing capacity;

e) Improves operational efficiency through reduced delays and holds, and enables continuous descent and continuous climb operations;

f) Lessens the environmental impact by contributing to reduced aircraft fuel burn and noise emissions.

2.5.2 The introduction of the PBN concept dispels other attempts to breed new specifications which would add confusion to the seemingly difficult task of implementing RNAV or RNP procedures. With clearly spelt out criteria, standards and operational requirements, ANSPs can now focus on areas for improvement and set appropriate target to reap maximum benefits for themselves as well as for airlines, thus reducing time and effort in trying out the various standards.

2.5.3 PBN harmonisation is global. This reassures international airlines to go for suitable fleet equipage depending on the regions that they operate or wish to operate. While navigation specifications may differ from region to region, certification and approval requirements for each specification have now been made consistent, and operators having attained one type of PBN approval can expect interoperability with another region having the same PBN type as requirement. This enables airlines to look ahead and plan economically, resulting in savings in the long run. As for ANSPs, PBN harmonisation ensures smooth operation between airspaces. Regional air navigation planning should take shorter time than before, bringing forward improvements to route structures which in turn will motivate airlines to get the right equipage early.

2.5.4 Tactically, PBN could be employed to alleviate air traffic issues like TMA congestion. For example, RNAV1 navigation specification supports close track spacing that could be used to segregate traffic flows in different directions. For areas with limited surveillance coverage, RNP1 is a good alternative.

Chapter 3 – Implementation Challenges

3.1 Safety

3.1.1 Safety challenges revolve largely around the safe operation of the ATM system during the transition of PBN operations. Safety gaps will inadvertently occur within the CNS/ATM system noting that PBN addresses only the navigation aspect of the system and advances in navigation may outpace advances in communications and/or surveillance. Safety challenges also include the following:

a) ATM system integration to support PBN;

b) Safety monitoring of ATM system;

c) Mixed operating environment;

d) Ensuring satisfactory Target Level of Safety (TLS);

e) Continues evolution of PBN navigation specifications and their deployment;

f) Education and training of stakeholders;

g) Naming and charting conventions; and

h) Aeronautical data integrity.

3.2 Aircraft Operations

3.2.1 The aircraft fleet mix operating in Singapore FIR can be categorised into the following wake turbulence category;

Wake Turbulence Category	Percentage
Super Heavy	2%
Heavy	32%
Medium	66%
Light	1%

3.2.2 In 2015, eight new airlines started operating to Changi Airport, bringing the number of airlines operating there to over 100. Connectivity continues to improve from year to year, with 10 new city links established in 2015 while codeshare city links grew by 27, providing connectivity to a total of 320 cities worldwide.

3.3 Infrastructure

3.3.1 Given that the Singapore FIR comprises mainly “oceanic” airspace under which it is not possible to introduce any ground-based navigation aids to enhance safety or capacity, Singapore is exploring other means of airspace enhancements that leverage on emerging technologies and aircraft navigation capabilities.

3.3.2 In February 2015, Singapore and Aireon LLC signed a Memorandum of Agreement (MOA) to enhance aircraft tracking in the Singapore FIR. Through this collaboration, Aireon aims to work with Singapore to enhance surveillance coverage over the entire Singapore FIR with the deployment of a space-based Automatic Dependent Surveillance - Broadcast (ADS-B) service.

3.4 Efficiency and Capacity

3.4.1 Efficient operations challenges include the needs of other airspace users in a scenario of mixed operating environment. Effective collaboration with users such as military organisations and the general aviation community is taken to help shaped the considerations of implementing PBN in Singapore.

3.5 Environment (Noise and Emissions)

3.5.1 Environmental challenges include minimising the impact of noise and carbon emissions on both the communities in the proximity of the airport and the global environment. PBN will support the achievement of these goals while preserving aviation safety and efficiencies in the ATM system, but a collaborative approach will be essential to deliver these objectives.

3.5.2 Continuous Descent Operation (CDO) procedures were implemented for arrivals into Singapore Changi Airport. CDO enables the pilot to execute an optimised arrival descend profile utilising the onboard capability of the aircraft thus reducing the impact of noise and carbon footprint of an arrival.

3.6 Regulatory

3.6.1 Singapore have developed national regulatory material to address the PBN applications relevant to Singapore FIR or relevant to operations conducted in another State by the operators and aircraft registered in that State. The regulations are categorized by operation, flight phase, area of operation and/or navigation specification. Approvals for commercial operations should require specific authorization.

3.7 Resources

3.7.1 Instrument flight procedures (IFP) design is an essential component of PBN development and implementation. A Flight Procedure Design Office (FPDO) has been established in Singapore since 2010 to develop PBN IFP and review existing IFPs. Flight procedure designers in Singapore use advance planning and designing tools to support procedure designers and airspace planners in their tasks to fully reap the benefits of PBN.

Chapter 4 – Implementation

4.1 Short Term (2008-2012)

4.1.1 In line with the ICAO Asia Pacific Seamless ATM Plan, the time frame for short term implementation is 2008 – 2012. Singapore's concept for the PBN implementation in the short term for the respective areas is listed as follows.

Oceanic, Remote and Continental En-route

- RNAV10 for up to 50% of international routes
- RNP4 for heavily utilised routes (up to 25% of international routes)

Terminal Area (SIDs and STARs)

- RNAV1 SIDs and STARs for Changi Airport

Approach

- RNP APCH with vertical guidance (Baro-VNAV) to be implemented for remaining Changi Airport runway ends

4.2 Medium Term (2013-2017)

4.2.1 In line with the ICAO Asia Pacific Seamless ATM Plan, the time frame for medium term implementation is 2013 – 2017. Singapore's concept for the PBN implementation in the medium term for the respective areas is listed as follows.

Oceanic, Remote and Continental En-route

- Surveillance
  - RNAV5 routes whenever feasible
- Procedural
  - RNAV10 routes
  - RNP4 wherever feasible

Terminal Area (SIDs and STARs)

- RNAV1 SID and STAR for Seletar Airport

Approach

- RNP APCH with vertical guidance (Baro-VNAV) for Changi, Paya Lebar and Seletar Airports

4.3 Long Term (beyond 2018)

4.3.1 In line with the ICAO Asia Pacific Seamless ATM Plan, the time frame for far term implementation is 2018 and beyond. In this phase, GNSS is expected to be a primary navigation infrastructure for PBN implementation. States should work co-operatively on a multinational basis to implement GNSS in order to facilitate seamless and inter- operable systems. Singapore's concept for the PBN implementation in the far term for the respective areas is listed as follows.

Oceanic, Remote and Continental En-route

- Surveillance
  - RNAV5 routes whenever feasible
  - RNAV2 routes whenever feasible
- Procedural
  - RNAV10 routes
  - RNP4 wherever feasible
  - RNP2 wherever feasible

Terminal Area (SIDs and STARs)

- Basic-RNP 1 for Seletar Airport

Approach

- RNP AR for Changi and Seletar Airports

4.4 End State

4.4.1 The end state of the PBN Implementation Plan is to meet the objectives of Resolution A37-11. The goal towards building a seamless sky can only be achieved by the active cooperation, collaboration and participation of all aviation stakeholders. Under the ICAO Aviation System Block Upgrades (ASBU) framework, PBN is in Block 0 which includes capabilities or modules that are available currently. This will form the foundations of other future Block Upgrades. For this very reason, Singapore shall continue to build on existing capabilities and continue to cooperate and engage the other stakeholders to ensure a harmonised and coordinated PBN implementation in the Asia Pacific region.

Chapter 5 – Plan Coordination and Review

5.1 Coordination and Consultation

5.1.1 Various stakeholders are involved in the development of the airspace concept and the resulting navigation application(s) in the PBN Implementation Plan. These stakeholders are the airspace planners, procedure designers, aircraft manufacturers, pilots and air traffic controllers; each stakeholder has a different role and set of responsibilities. The stakeholders of PBN use the concept at different stages.

5.1.2 At a *Strategic Level*, airspace planners and procedure designers translate "the PBN concept" into the reality of route spacing, aircraft separation minima and procedure design. Airworthiness and regulatory authorities ensure that aircraft and aircrew satisfy the operating requirements of the intended implementation. Similarly, operators/users need to understand the operating requirements and effect any necessary changes for equipage and personnel training.

5.1.3 At a Tactical Level, controllers and pilots use the PBN concept in real-time operations. They rely on the "preparatory" work completed at the strategic level by other stakeholders.

5.1.4 This PBN Implementation Plan has been developed with the support of and close collaboration with the various stakeholders in Singapore.

5.2 Plan Review

5.2.1 The PBN Implementation Plan shall be reviewed on an annual basis. Feedback from stakeholders and users will be considered throughout the implementation plan. Stakeholders includes not only pilots, but where relevant, others such as ATC, neighbouring ANSPs, and others that may be affected by the implementation plan. Feedback will be actively sought and gathered from the relevant regular meetings with stakeholders or through focus group discussions. Other sources to gather feedback includes results (reports) from a consultation (questionnaire), engagement surveys or through the corporate enquiry portal. Feedback from stakeholders will be recorded and documented for traceability.

5.2.2 Elements that generate positive feedback shall be considered for other procedures. Negative feedback shall be evaluated and any problems encountered or implementation issues identified shall be thoroughly assessed by the ANSP so that corrective action can be initiated where appropriate. Feedback and the follow-up action taken shall be documented accordingly.

Chapter 6 – Safety

6.1 Preliminary Safety Assessment and Risk Analysis

6.1.1 A safety assessment shall be carried out in respect of proposals for significant airspace reorganisations, for significant changes in the provisions of ATS procedures applicable to an airspace or aerodrome, and for the introduction of new equipment, systems or facilities such as:

a) A reduced separation minimum to be applied within Singapore FIR or Changi and Seletar Airports;

b) A new operating procedure, including departure and arrival procedures, to be applied with Singapore FIR or Changi and Seletar Airports;

c) A reorganization of the ATS route structure;

d) A resectorisation of an airspace; and

e) Implementation of new communications, surveillance or other safety-significant systems and equipment, including those providing new functionality and/or capabilities.

6.1.2 Proposals shall be implemented only when the assessment has shown that an acceptable level of safety will be met. The safety assessment shall consider relevant factors determined to be safety-significant, including:

a) Types of aircraft and their performance characteristics, including aircraft navigation capabilities and navigation performance;

b) Traffic density and distribution;

c) Airspace complexity, ATS route structure and classification of the airspace;

d) Type of air-ground communications and time parameters for communication dialogues, including controller intervention capability;

e) Type and capabilities of surveillance system, and the availability of systems providing controller support and alert functions;

f) Any significant local or regional weather phenomena.

6.1.3 Any actual or potential hazard related to the provision of ATS within an airspace or at an aerodrome, whether identified through an ATS safety management activity or by any other means, shall be assessed and classified by Singapore for its risk acceptability.

6.2 Implementation Of Safety Assessment

6.2.1 Provision is made for post-implementation monitoring to verify that the defined level of safety continues to be met. Appropriate measures are also implemented to eliminate any identified risk or reduce the risk to a level that is acceptable. If it becomes apparent that the level of safety applicable to an airspace or an aerodrome is not, or may not be achieved, the ANSP shall implement appropriate remedial measures. Implementation of any remedial measure shall be followed by an evaluation of the effectiveness of the measure in eliminating or mitigating a risk.

Appendix A

Assembly Resolution A37-11

PERFORMANCE BASED NAVIGATION GLOBAL GOALS

Note: Resolution A37-11 is a result of the 11th Air Navigation Conference recommendations on area navigation implementation and Resolution A33-16 that requested Council to develop a program to encourage States to implement approach procedures with vertical guidance. The main points of Resolution A37-11 are as follows:
{Preamble Removed}

The Assembly

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

2. *Resolves* that:

   a) States complete a PBN implementation plan as a matter of urgency to achieve:

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

      ii. Implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS), including LNAV–only minima, 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% by 2010, 70% by 2014; and

      iii. Implementation of straight-in LNAV-only procedures, as an exception to 2) above, for instrument runways at aerodromes where there is no local altimeter setting and where there are no aircraft suitably equipped for APV operations with a maximum certificated take-off mass of 5700 kg or more;

   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 5700kg 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, as necessary;

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

6. *Declare* that this resolution supersedes Resolution A36-23.

Appendix B

PBN Implementation Schedule for En-route, Terminal and Approach Procedures
Status as of December 2016

	Near Term (2008 – 2012)		Medium Term (2013 – 2017)		Long Term (2018 onwards)
	Planned	**Status**	**Planned**	**Status**	**Planned**
Enroute Surveillance	-	-	RNAV5 (up to 50%)	• 10%	RNAV5 (up to 75%) RNAV2
Enroute Procedural	RNAV10 (up to 50%) RNP4 (up to 25%)	• 32% • 0%[1]	RNAV10 (up to 75%) RNP4 for ATS routes: L625, M767, M768, M772, N884	• 87.5% • 0%	RNAV10 RNP4 RNP2
Terminal Area	RNAV1 SIDs STARs • Changi	• 100%	RNAV1 SIDs STARs; • Seletar	• 0%	Basic-RNP1; • Seletar
Approach	RNP APCH; • Changi (2 RWYs)	• 50%	RNP APCH; • Changi (2 RWYs) • Paya Lebar • Seletar	• 100% • 100% • 0%	RNP AR APCH; • Changi • Seletar

[1] The introduction of ADS-B over some portion of Singapore FIR has minimise the need for RNP4 routes in high volume routes that are covered by surveillance. However, some areas where surveillance gap exists, RNP4 could be implemented.