MLTM
Ministry of Land,
Transport and Maritime Affairs

CIVIL AVIATION OFFICE

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Ref.: ATM- 6 April 2011

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Asia and Pacific Office
International Civil Aviation Organization
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Thailand

Subject: Amended PBN Implementation Plan of the Republic of Korea

In references to your letter T6/3.11.1: AP-FS0349/10 dated 18 October 2010 with regard to the review report of State PBN Implementation Plan, here is the amended PBN Implementation Plan of the Republic of Korea. Please find the attached enclosure.

Recognizing the various benefits of PBN, the Republic of Korea will continue the implementation of PBN in harmony with Asia Pacific Regional PBN Implementation Plan and will gladly cooperate with ICAO Asia and Pacific Regional Office for the facilitation of PBN implementation in the Region.

Yours sincerely,

Kim, Jae-young
Director for ATM Division
Aviation Safety Policy Bureau
Office of Civil Aviation

Attachment: Amended PBN Implementation Plan of the Republic of Korea

Performance Based Navigation Implementation Plan

Ministry of Land,
Transport and Maritime Affairs

Performance Based Navigation Implementation Plan

CONTENTS

Executive Summary

Domestic air traffic increased at an average of 7.3% per year for the past 20 years and is expected to show continued growth. International Air Transport Association (IATA) estimates the air traffic volume to triple over the next 20 years and, likewise, the traffic volume of Incheon International Airport is estimated to triple, compared to 2005, to 490K flights in 2025.

There is very limited airspace and such fact calls for new solutions to relieve congestion caused by the increase in air traffic and to handle the traffic in the future.

At the same time, we must deal with environmental issues such as noise and greenhouse gases. These are not only domestic but global issues that must be dealt with as a common global task. Many countries are introducing performance-based navigation (PBN) as a solution to improving environmental problems, and ICAO also encourages PBN.

PBN is a new navigation concept based on area navigation (RNAV), utilizing advanced avionics and satellites that allow flights on any desired path and enable much higher precision flights than in the past and making it possible to establish many more routes within a limited airspace. This will enhance the airspace capacity, improve air traffic flows and allow setting shorter routes.

This will mean lesser delays and shorter flight distances which contribute to reduction of fuel consumptions (aircraft CO_2 emissions), making PBN the best way for achieving "Low Carbon, Green Growth" in the aviation sector. Further, PBN utilizes satellites and other state-of-the-art navigation systems so that it can be the optimum solution for the most efficient use of current capabilities.

The Ministry of Land, Transport and Maritime Affairs decided to gradually change the navigation system within airspace of the Republic of Korea (ROK) from the current sensor based navigation to performance based navigation. Further, to ensure that airspace users are well prepared for this transition, the Ministry decided to draw up a PBN implementation plan and formed a task force for that purpose in November 2008.

Composed of experts from all related fields including flight procedures, airspace, air traffic control, NAVAIDs operations, airworthiness, flight inspection, aeronautical information, airport, etc., the PBN Task Force worked for about a year to draft the PBN implementation plan and evaluate requirements necessary for implementation of PBN. Thanks to their hardworking efforts, it is with great pleasure to announce that the PBN implementation plan is now ready for release. This will be a new momentum in the improvement of Korea's airspace system, flight safety, flight efficiency, and environmental issues. Improvements and benefits derived from the transition to PBN will serve as the foundation for even further development of aviation industry.

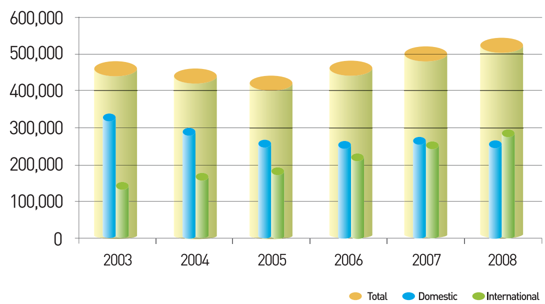
All concerned air navigation organizations will continue to exert efforts and to work cooperatively with each other to ensure smooth transition to the new navigation system in accordance with the implementation plan. All airspace users should be fully aware of this and be well prepared for changes to come in the future.

Deputy Minister of Civil Aviation, MLTM

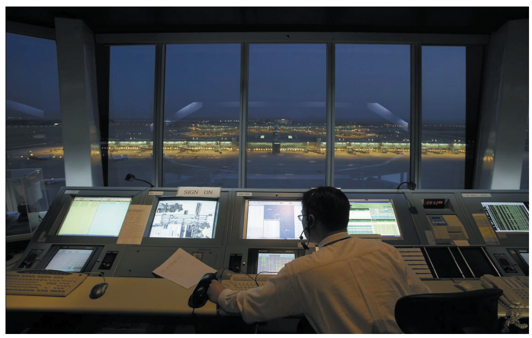
01 Background

Airspace Capacity

Air traffic in the ROK has increased at an annual average of approximately 7.3% in the past 20 years. In the case of domestic services, the traffic had decreased for a short period following opening of the high speed train services (KTX) in 2003. However, services by low cost carriers (LCCs) have turned that around and domestic air traffic is on the rise again. International air traffic continues to record steady growth with more frequent services to Japan, America, and China and the Southeast Asia in particular.



International Air Transport Association (IATA) forecasted that international passenger flights would increase 4.9% every year from 2007 to 2026 and grow almost triple in size within 20 years. It is forecasted that Korea's air traffic will show similar rate of growth. The traffic at Incheon International Airport in 2025 is estimated to be approximately 490K flights, about three times that of 2005. In the same year, the traffic in Incheon FIR is forecasted to reach around 1033K flights.



The biggest issue following such traffic growths is congestion of airspace. Over 60% of the total air traffic of the ROK is in the airspace of the capital region, making it the most congested airspace and it is expected that congestion will worsen rapidly. Congestion causes delays and not only impedes efficient operation but also results in heavier air traffic control workloads that could affect flight safety.

Although Incheon International Airport has been continually expanded (opening of 3rd runway in 2008 and construction of 4th runway planned) since its opening in March 2001, in order to prepare for the growing traffic and transport share being concentrated in the capital region, expansion of airport facilities cannot be the fundamental solution to improving airspace capacity.

There is a need to come up with ways to use the available limited airspace in a more efficient manner in order to ease airspace congestion and to accommodate the growing air traffic. That is, the solution must ensure flight safety and at the same time improve air traffic flow.

Environmental Issues

Growth of air transport industry has positive effects on a country's economic growth but it also accompanies negative environmental effects such as greenhouse gases and noise.

Globally, greenhouse gases from aircraft account for about 3% of all emissions and 12% of total emissions from the transport sector. The numbers are not very high and air transport is not the major cause of emissions but what must be noted is that its effects are increasing at a fast rate. Moreover, emissions of greenhouse gases from aircraft contain large amounts of nitrogen oxides in addition to carbon dioxide and are known to produce even greater greenhouse effects.

These problems will worsen as air traffic increases and it is necessary for the government to adopt "Low Carbon, Green Growth" policies in the aviation field that will promote the development of the aviation industry while reducing its influences on global warming. Such objectives can be achieved most effectively by using lesser fuel consumption through the use of optimum routes and reduced delays. That is, shortened flight routes and improved air traffic flow management (ATFM) can also be the solutions to environmental problems.

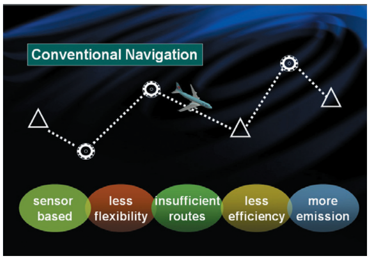
Another environmental issue is the noise problem. Extending airport operation hours has been used most often as a way to accommodate increasing traffic but it has become more difficult to do so because of noise-related complaints from local residents. Increasing the number of flights during operation hours is also being affected. As these problems will only be further aggravated, solutions to reduce noise while still promoting the development of the aviation industry are sorely needed.

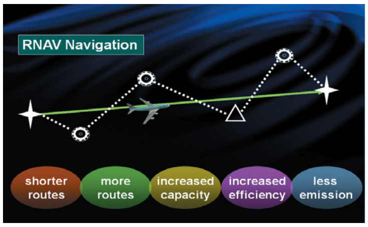
02

Evolution of Navigation

Area Mavigation

NDB, VOR/DME and other ground radio navigation aids were developed in order to overcome operational restrictions posed by early navigation that relied on pilot's eye. Conventional navigation that flies along the radio signals provided by ground facilities has contributed for decades to enhancing flight safety and accessibility.



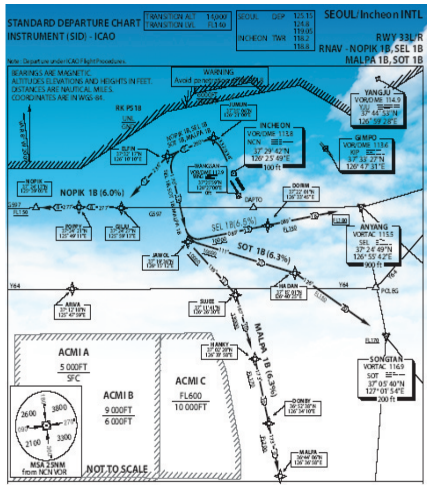


As navigation system develops, RNAV (Area Navigation), a method of navigation that permits aircraft operation on any desired course, has become available. Since RNAV is different from the conventional navigation in that flight between any two random points is possible regardless of the location of ground facilities, more flexible route structure can be designed.

Current Status in the ROK

To take advantage of these developments, the ROK first introduced RNAV route in 2001 in Seoul TMA that includes Korea's busiest airports, Incheon and Gimpo. Since then, RNAV routing has been expanded to other airports including Yangyang, Yeosu, Jeju and Muan Airports so that RNAV procedures account for about 30% of all SIDs and about 47% of all STARs.

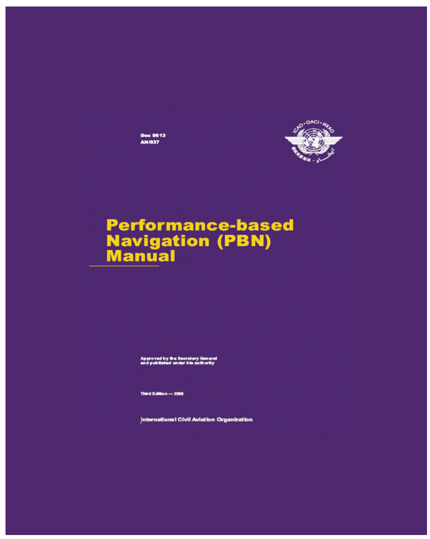
In the case of en routes, 6 of Korea's 25 en routes are now RNAV routes and they have been introduced since 2005. However, these RNAV routes are designed for the purpose of transitions between major routes and when taking into consideration the very advanced navigation performances of today's aircraft, RNAV routes in the ROK are providing only part of RNAV's full potential benefits.



PBN & Global Harmonization

At the same time, more aircraft are being equipped with RNAV system and the accuracy of RNAV system is being continually enhanced. This has led naturally to more and more demands from users wishing to make maximum use of the satellite and advanced avionics. In response to these demands, RNAV standards and systems were developed but only resulted in different standards that were not consistent from region to region or from industry to industry and it has been pointed out for many years that such inconsistencies could impede flight safety.

This incited ICAO to provide guidance materials and introduce a new navigation concept based on RNAV called performance-based navigation (PBN) for global harmonization of navigation identifying ATS routes into different categories according to navigation performances. In addition, ICAO urged all Member States to implement RNAV and RNP ATS routes and approach procedures in accordance with the ICAO PBN concept laid down in the PBN manual(Document 9613) at the 36th ICAO Assembly .



03

Development of PBN Implementation Plan

National PBN Task Force

The Ministry of Land, Transport and Maritime Affairs is making a stage by stage transition from the current conventional navigation to performance based navigation in Korea's airspace. Further, the Ministry decided to draw up a PBN implementation plan to help airspace users make a smooth transition and organized the national PBN Task Force composed of experts from all related fields including flight procedures, airspace, air traffic control, NAVAIDs operations, airworthiness, flight inspection, aeronautical information, airport etc. Over the past year, the task force has been carrying out given tasks such as the establishment of the PBN implementation plan and evaluating necessary requirements for implementation of PBN. The task force team meets regularly to discuss current issues raised regarding the PBN implementation. A leader of the team is from MLTM and he/she keeps up-to-date data related to PBN transition tasks at national level by constantly receiving information from each team member. The team leader also pushes to address their efforts to the global trend for harmonization with adjacent countries and regional plans.

Principles

The following principles were applied in drawing up the PBN implementation plan.

First : Global harmonization

Have all regulations, navigation requirements, and flight procedures designs comply with ICAO's PBN Manual, SARPs, PANS, and other international standards.

Second : Smooth transition

Continue operation of conventional procedures during the transition period in order to ensure the operation of aircraft not equipped with RNAV.

Third : Regional harmonization

There should be no conflict with Asia-Pacific region's PBN implementation plan.

Fourth : Safety Assessment

Conduct safety assessment before and after PBN implementation to ensure that proper level of safety is achieved and maintained.

Assessment of CNS Infrastructure

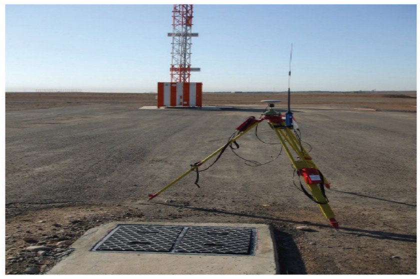
The status of navigation infrastructure for PBN implementation are as follows.

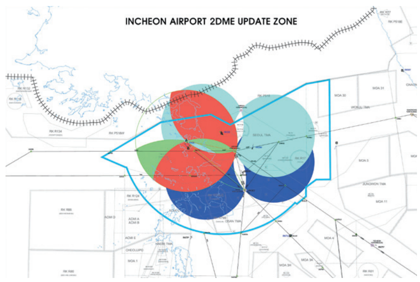
All RNAV and RNP operations are conducted solely with reference to WGS-84 coordinates. It was first adopted in the ROK in 1998 and surveys at all airports in the country are based on WGS-84. Hence, as far as coordinate system goes, basic conditions for PBN implementation are already met.

Assessment of aircraft navigation performance concluded that most of commercial aircraft in the ROK were already equipped with RNAV. In detail, 93% of the aircraft registered for air transport industry is ready for RNAV using satellites and 100% is ready for RNAV using DME/DME/IRU. In addition, radar surveillance and two way radio communication service for every corner of the airspace within Incheon FIR is provided.

However, in case of RNAV 1 and RNAV 2, it was found that it would be necessary to restrict the sensors to DME/DME/IRU and GNSS or GNSS only because of the presence of gaps at low altitudes in many TMAs due to topography or geometry of DMEs. In addition, 76% of airways in Incheon FIR, 66% of SID and 27% of STAR are still operated with ground based conventional navigation system such as VOR, TACAN, VORTAC, DME and so forth.

Consequently, it can be said that communication and surveillance infrastructure for PBN are properly prepared and aircraft's capabilities are almost met for PBN implementation.





Assessment of PBN fleet Readiness

■ Domestic fleet

The majority of aircraft registered in the ROK are operated by airlines. The aircraft which are expected to use PBN airspaces are mainly jet transporters equipped with advanced navigation capability. Almost all the aircraft operated by national carriers of the ROK are equipped with GPS receivers and other equipment required for PBN implementation. There are 68 aircraft being operated by the operators other than airlines. Following table shows overall fleet composition of aircraft registered in the ROK including general aviation.

Type of aircraft	Total Number	RNP 2/1, RNP APCH	RNAV 5/2/1
B747-400	24	24	24
B777-300	4	4	4
B777-300ER	4	4	4
B777-200	18	18	18
A330-223	3	3	3
B767-300	7	0	7
B767-300F	1	0	1
B737-500	3	0	3
B737-400	5	0	5
A330-323	11	11	11
A330-322	5	5	5
A300-600R	10	10	10
B737-800	24	24	24
B737-900	16	16	16
B747-400F	32	32	32
A320-200	11	11	11
A321-100	2	2	2
A321-200	13	13	13
A330-300	8	8	8
B777-200ER	11	11	11
B737-700	5	5	5
B737-600	1	1	1
others	68	28	48
Total	286	230	266

■ International fleet expected to use Incheon FIR

Within Incheon FIR, there are eight international airports. The operators of foreign registered aircraft are mainly airlines, and there have been 52 airlines which have used Incheon FIR in recent years. It was found that 100% of the foreign fleet are capable of RNAV and 85% are capable of RNP through the survey of 39 airlines conducted in May 2010. The table below shows the status of PBN implementation capability of foreign airlines operating at international airports in the ROK.

Total Airlines	Surveyed Airlines	GPS equipped	GPS not equipped	RNAV 5	RNAV 2	RNAV 1	RNP 2/1	RNP APCH
52	39	33	6	39	39	39	33	33

Noting that the majority of aircraft operating in Incheon FIR has capability of RNAV and RNP navigation, not any significant problems are expected in implementing PBN.

04

Challenges

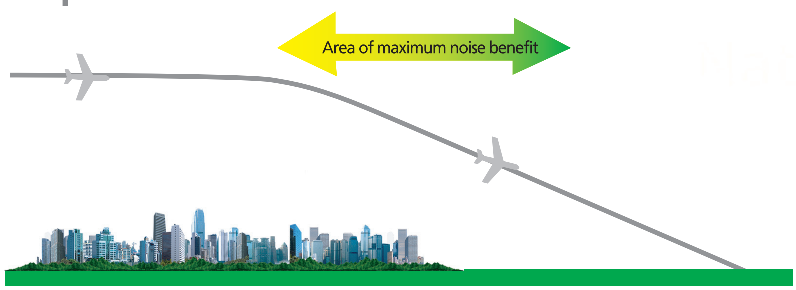
Enhancement of Airspace capacity

The traffic on 5 major routes (B576, G597, G585, A582 and A586) accounts for 82 percent of total traffic volume. Even among these routes, majority of the traffic is concentrated on B576 and G597 routes used for flights to/from the capital region. In particular, a survey found that a city pair between Seoul (Gimpo) and Jeju, operating on B576, was the third busiest city pair in the world at 858 flights per week in 2007 already. Operations for this city pair are increasing rapidly and have reached up to 1,152 flights per week in 2009.

New routes are direly needed in order to ease this heavy congestion and to cope with future traffic but establishing additional routes is not very flexible using the conventional method that also requires much more airspaces. On the other hand, higher navigation accuracy means lesser deviation and such ability to keep flight paths makes narrowing of route widths and cushions between routes possible, so that new routes can be added to the limited airspace. Utilizing the advantages of PBN, new routes will be added in congested airspaces, and routes between neighboring countries straightened out, and routes established exclusively for over flights to disperse air traffic. These will not only improve air traffic flow to ease congestion but will also reduce air traffic control workload and contribute to flight safety by lowering the incidence of aircraft proximity.

Low Carbon, Green Sky

Continuous Descent Operations



The most effective way to reduce carbon dioxide in aviation field is to cut fuel consumption by shortening flight distances. With conventional navigation, aircraft flies along a route defined by signals provided by ground navigation facilities so that air routes are influenced by the locations of ground radio navigation facilities. This poses limitations in shortening flight distances using conventional navigation. On the other hand, air routes can be set more freely with PBN making it easier to shorten distances and is effective in reducing CO_2. Accordingly, continued implementation of PBN for reduction of GHG was included in the Ministerial Declaration of the 6th APEC Transport Ministers' Meeting in April 2009.

In establishing new air routes, the Korean government will place top priority on shortening flight distances with specific goal to reducing at least 2 miles per departure/arrival route. This will cut fuels costs by approximately 11.5 billion won and reduce CO2 emissions by about 45,000 tons annually, thus simultaneously bringing positive economic effects and solving environmental problems. Furthermore, continuous descent operations (CDO) with optimized thrust power compared with that of sept-down operations would contribute to saving fuel. CDO has already been adopted at Gimpo Airport upon completing test operations and will be expanded to other major airports in the country.

Implementation of Approach Procedure with Vertical Guidance (APV)

In the ROK, 34 percent of the runways are non-precision runways without instrumental landing systems (ILS) that support precision approach. Landing is possible only with non-precision approaches at these runways. Step-down descent method used in the non-precision approach not only consumes much fuel but hinders flight safety by causing controlled flight into terrain (CFIT). Further, final approach courses in most non-precision approach procedures using VORs are off-set from runway centerline rendering greater flight difficulties. These weak points act as factors that raise the weather minimum which means that airport accessibility is not good under bad weather conditions.

However, most commercial aircraft nowadays use satellites and have necessary equipments installed on aircraft so that they can make constant descent with approach procedure with vertical guidance (APV). Furthermore, final approach course can also be aligned with the runway center line. Hence, adoption of APV would complement many weaknesses of non-precision approach procedures. For this reason, APV will be used in preference to all non-precision approach procedures and will be used as preliminary procedures at precision approach runways.

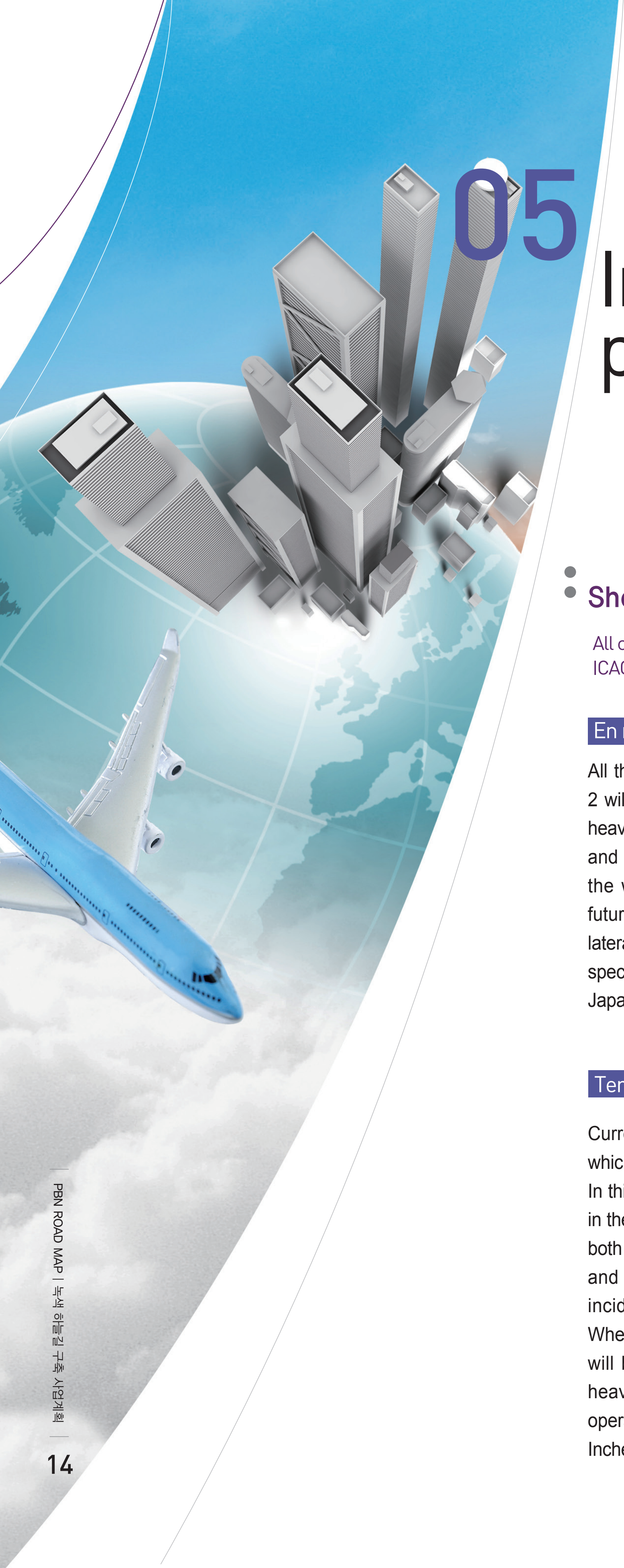
Noise Reduction

Noise problems can grow as air traffic volume grows. In particular, there will naturally be more noise complaints at airports located nearby downtown areas and will pose a obstacle in extending airport operation hours even when it is necessary owing to increased traffic. Implementation of PBN will not do away completely with noise problems but it will help since aircraft can easily avoid residential or noise sensitive areas along the prescribed track.

Under Article 108-2 of Korea's Aviation Act, these will be taken into consideration in establishing routes in airports where noise abatement procedures are required. In addition, adoption of continuous descent operation that was adopted at Gimpo Airport in 2007 and proven to have noise abatement effects will be expanded to other major airports including Incheon International Airport.

Enhancement of Accessibility

Some airports surrounded by high terrains only permit landings by circling approaches instead of straight-in and it frequently brings flight cancellation during adverse weather conditions due to high weather minimum. To this end, RNP AR approach procedure will be introduced which allows curved approach on final approach segment. Considering that RNP AR requires the highest level of navigation accuracy with which not many aircraft are able to meet, operational benefits and feasibility will be evaluated first before introduction, and safety assessment is prerequisite to introduction.



05 Implementation plan

Short Term 2010 ~ 2012

All current RNAV routes in the ROK will be readjusted to meet ICAO's PBN concept and clearly state navigation specification.

En route

All the current RNAV routes will be changed to RNAV 5. RNAV 2 will be introduced to establish unidirectional parallel routes on heavily congested routes such as B576 to improve air traffic flow and the number of aircraft that can be handled without adding the workload to air traffic controllers will be increased in the future as well. Those routes will be separated by at least 8NM laterally. In addition, efforts will be made to harmonize navigation specifications on routes connected with neighboring countries like Japan.

Terminal

Current RNAV STAR and SID will be switched over to RNAV 1 which will also be applied to new STAR and SID during this term. In this case, priority will be given to easing congestion of airspace in the capital region and reducing the controller's workload. This is both to cope with the congestion and growing air traffic demands and at the same time to improve flight safety by lowering the incidence of aircraft proximity and other safety impediments. When selecting SID courses, RNAV's track keeping advantages will be utilized to the fullest to give consideration to avoiding heavily populated residential areas. And, continuous descent operations (CDO)will be expanded to all major airports including Incheon and Jeju.

Approach

APV-Baro VNAV will be introduced to all international airports and high traffic domestic airports. At these airports, APV-Baro VNAV will be adopted at non-precision runways without ILS for priority operation over non-precision approach procedures and this will help to tackle problems off-set and step-down approach of non-precision approaches and eventually the flight safety and accessibility.

Mixed navigation environment will be inevitable during the transition period. Therefore, taking air traffic control workload into account, instrument approach procedures will be designed as much as possible to have initial approach waypoints correspond with the initial approach fixes of conventional approach procedures. In addition, study on introduction of GBAS will be launched as well.

Medium Term : 2013 – 2016

En route

RNAV 2 or RNP 2 will be applied to new RNAV routes installed during this period. Routes between the ROK and neighboring countries will be straightened out during this period as well and new routes will be established exclusively for overflights in an effort to diversify traffic. Concerned countries will be consulted for the development of new routes and for regional harmonization of navigation specifications.

Terminal

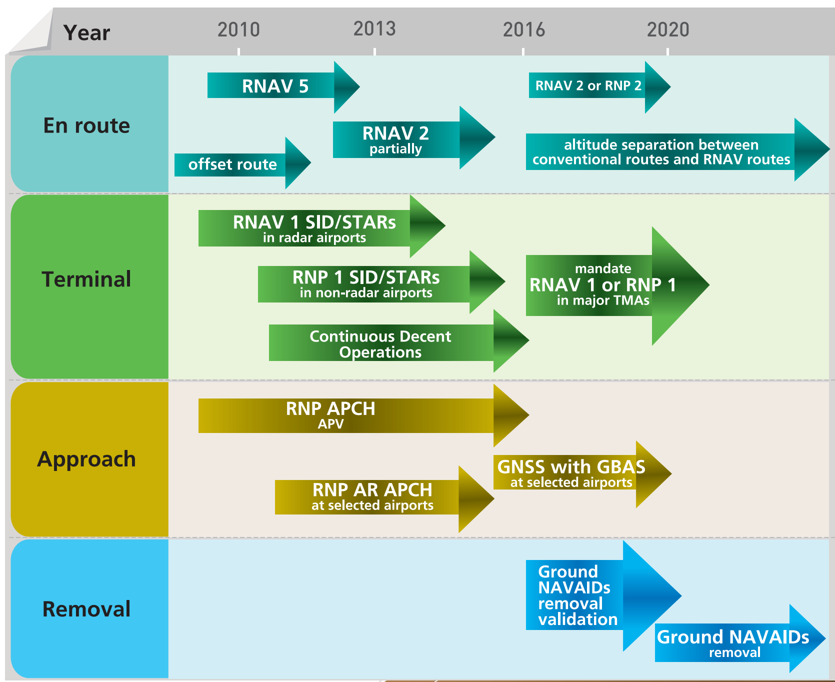
Introduction of RNAV 1 or RNP 1 in International airports will be completed during this period and RNAV 1 or RNP 1 will be expanded to major domestic airports. And, as needed, RNAV 1 or RNP will be mandated within some congested TMAs. Continuous descent operation (CDO) will be expanded to domestic airport as well.

Approach

Introduction of APV-Baro will be completed at all airports in the ROK and trial operation of GLS (GBAS Landing System) will be started at the selected airports. During this term, studies will be conducted to review the progress of PBN implementation and to evaluate the need of each ground NAVAID. Thereafter, evaluation results will be noticed to public.

Long Term 2017 ~

All RNAV 5 routes in operation will be switched over to RNAV 2 or RNP 2 and Approach procedures using GBAS will be expanded to other airports. VOR routes and RNAV routes will be completely separated at specific altitudes. Ground NAVAIDs on the removal notice will be out of commission gradually from 2021 and conventional routes will be replaced with RNAV routes. The safety assessment associated with the removal of existing ground navigational aids will be conducted with consideration of ensuring TLS be met at involved airspace.



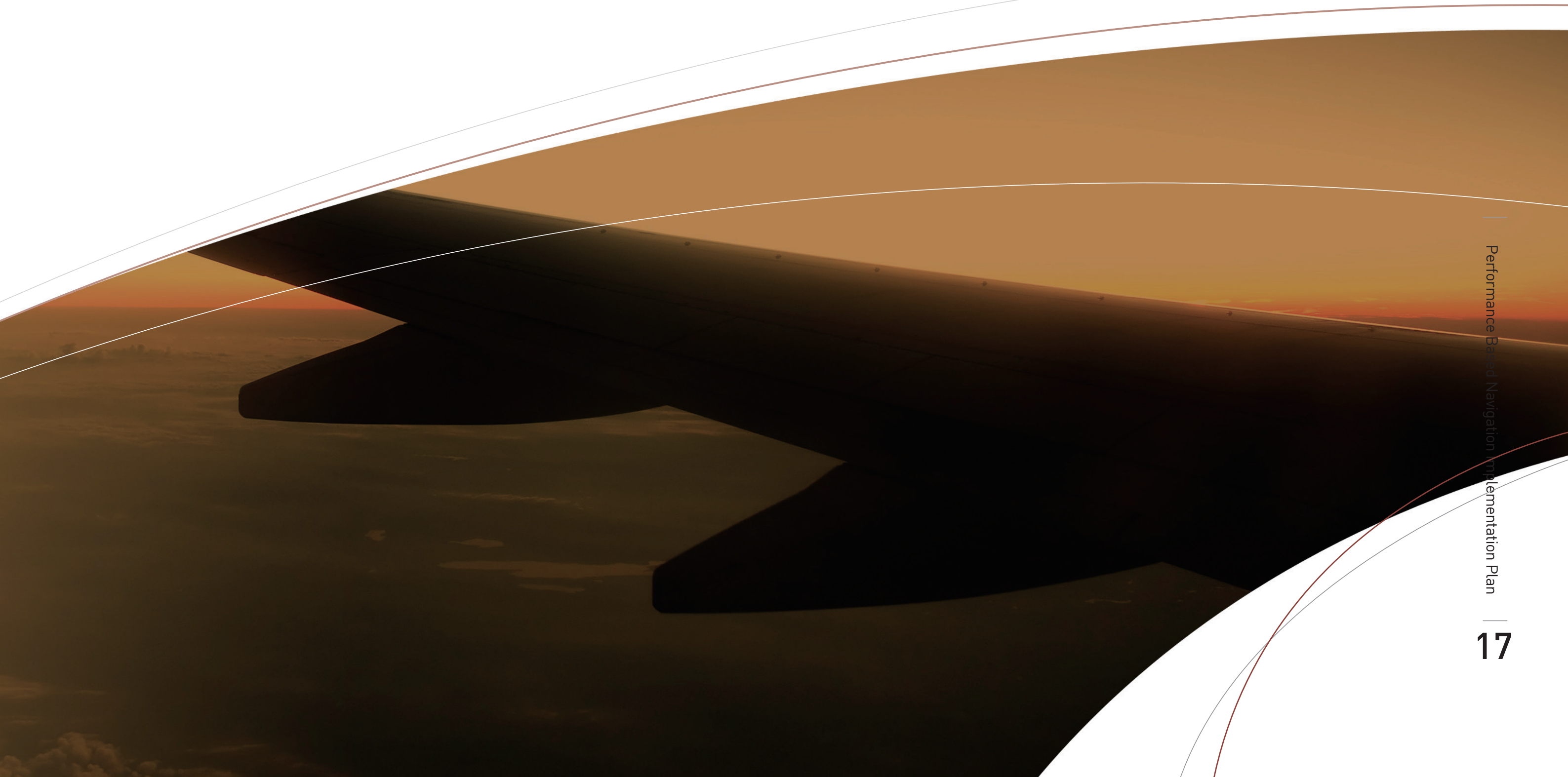
06

Safety Assessment

Safety assessment will be conducted to ensure safe operation that meets TLS. The safety assessment process has three stages; (1) Review stage; (2) Pre-implementation assessment, and (3) Post-implementation assessment.

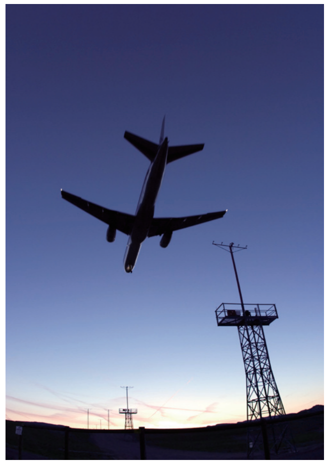
Review stage

Once the design process has been completed for any PBN implementation, a series of review meetings will be held in order to identify any significant hazards or violation of safety regulations. The review team will be composed of pilots from airlines, flight procedure designers and air traffic controllers. If the team finds any serious defect which results in unacceptable level of safety, then the airspace in question must be redesigned. The team will meet several times to finalize the airspace design that delivers an acceptable level of safety.



Pre-implementation safety assessment

Though the airspace is reviewed and is verified of having an acceptable level of safety, a meeting for official safety assessment should be held to see if every corner of operational environment is safe, reflecting changes introduced by the new concept of navigation specification. The meeting will identify any hazards, even those with minor problems, and organize them into a list. Then a risk assessment process will be conducted to list-up the expected risks and rate them according to the guidelines provided by ICAO SMS manual. The members of the safety assessment meeting are composed of pilots from airlines, airspace planners, flight procedure designers, air traffic controllers, navaid facility operators, and other experts from related organizations. If the meeting finds risks which require risk mitigation, they will recommend specific remedial actions for risk mitigation. When the level of safety is considered sufficient to meet TLS after the above mentioned process, the operation of the PBN airspace can be started.



Post-implementation safety assessment

It is necessary to analyze flight track data after the implementation of the PBN procedure to see if TLS is met. As a source of flight track, the radar track data will be used at the initial stage. Also a system that utilizes ADS-B track data as another source of flight track data will be developed in the near future. The recorded source data for specific months of the year will be collected for deviation analysis. Software for measuring magnitude of deviation from collected flight track will be developed and safety assessment experts will evaluate the level of safety through deviation analysis and collision risk analysis utilizing a Probability Density Function and Collision Risk Model.

Ministry of Land,
Transport and Maritime Affairs

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