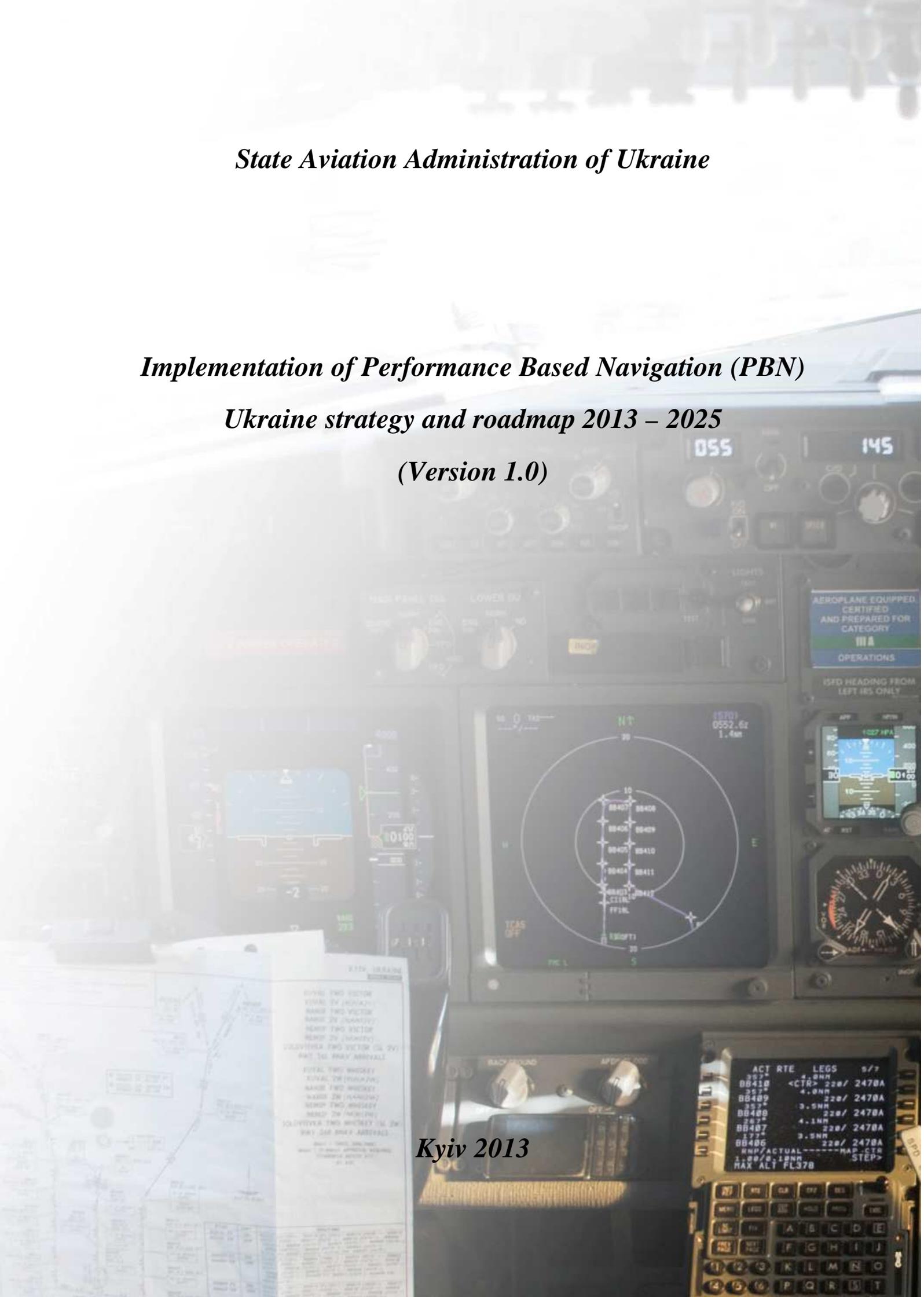


State Aviation Administration of Ukraine

Implementation of Performance Based Navigation (PBN)

Ukraine strategy and roadmap 2013 – 2025

(Version 1.0)



Kyiv 2013

ACT RTE	LEGS	s/z
BB418	<CTR> 22e/ 2478A	
357*	4.0NM	
BB489	22e/ 2478A	
357*	3.5NM	
BB488	22e/ 2478A	
357*	4.1NM	
BB487	22e/ 2478A	
177*	3.5NM	
BB486	22e/ 2478A	
RNP/ACTUAL	MAP-CTR	
1.08/4.18NM	STEP	
	MAX ALT FL378	

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Contents

1. Introduction	4
2. Strategic objectives	4
3. General implementation strategy	5
4. Initial State of PBN implementation	6
5. Navigation application of RNAV and RNP ICAO specifications	7
6. Aircraft navigation capability.....	18
7. Action by the Authorities and industry	22
8. Action plan for authorities and stakeholders.....	25

1. Introduction

Demand for air transportation services in the East European Region has increased over the last decennium and this trend is expected to continue the next years to come. States are faced with finding solutions to safely increase capacity, efficiency and, where appropriate, access to terrain challenged airports. These constraints are largely a result of reliance upon conventional navigation aids (e.g., VOR, DME, NDB), which limit routes and procedures to the physical locations of ground-based navigation aids. It is evident that an increase in capacity of the ATM system is needed to accommodate future traffic flows as well as increasing flight efficiency.

At the 36th Session of the ICAO Assembly, it has been agreed by Resolution A36/23: “All the contracting States should have a PBN implementation plan in place by 2009 to ensure a globally harmonized and coordinated transition to PBN by 2016”. The main principles of PBN implementation in Ukraine are described in Attachment A to this document.

This resolution was superseded in 2010 by the 37th ICAO Assembly Resolution A37/11 with the following specific requirements:

- (1) Implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones;
- (2) 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 per cent by 2010, 70 per cent by 2014; and
- (3) 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 available and where there are no aircraft suitably equipped for APV operations with a maximum certificated take-off mass of 5 700 kg or more.

In complement to the global ICAO intention the following pan-European tasks were assessed and legally approved in the Local Single Sky Implementation (LSSIP) Ukraine (formally known as LCIP) document:

- NAV03: Implementation of Precision Area Navigation RNAV (P-RNAV);
- NAV10: Implement Approach Procedures with Vertical Guidance (APV).

By introducing the PBN environment supported by GNSS technology, SAA wants to facilitate more efficient use of airspace and more flexibility for procedure design, which cooperatively result in improved safety, capacity, predictability, operational efficiency, fuel economy, and environmental effects.

2. Strategic objectives

The strategic objectives in the context of PBN have been established by SAA in accordance with the ICAO framework for Ukrainian air navigation system up to 2025:

- to improve flight safety by recognition of multi-constellation GNSS navigation with a backup ground-based infrastructure;
- to develop an interoperable harmonized CNS/ATM system supported by modern ATM techniques, flow performance metrics and perspective CNS capabilities;
- to improve airports accessibility with GNSS/APV approaches;
- to improve operational efficiency by implementation of CDO, Free Routes and ETA concepts;
- to protect environment by reducing fuel emission, noise pollution over sensitive areas.

The PBN implementation in Ukraine is one of key enablers which allow accomplishing the strategic objectives listed above and has to be realized through the task for application of RNAV and RNP operations in accordance with the ICAO EUR PBN regional planning. To successfully implement PBN in Ukraine the following deliverables have to be developed:

- the high-level strategy for the evolution of the PBN applications (including Advanced RNP) in Ukraine up to 2025;
- the operational requirement for the PBN implementation;
- the cost-benefit analyses of the implementation of the RNAV and/or RNP specifications in each particular airspace where PBN implementation is planned;
- the timelines in terms of the mandate aircraft equipment policy to determine benefits from PBN implementation.

3. General implementation strategy

At the 37th Session of the Assembly of ICAO held in 2010, Ukraine agreed to ICAO Resolution A37-11, which urges all States to implement PBN. States are therefore requested to produce a PBN implementation plan and implement Approach Procedures with Vertical guidance (APV) by 2016.

As a follow-up of the ICAO Assembly Resolutions A36-23 and A37-11, initiatives have been taken by the ICAO Regional office to include in the EUR Regional Air Navigation Plan (EUR ANP) the implementation of PBN. The European Commission identified the gradual transition towards GNSS based PBN environment as one of the main pillars of the SESAR/Next Gen concept which in turn is aimed at achieving ICAO's Global ATM Concept. The strategy for PBN implementation in Europe (ECAC region) is contained in the EUROCONTROL Document "Navigation Application & Navaid Infrastructure for the ECAC area up to 2020".

For the development of the Ukraine strategy on PBN implementation and the acceptance of the associated implementation roadmap a National PBN taskforce has been established by the SAA in which are participating the appropriate (civil and military) authorities and affected aviation industry (Airlines, Airports, ANSP's, Antonov Design Bureau, National Aviation University).

The implementation targets have been established at regional level in the ICAO EUR Regional Air Navigation Plan as well as in the SES II and SESAR concepts affecting Air Traffic Services, Airspace organization and Air Traffic Flow management.

The following initial principles to implement PBN in Ukraine airspace should be taken into consideration by the National PBN taskforce (PBN TF):

- *RNAV specification to be introduced in all types of airspace;*
- *mandate RNAV-1 for all (international) IFR traffic in TMA's of international aerodromes in Ukraine as a basis for optimized arrival and departure procedures ultimately by 2016;*
- *conventional non-precision (NPA) procedures of instrument runways of international aerodromes are supplemented with RNP approach procedures that provide vertical guidance (APV) by means of barometric (Baro-VNAV) or satellite altimetry (SBAS-VNAV) ultimately by 2016;*
- *airspace users shall hold airworthiness and an operational approval by their national supervisory authority to conduct RNAV/RNP operations;*
- *GNSS Signal in Space (SIS) performance in Ukrainian airspace to be monitored and to that regard promoting the extension of EGNOS coverage to Ukraine.*

The core segment of the PBN TF consists of experts from SAA who have responsibility and extensive expertise in the following subjects:

- ATM;
- CNS;

- airworthiness & certification;
- aircraft operations and operational approval;
- flight safety.

In order to increase the efficiency of implementation and to take appropriate actions, the following parties outside SAA have been included to support the core segment of the PBN TF:

- air navigation service providers, in particular UkSATSE;
- major aircraft operator, in particular Aerosvit Airlines, Ukraine International Airline (UIA), Dniproavia;
- Civil-Military coordination experts from the Ministry of Defense.

On part-time basis, pending the agenda of the PBN TF meeting and their specific area of interest, additional experts could join the core segment of PBN TF:

- National Aviation University;
- aircraft and avionics manufacturers / Antonov Design Bureau;
- environmentalists;
- general aviation representatives;
- AIS specialists;
- International experts from regional or world-wide organizations.

This plan implies that Ukraine air law and aviation legislation should provide the basis for certification of airborne equipment, safety validation of PBN flight procedures and operational approval of the operator and aircrew. The SAA should be prepared to review the applications for certification and operational approval and consider, as appropriate, conditions for issuance. The ATM system during the transition period needs to cater for a large array of aircraft capabilities which can range from conventional VOR/DME navigation to state-of-the art FMS and GNSS avionics. Aircraft equipped with appropriate PBN capability should be handled by ATC with preference over non-PBN equipped aircraft.

This Strategic Roadmap document summarizes the principles that should apply for the implementation of PBN, describes the various navigation applications and identifies the actions to be taken by authorities and aviation industry.

This Strategic Roadmap document distinguishes the following timelines:

- short term (ST): now – end of 2015;
- medium term (MT): 2016 – end of 2019;
- long term (LT) 2020+.

4. Initial State of PBN implementation

In 2010 the SAA has approved the initial implementation plan of PBN for the short-term perspective.

The Ukraine Aeronautical Information Service (AIS) has published an Aeronautical Information Circular (AIC 05/11 dated 10 November 2011) which provides information concerning the introduction of Performance Based Navigation (PBN) in Terminal Airspace of Ukraine prescribed by the 2010-2014 State Development Program for the Use of Ukrainian Airspace (the resolution of the Cabinet of Ministers of Ukraine № 44 dated 13 JAN 2010). The framework has been established at Regulator level and an appropriate working group was created at UkSATSE to implement RNAV 1 (P-RNAV) specification for PBN operations in a number of TMA's.

Further details of the short term-planning have been included in the appropriate chapters of this document.

5. Navigation application of RNAV and RNP ICAO specifications

For the introduction of RNAV and RNP operations distinction has been made in the following areas:

- (1) En-route.
- (2) Terminal areas, including arrival and departure routes.
- (3) Approach and landing operations.

The following chapters 5.1 to 5.3 will contain into detail the implementation roadmap in these areas for the short-, medium- and long-term perspectives.

5.1 En-route

5.1.1 Basic principles for implementation

In accordance with ECAC Strategy for the 1990s on ATM, which was adopted at ECAC ministers of transport level, starting from 1998, ICAO specification RNAV 5 (previously referred as B-RNAV) became mandatory as the primary mean of navigation in all ECAC en-route airspace from FL95 and above. VOR/DME should remain available for reversionary navigation and for use on domestic ATS routes in the lower airspace, as appropriate.

The development of PBN for en-route operations in Ukraine airspace should be in line with European planning as developed by the ICAO/EANPG (European Air Navigation Planning Group). Principles applied for PBN implementation for en-route operations are listed below:

- ICAO specification RNAV 5 (B-RNAV) will be gradually phased out and will be followed-up by ICAO specification RNAV 1;
- The decision on en-route ICAO specification RNAV 1 implementation should be based on:
 - ICAO specification for the appropriate terminal areas to allow a seamless transition for arriving and departing aircraft;
 - the results of fleet capacity assessment and forecast.

Ukraine is planning to implement ICAO specifications RNAV 5 and RNAV 1 in the following steps:

- Presently RNAV 5 (above FL 275);
- 2013 – 2016 RNAV 5 (whole airspace);
- 2016+ RNAV 1.

5.1.2 Current Airspace structure and Air Navigation services

Ukraine airspace consists of 5 Air Traffic Control areas:

- *Kyiv FIR/ACC*
- *L'viv FIR/ACC*
- *Odesa FIR / ACC*
- *Simferopol' FIR/ACC*
- *Dnepropetrovs'k FIR/ACC*

RVSM airspace has been established between FL 290 and FL 410.

The Division Flight Level (DFL), separating upper from lower airspace, is presently at FL 275 but might be changed in the context of integration into the Common European Airspace.

The common transition altitude is established at 10.000 ft.

Air Navigation service provision is being delivered by UKSATSE. UKSATSE has been certified by the State Aviation Authority. UKSATSE also provides communication, navigation and surveillance services in its area of responsibility. DME/DME coverage in the Ukraine FIRs is suitable to perform operations in accordance with ICAO specifications RNAV 5 and RNAV 1.

5.1.3 ATC units

The following table lists the ACCs and APPs (with associated FIRs) in the Ukrainian airspace, including the airspace in which the provision of ATS is delegated to Ukraine (part of the airspace of the Black Sea):

ATC Unit	Number of sectors		Associated FIR(s)
	En-route	TMA	
Kyiv ACC	7	4	UKBV Kyiv FIR
Simferopol' ACC	5	2	UKFV Simferopol' FIR
Odesa ACC	3	2	UKOV Odesa FIR
L'viv ACC	4	1	UKLV L'viv FIR
Dnipropetrovs'k ACC	4	1	UKDV Dnipropetrovs'k FIR
Kharkiv APP		3	UKDV Dnipropetrovs'k FIR
Donets'k APP		2	UKDV Dnipropetrovs'k FIR

5.1.4 Airspace concept development and implementation roadmap

Ukraine airspace is considered to be a “Continental airspace” that would imply that the following implementation principles shall be applied:

Classified areas	Short Term	Medium Term	Long Term
Continental en-route	RNAV 5	RNAV 1	A-RNP

Based on an evaluation of the traffic density, route structure and expected growth in traffic, the following roadmap has been established:

Implementation roadmap en-route continental airspace						
Airspace	Short term	Year	Medium Term	Year	Long term	Year
Kyiv FIR/ACC	RNAV 5	Currently*	RNAV 1	2016**	A-RNP	t.b.d.
L'viv FIR/ACC	RNAV 5	Currently*	RNAV 1	2016**	A-RNP	t.b.d.
Odesa FIR/ACC	RNAV 5	Currently*	RNAV 1	2016**	A-RNP	t.b.d.
Simferopol' FIR/ACC	RNAV 5	Currently*	RNAV 1	2016**	A-RNP	t.b.d.
Dnepropetrovs'k FIR/ACC	RNAV 5	Currently*	RNAV 1	2016**	A-RNP	t.b.d.

*Currently ICAO specification RNAV 5 is in the airspace above FL275.

**Tentative.

As the route structure and related en-route operations are complicated in the Ukrainian airspace, considering the domestic and international traffic characteristics and associated limitations in PBN equipage, the transition period to PBN shall accommodate PBN and non – PBN equipped aircraft in a proper way.

The requirement for the transition period dictates designing the airspace concept by considering the following guidelines and targets:

1) In the medium term ICAO specification RNAV 1 should become mandatory for IFR flights in Ukrainian FIRs above FL 95, priority be given to a routes with high PBN equipage level traffic given that:

- a. An analysis be made on current and forecasted navigation equipage of the aircraft operations along each route under consideration;
- b. Implementation of RNAV 1 routes connecting en-route and TMA's where RNAV 1 performance is required should be considered in order to ensure seamless transition;
- c. Routes network accommodating transiting traffic (East-West or North-South) with a high level of PBN equipage should be implemented as a priority;
- d. Consideration should be given to simplify the route structure in Ukraine airspace based on RNAV 1 network principles with priority to the routes with a higher traffic density;
- e. Consideration should be given to exempt domestic IFR flights and recreational GA IFR flights during the initial implementation phase.

2) In the longer term ICAO specification A-RNP should become mandatory for all IFR flights at and above FL95. Consideration will be given to exempt recreational GA IFR flights and domestic operations during the initial implementation phase.

3) At the lower airspace (below FL 95) ICAO specification RNAV 5 is gradually being replaced by ICAO specification RNAV 1 based on operational requirements in the TMA's and the user navigation capability, such as PBN equipage level of their fleet and obtained operational approvals.

Based on the above principles for the airspace design concept, initially an evaluation will be made of the current Ukraine FIR route structure and traffic volumes for each route, including aircraft equipage, to consider ICAO specification RNAV 1 implementation and set priorities for the implementation of ICAO specification A-RNP.

Regarding the connections to the Kyiv TMA and for transiting traffic, the following routes should be reviewed:

- East-West:

- M70, A87, P27, M986 (KYIV (Boryspil') [UKBB] Arrival/Departure);
- L980, L984 (Transit & Connection);
- L984 (Transit & Connection);

- North-South:

- L33, M850 (KYIV (Boryspil') [UKBB] Arrival/Departure);
- N181, N180 (Transit & Connection).

Similar review as above for KYIV (Boryspil') [UKBB] should be carried out for traffic to / from Dnipropetrovs'k [UKDD], Donetsk [UKCC], Kharkiv (Osnova) [UKHH], KYIV (Zhuliany) [UKKK], L'viv [UKLL], Odesa [UKOO], Simferopol' [UKFF], regarding the following routes:

<i>East - West routes</i>								
M70	M986	L981	M987	N623	M747	W538	P567	L850
M141	M991	N190	P851	M996	T555	L69	T502	L99
T199	L986	L140	L32	A83	T145	W533	M406	M986

<i>North - South routes</i>							
P156	M861	N743	P987	L4	L98	M995	P29
N616	P727	M854	N180	N604	M853	G476	T504
P26	L156	L33	N617	T248	W533	T242	----

Simplification of the route structure should be considered. The alignment of lower and upper route network was completed in November of 2012.

5.2 Terminal Control Area (TMA)

5.2.1 Current Implementation planning

As for the beginning of 2013 the aerodrome network of Ukraine comprises of 34 certified aerodromes of which 23 have an airport infrastructure. Institutionally 4 airports are independent bodies, 4 airports are state-owned enterprises, 13 are municipal enterprises, 1 is a community property enterprise and 1 is a subdivision of a concern. Depending on the operational need for the implementation of PBN, in particular the present and future aircraft PBN equipage at a specific aerodrome, there is a need to set initial priorities for the implementation roadmap at the aerodromes mentioned above in cooperation with the airport owners / aerodrome operator.

In 2011 the Aeronautical Information Service of Ukraine (AIS of Ukraine) published an Aeronautical Information Circular (AIC 05/11 dated 10 November 2011) in which ICAO specification RNAV 1 (P-RNAV) is being introduced in the TMA's of following international aerodromes in 2012:

KYIV (Boryspil') [UKBB], Dnipropetrovs'k [UKDD], Donets'k [UKCC], Kharkiv (Osnova) [UKHH], KYIV (Zhuliany) [UKKK], L'viv [UKLL], Odesa [UKOO], Simferopol' [UKFF]. KYIV (Boryspil') [UKBB] was selected for a pilot project for implementation of ICAO specification RNAV 1.

The associated implementation planning from AIC 05/11 dated 10 November 2011 has been incorporated in this document.

5.2.2 Implementation principles

The general strategy for implementation of PBN in Terminal Control Areas (TMA) and Aerodrome Flight Information Zones (AFIZ) is dependent on traffic density and of the specific function of the specific aerodrome in terms of:

- *International air traffic (scheduled and unscheduled);*
- *Domestic air traffic (scheduled and unscheduled);*
- *Business/corporate operations;*
- *General aviation operations;*
- *Aerial works, aviation industrial production, sports aviation, etc.*

PBN implementation in the TMA will support departure procedures (SIDs) and arrival procedures (STAR's) down to Initial Approach fix (IAF) or to Final Approach Fix for the special type of arrivals "Transition To Final Approach". The implementation roadmap for PBN approach procedures is contained in chapter 5.3.

The design of TMA PBN procedures:

- *Shall be consistent with the relevant parts of ICAO Doc 8168 OPS/611;*
- *Follow the guidelines of EUROCONTROL document NAV.ET1.ST10;*
- *Shall be based upon WGS 84 coordinates;*
- *Shall be (safety) validated and shown to be aircraft compatible (in particular cases flight validation can be applicable).*

Based on the traffic volume and the specific nature of traffic, operationally distinction could be made in four types of TMA's serving IFR traffic at aerodromes (a, b, c and d). On aerodromes, where Aerodrome Flight Information Service is provided, AFIZ are established (e):

a. High traffic density, being mainly international operations/Hub:

KYIV (Boryspil') [UKBB]

b. Medium traffic density, being mainly international operations:

Dnipropetrovs'k [UKDD], Donetsk [UKCC], Kharkiv (Osnova) [UKHH], KYIV (Zhuliany) [UKKK], L'viv [UKLL], Odesa [UKOO], Simferopol' [UKFF];

c. Low to medium traffic being domestic with mainly national / commuter operations:

Chernivtsi [UKLN], Ivano-Frankivs'k [UKLI], Luhans'k [UKCW], Mariupol' [UKCM], Mykolaiv [UKON], Rivne [UKLR], Uzhhorod [UKLU], Vinnytsa (Gavryshivka) [UKWW], Poltava [UKHP], Sevastopol' (Bel'bek) [UKFB], Sumy [UKHS];

d. Cargo Operations/Test Flights:

Kryvyi Rih (Lozuvatka) [UKDR], KYIV (Antonov-1) [UKKT], KYIV (Antonov-2) [UKKM], Kirovohrad [UKKG], Kremenchuk (Velyka Kokhmivka) [UKHK], Kharkiv (Sokolnyky) [UKHD], Zaporizhzhia (Mokraya) [UKDE]

e. GA/Sport/AFIS (in accordance to AIC A 08/11 effective 16 DEC 2011):

Lymans'ke [UKOM], Cherkasy [UKKE], Khmel'nyts'kyi [UKLH], Ternopil' [UKLT], Berdians'k [UKDB], Simferopol' (Zavods'ke) [UKFW], Zhytomyr (Ozerne) [UKKO], Severodonets'k [UKCS].

5.2.3 TMA implementation roadmap

Based on the global planning by the ICAO Assembly Resolution A37/11 and the regional planning by EUROCONTROL, legally approved in Local Single Sky Implementation (LSSIP) Ukraine (formally known as LCIP), taking into account the high level of PBN equipage of international traffic to/from Ukraine and the relative low PBN equipage of domestic traffic, the following principles were applied for the implementation roadmap for TMA's in Ukraine:

- *At short term perspective RNAV 1 is introduced to facilitate IFR traffic in all TMA's with considerable international traffic (aerodromes from group a. and b., see 5.2.2) with a temporary exemption for GA and domestic air traffic to follow conventional routes.*

- *At medium term perspective RNAV 1 will become mandatory for all IFR traffic in all TMA's serving international flights. Timing will be dependent on operational need and aircraft equipage. Consideration be given to A-RNP introduction in Kyiv TMA. At domestic aerodromes RNAV 1 will be introduced only if there is an operational need.*

- *At long term perspective A-RNP is introduced for all IFR traffic in all TMA's serving international flights. Consideration will be given to A-RNP mandatory in Kyiv TMA. This also implies that mandatory carriage of GNSS is needed. A-RNP mandatory in other TMA's only if there has been shown an operational need and adequate aircraft PBN equipage for minimum 90 % of all traffic.*

When the principles above are being applied to the several categories of aerodromes (see 5.2.2), the following schedule for implementation should be used.

General planning for PBN implementation in the Ukraine TMA's			
Terminal control areas (TMA)/AFIZ	Short Term	Medium Term	Long Term
International high traffic density/Hub (a): <i>KYIV (Boryspil') [UKBB]</i>	RNAV 1 introduction (conventional procedures maintained)	RNAV 1 mandatory Introduction of A RNP	A RNP mandatory
International medium traffic density (b): <i>Dnipropetrovs'k [UKDD], Donetsk [UKCC], Kharkiv (Osnova) [UKHH],</i>	RNAV1 introduction (conventional procedures)	RNAV1 mandatory	A RNP introduction

<i>KYIV (Zhuliany) [UKKK], L'viv [UKLL], Odesa [UKOO], Simferopol' [UKFF]</i>	maintained)		
Low to medium traffic density/Domestic (c): <i>Chernivtsi [UKLN], Ivano-Frankivs'k [UKLI], Luhans'k [UKCW], Mariupol' [UKCM], Mykolaiv [UKON], Rivne [UKLR], Uzhhorod [UKLU], Vinnytsa (Gavryshivka) [UKWW], Poltava [UKHP], Sevastopol' (Bel'bek) [UKFB], Sumy [UKHS]</i>	RNAV 1 introduction (conventional procedures maintained)	RNAV 1 introduction	RNAV 1 mandatory
Cargo Operations/Test Flights (d): <i>Kryvyi Rih (Lozuvatka) [UKDR], KYIV (Antonov-1) [UKKT], KYIV (Antonov-2) [UKKM], Kirovohrad [UKKG], Kremenchuk (Velyka Kokhnivka) [UKHK], Kharkiv (Sokolnyky) [UKHD], Zaporizhzhia (Mokraya) [UKDE]</i>	Conventional procedures	RNAV 1 introduction	RNAV 1 introduction
GA/Sport /AFIS (e): <i>Lymans'ke [UKOM], Cherkasy [UKKE], Khmel'nyts'kyi [UKLH], Ternopil' [UKLT], Berdians'k [UKDB], Simferopol' (Zavods'ke) [UKFW], Zhytomyr (Ozerne) [UKKO], Severodonets'k [UKCS]</i>	N/A	N/A	N/A

5.2.4 Detailed planning for TMA's at main international aerodromes

Taking into account the short term planning as contained in Aeronautical Information Circular AIC 05/11 for the aerodromes with considerable international traffic, the following detailed planning is anticipated for these aerodromes.

Implementation of arrival and departure procedures in TMA's at main international aerodromes						
Airport	Short term	Year	Medium term	Year	Long term	Year
KYIV (Boryspil) [UKBB]	RNAV 1 introduction	1st Qua 2012	RNAV 1 mandatory Introduction of A-RNP	2016 2016	A-RNP mandatory	t.b.d.
KYIV (Zhuliany) [UKKK]	RNAV1 introduction	Mid 2013	RNAV 1 mandatory	2017*	Introduction A-RNP	t.b.d.
L'viv [UKLL]	RNAV1 introduction	Mid 2012	RNAV 1 mandatory	2017*	Introduction A-RNP	t.b.d.
Donets'k [UKCC]	RNAV1 introduction	1st Qua 2012	RNAV1 mandatory	2017*	Introduction A-RNP	t.b.d.
Dnipropetrovs'k [UKDD]	RNAV1 introduction	Mid 2012	RNAV1 mandatory	2018*	Introduction A-RNP	t.b.d.
Kharkov [UKHH]	RNAV1 introduction	Mid. 2012	RNAV1 mandatory	2018*	Introduction A-RNP	t.b.d.
Odesa [UKOO]	RNAV1 introduction	End 2013	RNAV1 mandatory	2018*	Introduction A-RNP	t.b.d.
Simferopol' [UKFF]	RNAV1 introduction	End 2013	RNAV1 mandatory	2018*	Introduction A-RNP	t.b.d.

*Tentative.

After a careful evaluation on the operational need, a similar planning will be made for all aerodromes (see 5.2.2) based on PBN equipage of the aircraft operating to/from the specific aerodrome.

5.3 Approach and landing operations

5.3.1 Implementation principles

The basic policy of the SAA is to introduce instrument approach procedures with vertical guidance at all instrument runways of major aerodromes in order to enhance flight safety.

PBN approach concepts cover all segments of the instrument approach, i.e. initial, intermediate, final and missed approach. They will increasingly call for aircraft RNP specifications requiring a navigation accuracy of 0.3 NM to 0.1 NM or better. Typically three sorts of RNP applications are characteristic for approach and landing operations:

- *new procedures to runways never served by an instrument procedure;*
- *procedures either replacing or serving as backup to existing instrument procedures based on different technologies;*
- *procedures developed to enhance airport access in demanding environments.*

In general, the safety of instrument approaches to Ukrainian airports without ILS (or as back-up procedure for unserviceable ILS) is enhanced by replacing conventional non-precision approaches (NPAs) with approach procedures supported by vertical guidance (APV). [see EUROCONTROL APV Baro Safety Assessment]. It is the intention to implement ICAO specification RNP APCH with Baro-VNAV procedures to the maximum possible number of airports, primarily international airports.

Conventional approach procedures and conventional navigation aids will be maintained to support non-equipped aircraft during the transitional period. During this transitional period, approaches based on PBN will be designed to accommodate mixed-equipage (PBN and non-PBN) environment. ATC workload should be taken into account while developing approach procedures. The amount of published procedures for a certain airport should be limited (NAV data base size) and their design should be kept as simple as possible. One possible way to accomplish this is to co-locate the Initial Approach Fix (IAF) for both PBN and conventional approaches.

ILS will remain in European region on the medium to long term as the prime source of guidance for precision approaches and landings and is currently the only system available for ICAO CAT II and III operations.

In specific cases GNSS/GBAS CAT I could gradually be introduced from 2015 onward where operationally required.

On the long term GNSS/GBAS CAT II/III may become possible as multi-constellation GNSS (GPS/GLONASS/Galileo) pending the development of ICAO technical and operational specifications (2020+).

5.3.2 Implementation roadmap

In line with the ICAO resolution A37/11 it is foreseen that for all relevant instrument runway ends APV Baro-VNAV and/or additionally APV SBAS procedure are available by 2016. Airport access, particularly during low visibility conditions, may be further increased by introducing or improving of existing installation of ILS and/or GLS (GBAS). This implies that the following aspects should be taken into account in defining the implementation roadmap:

- *Gradual phase-out during 2011-2016 of conventional Non precision approaches (NPAs) such as VOR and NDB without vertical guidance, to be replaced by APV Baro-VNAV (and/or additionally APV SBAS) to include vertical guidance. Based on operational need, consideration is given to extend the phase out to 2020 for Ukraine.*
- *NPA with ICAO specification RNP APCH will be introduced as a fall-back for APV Baro-VNAV and/or APV SBAS.*

- From 2013 to 2016 publication of APV Baro-VNAV procedures for relevant instrument runway ends at International airports and domestic airports is planned. Based on operational need, consideration be given to extend the period to 2020 for Ukraine.

- Consider the need for straight-in LNAV only procedures for instrument runways at aerodromes where there is no local altimeter setting available and where there are no aircraft suitably equipped for APV operations (max. take-off mass of 5 700 kg or more).

- Airlines will require an approval for RNP APCH operations to conduct APV Baro-VNAV and/or APV SBAS approaches; hence a mandate for RNP APCH is foreseen for 2016 with the extension to 2020 in particular cases .

- From 2016 onwards, the EGNOS infrastructure is expected to be fully available in Ukraine to support SBAS operations, however to benefit from EGNOS a dedicated SBAS receiver is required, presently only to support operations with decision heights for ICAO CAT I minima's or higher.

- Actual timescale for SBAS introduction depend on cost-benefit analysis for airlines and GA IFR user community.

- The CAT I functionality, which is to be provided by EGNOS LPV-200 (200 ft DH), is still under development and may prove to be advantageous for specific airports. Therefore, APV-I EGNOS service is to be considered for APV SBAS implementation.

- GLS CAT I applications are expected to be gradually introduced onwards from 2016. If e.g. curved final approaches during LVP (Low Visibility Procedures) are required then GBAS could be considered. Presently it requires implementation of ICAO specification RNP AR APCH instead of more common RNP APCH and requires from an airline to obtain a specific operational approval.

- GBAS CAT I installations are commercially available and have been installed at some airports. However these installations are experimental due to limited number of airlines bearing operational approval for this type of operation.

RNP AR APCH is costly and will only bring benefits to airlines that have the capability. Any airline wanting to use RNP AR APCH has to perform a functional operational safety assessment (FOSA) before getting approval.

The application of GLS as CAT II/III landing system can become relevant in case the ILS CAT II/III status of particular runways can no longer be upheld. It is the view of the ICAO that certified GLS CAT II/III installations and operational experience is not available before 2020. GLS CAT I/II/III will be considered when a multi-constellation (GPS/GLONASS/Galileo) is available to reduce the risk of failure of one of the two failing GNSS constellations. This is also expected 2020+.

5.3.3 PBN Instrument Approach Procedures

Implementation roadmap encompasses the design and publication of PBN-based instrument approach procedures in-line with ICAO Assembly Resolution A37/11: 30% by 2010, 70% by 2014 and 100% by 2016.

All procedures should be validated in accordance with ICAO Doc 9906 AN/472 “Quality Assurance Manual for Flight Procedure Design” volume 5 “Validation of Instrument Flight Procedures” and volume 6 “Flight Validation Pilot Training and Evaluation” and approved by the SAA/NSA.

The following basic infrastructure and navigational support are related to the specific PBN approach procedures:

(1) Non- Precision Approach (NPA) based on GNSS procedures:

- RNP APCH, LNAV supported by core GNSS (GPS or GLONASS):

- NPA LNAV (no vertical guidance);

- APV LNAV/VNAV with Baro-VNAV guidance down to APV I;

- RNP APCH, LNAV supported by augmented GNSS (EGNOS):
 - APV LNAV/VNAV with SBAS-VNAV guidance down to APV I;
 - APV LNAV/VNAV with SBAS-VNAV guidance down to LPV-200;
- RNP AR APCH, LNAV supported by augmented GNSS (EGNOS):
 - APV LNAV/VNAV with Baro-VNAV or augmented GNSS (EGNOS) guidance;
 - requires specific crew training and operational approval.
- (2) Precision Approach (PA) based on GNSS procedures:
 - SBAS CAT I LPV (EGNOS), still under development:
 - need for certified SBAS receiver;
 - pending certification against SES criteria of the EGNOS Service Provider.
 - GBAS CAT I:
 - need for certified GPS receiver;
 - multi-constellation GNSS (GPS, GLONASS, Galileo), may reduce the probability that both systems fail due to (intentional) interference.
 - GBAS CAT II & III, still under development:
 - multi-constellation GNSS (GPS, GLONASS, Galileo);
 - need for certified CAT II/III GBAS installation;
 - need for certified GPS receiver;
 - need for operational approval.

The introduction of APV using SBAS (in particular, EGNOS) will be available in case of fulfilling of the following conditions:

- a space segment of at least two geostationary satellites (GEO) with coverage of their signals in Ukrainian airspace;
- ground segment that provides the augmentation data to be propagated to on-board with deployment of one or few Ranging and Integrity Monitoring Stations (RIMS) in Ukraine.

It is expected that Ukraine will have EGNOS coverage not earlier than 2016.

5.3.4 Classification of aerodromes

Similar as for the Terminal Manoeuvring Airspace (TMA), distinction is made in five types of aerodromes, dependent on traffic density in the TMA (AFIZ) and on the specific aviation function of the aerodrome in terms of international-, domestic-, business- or general aviation operations:

a. High traffic density, being mainly international operations

KYIV (Boryspil') [UKBB].

b. Medium traffic density, being mainly international operations

Dnipropetrovs'k [UKDD], Donetsk [UKCC], Kharkiv (Osnova) [UKHH], KYIV (Zhuliany) [UKKK], L'viv [UKLL], Odesa [UKOO], Simferopol' [UKFF].

c. Low traffic density/domestic

Chernivtsi [UKLN], Ivano-Frankivs'k [UKLI], Luhans'k [UKCW], Mariupol' [UKCM], Mykolaiv [UKON], Rivne [UKLR], Uzhhorod [UKLU], Vinnytsa (Gavryshivka) [UKWW], Poltava [UKHP], Sevastopol' (Bel'bek) [UKFB], Sumy [UKHS].

d. Cargo Operations/Test Flights

Kryvyi Rih (Lozuvatka) [UKDR], KYIV (Antonov-1) [UKKT], KYIV (Antonov-2) [UKKM], Lymans'ke [UKOM], Kirovohrad [UKKG], Kremenchuk (Velyka Kokhnivka) [UKHK], Kharkiv (Sokolnyky) [UKHD], Zaporizhzhia (Mokraya) [UKDE].

e. GA/Sport/AFIS (in accordance to AIC A 08/11 effective 16 DEC 2011)

Cherkasy [UKKE], Khmel'nyts'kyi [UKLH], Ternopil' [UKLT], Berdians'k [UKDB], Simferopol' (Zavods'ke) [UKFW], Zhytomyr (Ozerne) [UKKO], Severodonets'k [UKCS].

Taking into account the timelines from the ICAO Assembly resolution the following general implementation strategy for implementation of PBN at Ukraine aerodromes has been established (implementation progress is dependent on the level of present and future equipage of aircraft operating to/from the specific airport).

Implementation strategy for introduction of PBN Approach procedures			
Airport	Short term	Medium term	Long term
<i>International airport High traffic density</i>	<i>NPA APV Baro-VNAV</i>	<i>APV SBAS-VNAV SBAS CAT I</i>	<i>GBAS CAT I</i>
<i>International airports Medium traffic density</i>	<i>NPA</i>	<i>APV Baro-VNAV</i>	<i>APV SBAS-VNAV</i>
<i>Domestic airports Low traffic density</i>		<i>NPA APV Baro-VNAV</i>	<i>APV SBAS-VNAV</i>
<i>Cargo & Business airports Low traffic density</i>		<i>NPA</i>	<i>APV Baro-VNAV APV SBAS-VNAV</i>
<i>GA/Sport/AFIS</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>

5.3.5 Detailed planning for PBN approaches at Ukraine aerodromes

Based on the general implementation strategy and the operational need to the implementation of PBN approach procedures at specific aerodromes, the PBN roadmap has been reflected in three tables: short term perspective, medium term perspective and long term perspective.

PBN TF will permanently evaluate the operational need for the specific international, domestic, and general aviation aerodromes and establish (adjust) a time line for implementation of the PBN approach procedures.

PBN implementation for approach procedures (short term perspective)		
Airport	Instrument Flight procedure	Year
<i>KYIV (Boryspil') [UKBB]</i>	<i>RNAV NPA APV Baro-VNAV</i>	<i>2014* 2015*</i>
<i>Dnipropetrovs'k [UKDD], Donets'k [UKCC], Kharkiv (Osnova) [UKHH], KYIV (Zhuliany) [UKKK], L'viv [UKLL], Odesa [UKOO], Simferopol' [UKFF]</i>	<i>RNAV NPA (50 %)</i>	<i>2015*</i>
<i>Chernivtsi [UKLN], Ivano-Frankivs'k [UKLI], Luhans'k [UKCW], Mariupol' [UKCM], Mykolaiv [UKON], Rivne [UKLR], Uzhhorod [UKLU], Vinnytsa (Gavryshivka) [UKWW], Poltava [UKHP], Sevastopol' (Bel'bek) [UKFB], Sumy [UKHS]</i>	<i>RNAV NPA (30%)</i>	<i>t.b.d.</i>

Kryvyi Rih (Lozuvatka) [UKDR], KYIV (Antonov-1) [UKKT], KYIV (Antonov-2) [UKKM], Lymans'ke [UKOM], Kirovohrad [UKKG], Kremenchuk (Velyka Kokhnyvka) [UKHK], Kharkiv (Sokolnyky) [UKHD], Zaporizhzhia (Mokraya) [UKDE]		
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PBN implementation for approach procedures (medium term perspective)		
Airport	Instrument Flight procedure	Year
KYIV (Boryspil') [UKBB]	APV SBAS-VNAV SBAS CAT I	2017* 2018*
Dnipropetrovs'k [UKDD], Donets'k [UKCC], Kharkiv (Osnova) [UKHH], KYIV (Zhuliany) [UKKK], L'viv [UKLL], Odesa [UKOO], Simferopol' [UKFF]	NPA (100%) APV Baro-VNAV (50%) APV Baro-VNAV (100%)	2017* 2018* 2019*
Chernivtsi [UKLN], Ivano-Frankivs'k [UKLI], Luhans'k [UKCW], Mariupol' [UKCM], Mykolaiv [UKON], Rivne [UKLR], Uzhhorod [UKLU], Vinnytsa (Gavryshivka) [UKWW], Poltava [UKHP], Sevastopol' (Bel'bek) [UKFB], Sumy [UKHS]	NPA (70 %) APV Baro-VNAV (30%)	t.b.d.
Kryvyi Rih (Lozuvatka) [UKDR], KYIV (Antonov-1) [UKKT], KYIV (Antonov-2) [UKKM], Lymans'ke [UKOM], Kirovohrad [UKKG], Kremenchuk (Velyka Kokhnyvka) [UKHK], Kharkiv (Sokolnyky) [UKHD], Zaporizhzhia (Mokraya) [UKDE]	NPA (30 %)	

PBN implementation for approach procedures (long term perspective)		
Airport	Instrument Flight procedure	Year
KYIV (Boryspil') [UKBB]	GBAS CAT I	t.b.d.
Dnipropetrovs'k [UKDD], Donets'k [UKCC], Kharkiv (Osnova) [UKHH], KYIV (Zhuliany) [UKKK], L'viv [UKLL], Odesa [UKOO], Simferopol' [UKFF]	APV SBAS-VNAV	t.b.d.
Chernivtsi [UKLN], Ivano-Frankivs'k [UKLI], Luhans'k [UKCW], Mariupol' [UKCM], Mykolaiv [UKON], Rivne [UKLR], Uzhhorod [UKLU], Vinnytsa (Gavryshivka) [UKWW], Poltava [UKHP], Sevastopol' (Bel'bek) [UKFB], Sumy [UKHS]	APV SBAS-VNAV	t.b.d.
Kryvyi Rih (Lozuvatka) [UKDR], KYIV (Antonov-1) [UKKT], KYIV (Antonov-2) [UKKM], Lymans'ke [UKOM], Kirovohrad [UKKG], Kremenchuk (Velyka Kokhnyvka) [UKHK], Kharkiv (Sokolnyky) [UKHD], Zaporizhzhia (Mokraya) [UKDE]	APV Baro-VNAV APV SBAS-VNAV	t.b.d.

* Tentative.

6. Aircraft navigation capability

6.1 General

The PBN strategy and roadmap, which are described in this document, provide Ukraine's State policy on the introduction of ICAO navigation specifications and associated operational procedures in Ukrainian airspace. These navigation specifications and operational procedures will be implemented according to established timelines: RNAV 5, RNAV 1, RNP APCH, and RNP AR APCH. Gradually all conventional non-precision approaches will be replaced by PBN approach procedures with vertical guidance (APV Baro-VNAV and/or APV SBAS-VNAV) with the main objective to further enhance safety during the approach phase of flight and potentially reduce the associated operational landing minima.

According to ICAO regulations (Doc 9613 AN/937 "Performance-based Navigation (PBN) Manual") aircraft and aircrew intending to perform RNAV/RNP operations shall be authorized by the Civil Aviation Authorities of the State of the Operator registry to ensure that they comply with the appropriate navigation performance requirements.

Presently the vast majority of aircraft involved in international air transport to and from Ukrainian airports holds an operational approval for operations according to ICAO specification RNAV 1 (P-RNAV) issued by the national Civil Aviation Authority of the State of Operator registry.

Modern business aviation aircraft are normally able to meet the a certain level of PBN requirements and, as appropriate, should apply for an authorization by their supervising Civil Aviation Authorities to carry out specific PBN operations.

Most aircraft involved in domestic operations in Ukraine and general aviation aircraft are presently not able to meet PBN requirements. It is expected that on the medium to longer term their navigation equipage will gradually increase to the required PBN level. This implies that conventional instrument procedures should remain available at airports serving domestic operations for quite some time.

In accordance with the internationally agreed provisions and common practices in Europe, the SAA should adopt specific requirements in terms of PBN for:

- airworthiness of the on-board RNAV/RNP systems;
- approval of operational procedures;
- aircrew competencies.

Operations in accordance with ICAO specification RNAV 5 (B-RNAV), as currently required for en-route operations in Ukrainian airspace above FL275, are approved by the SAA to the Ukrainian operators using these PBN routes.

According to the PBN strategy and roadmap, Ukraine registered airliners should be able to apply to the SAA for issuing an operational approval to conduct RNAV 1 and RNP APCH operations from 2013 onward, in order to operate in designated Ukrainian TMA's.

Starting from 2014, gradually instrument approaches will be introduced with vertical guidance either by barometric sensor and/or satellite based navigation (APV Baro-VNAV and APV SBAS-VNAV).

The instrument approach procedures based on ICAO specification RNP AR APCH and supported by satellite augmentation (EGNOS) or ground augmentations systems need specific authorization by the SAA. However there is no intention to introduce procedures based on ICAO specification RNP AR APCH at current stage.

GNSS landing systems supported by a ground augmentation system (GBAS) to ICAO Category I, II and III operational minima, are under development and expected to become operational not before 2020.

Roadmap for actions by the State Aviation Administration			
Subject	Action by	Timeline	Remarks
Certification of PBN capability and systems of Ukraine registered aircraft (develop procedures for certification)	SAA/AIR	2013: RNAV 1	- applicant demonstrates PBN compliance; - Approve Developer alteration to the AFM on PBN capability
		2014: APV Baro-RNAV	
		2016: APV SBAS	
Authorization of operators to carry out PBN operations (develop procedures for authorization)	SAA/OPS	2013: RNAV 1 / RNP 1	- operator demonstrates safety of PBN operation; - AOM approval on PBN; - training of aircrew.
		2014: APV Baro-RNAV	
		2016: APV SBAS	
Authorization of training institutes to train and qualify aircrew	SAA/OPS	2013 - 2016	- approval of PBN training programs and authorized instructors.
Safety review and approval of redesigned airspace / routes and instrument flight procedures	SAA/ATM and OPS	2013 - 2020	- safety assessments to be prepared by UkSATSE.
Accreditation procedures for suppliers of aeronautical databases (develop procedures for accreditation)	SAA/OPS	2013 - 2016	- safety to be demonstrated by the supplier.
Ensure quality of published aeronautical information (develop procedures for quality management)	SAA/ATM and OPS	2013 - 2020	- to be demonstrated by UkSATSE.

Current documentation and acceptable means of compliance for airworthiness certification and operational approval:

- ICAO Doc 9613 AN/937 «Performance-based Navigation (PBN) Manual».
- ICAO Doc 8168 OPS/611 «Procedures for Air Navigation Services — Aircraft Operations» vol. 1 «Flight procedures».
- EASA AMC 20 – 4 «Airworthiness Approval and Operational Criteria for the use of Navigation Systems in European airspace designated for Basic RNAV Operations».
- JAA TGL – 10 rev 1 «Airworthiness and Operational Approval for Precision RNAV Operations in Designated European Airspace».
- EUROCAE ED - 76 «Standards for Processing Aeronautical Data».
- EASA AMC 20 - 26 «Airworthiness Approval and Operational Criteria for RNP Authorization Required (RNP AR) Operations».
- EASA AMC 20 - 27 «Airworthiness Approval and Operational Criteria for RNP APPROACH (RNP APCH) Operations Including APV BARO-VNAV Operations».
- EASA AMC 20 – 28 «Airworthiness Approval and Operational Criteria related to Area Navigation for Global Navigation Satellite System approach operation to Localizer Performance with Vertical guidance minima using Satellite Based Augmentation System».

6.2 Airworthiness approval

The airworthiness approval process shall ensure that each element of the RNAV equipment is of a type and design appropriate to its intended function and that the installation functions properly under foreseeable operating conditions including the identification of any operational installation limitations. In

support to the applications for airworthiness approval, the SAA should establish internal procedures to validate:

- the accuracy, integrity, availability and continuity of the integrated on-board navigation system incorporating GNSS and augmentation as appropriate,
- the associated navigation functionalities,
- the essential navigation sensors which are integrated into the integrated onboard navigation system.

Based on information provided by the aircraft and avionics manufacturer the applicant shall demonstrate to the SAA the specific aircraft navigation performance capability during normal and non-normal conditions, including failure conditions and that the RNAV system installed in an aircraft shall be compliant with:

- (1) The basic performance requirements as described in the navigation specification for lateral navigation (LNAV) and (as appropriate) vertical navigation (VNAV):
 - track keeping accuracy and along-track positioning error of the on-board navigation system (95% of the flight time);
 - RNP horizontal / vertical error budget;
 - multi sensor-mixing in calculating the aircraft position (DME, INS etc.).
- (2) Specific functional requirements related to:
 - displays to pilot including / coupling arrangement (FD /AP) / failure scenarios;
 - performance monitoring, MEL, failure annunciation and alerting / contingency after failure;
 - path definition, flight planning, ‘fly-by’ / ‘fly-over’ fixes, flight guidance, leg transition (automatic switching).
- (3) A navigation database and aeronautical data:
 - database integrity;
 - capability to load aeronautical data and procedures from database.

In accordance with the results of the airworthiness validation by the SAA the Aircraft Flight manual shall include a statement which identifies the equipment certificated for PBN operation and a specific statement of navigation capability of the aircraft.

6.3 Operational approval

According to ICAO standards the State of the operator is the authority responsible for approving flight operations. In support to the application by the Operator for operational approval of PBN operations, the SAA should establish procedures to validate the safety of the PBN operations and associated navigation capability being demonstrated by the operator. Navigation specifications, their applicability for each phase of flight and planned timeframes for their introduction are referred in sections 5.1, 5.2 and 5.3. Operational approval procedure must cover following areas:

- (1) Aircraft Operation manual

The operator shall prepare amendments to the Aircraft Operations Manual and checklists to reflect relevant PBN procedure and database checking strategies to be submitted for review by the SAA as part of the approval process. In addition, the operator shall have in place a system for investigation and reporting of events. The Aircraft Operational Manual shall include the following PBN information:

- normal procedures:
 - standard operating procedures (preflight planning, flight operation, post flight procedures);
 - satellite-based stand-alone approaches / overlay approaches / multi-constellation sensor approaches’

- determination of operational minima for PBN approach procedures;
- abnormal procedures:
 - unexpected deviations in lateral / vertical flight path;
 - loss of integrity (RAIM alert signal);
 - total loss or multiple navigation equipment failure;
- limitations:
 - the (Master) Minimum Equipment List (MMEL/MEL) should be amended to identify the minimum equipment necessary to satisfy PBN operations;
 - restrictions on use of GNSS for conventional Non Precision Approaches.

(2) Navigation database

As part of its Safety Management System (SMS) the operator shall establish Navigation database management procedures to ensure:

- up-to-date cycle and timely distribution /insertion in NAV database;
- aeronautical data be provided by a SAA approved provider;
- quality monitoring of aeronautical information products;
- safety assessment by validation of RNP AR APCH operational procedures before flying the procedure in instrument meteorological conditions;
- monitoring and reporting of events.

(3) Qualification and training

Flight crew and ground staff should receive appropriate training-, briefing- and guidance material in order to ensure adequate knowledge of PBN procedures. Standard training and checking, such as recurrent training and proficiency checks, should include detailed information on PBN procedures and capability of the navigation equipment specific aircraft type. The flight crew training program should include:

- PBN operations, display features, controls & symbology, etc.;
- normal and abnormal operating procedures, responses to failure alerts and limitations;
- contingency procedures for loss or degradation of navigation capability;
- MEL requirements supporting PBN operations;
- evaluation of flight crew knowledge of PBN procedures in a SAA approved flight simulator or training flights.

The training program should be submitted to the SAA for review and approval.

6.4 Validation of Instrument flight procedures

Before the newly designed and prepared for publishing instrument procedure will become operational, it is essential that a safety validation program has been conducted by the ANSP to ensure safety of the procedure, the aeronautical data accuracy & integrity and, in some cases, the operational fly-ability of the procedure.

The validation program shall be approved by the SAA and consists of following elements: an independent review of the instrument procedure design and, as required, a simulator validation and/or and flight validation to validate the fly-ability. ICAO Doc 9906 AN/472 “Quality Assurance Manual for Flight Procedure Design” volume 5 “Validation of Instrument Flight Procedures” provides a detailed description of the validation process of new designed instrument flight procedures, including departure, arrival and approach procedures.

The report with results of the validation (as separated document of a part of complete safety assessment) shall be presented to the SAA for review and acceptance.

A flight simulator validation and/or operational flight validation should be performed in the following cases:

- if the fly-ability of a procedure cannot be determined by other means;
- if the procedure contains non-standard design elements (deviations from criteria e.g. non-standard approach angles/gradients, non-standard segment lengths, speeds, bank angles etc.);
- if the accuracy and/or integrity of obstacle and terrain data cannot be determined;
- if new procedures differ significantly from existing procedures.

An approach procedure supported by a satellite augmentation or ground augmentation system (SBAS/GBAS) shall always undergo simulator and flight evaluation to be accomplished by a qualified and experienced Flight Validation Pilot (FVP), certified or approved by the SAA.

7. Action by the Authorities and industry

7.1 Action by Regulators

For a successful implementation of PBN the following actions should be taken by the national regulators:

- 1) *Recognize GNSS as the primary means of navigation for all phases of flight: en-route, arrival/departure, approach and landing.*
- 2) *Provide a legal basis for aircraft airworthiness certification and for an operational approval to operate with ICAO specifications RNAV 5, RNAV 1, A-RNP, RNP APCH and RNP AR APCH.*
- 3) *Support the establishment of a global GBAS channel number allocation mechanism after an evaluation of present and future aircraft GBAS approach capability.*
- 4) *Ensure the quality of integrated aeronautical information package of Ukraine (AIP, NOTAMs), quality of air navigation database, on-board FMS database and implementation of Quality management systems by providers.*

7.2 Actions by SAA

For a successful implementation of PBN the following actions should be taken by the SAA:

- 1) *Designate a PBN focal point in the SAA to coordinate follow-up actions for the PBN implementations.*
- 2) *Establish procedures to be applied by the SAA to recognize the aircraft airworthiness and certificate associated navigation equipment.*
- 3) *Establish procedures to be applied by the SAA to authorize the operators to carry out RNAV 5, RNAV 1, A-RNP, RNP APCH and RNP AR APCH operations.*
- 4) *Designate specific airspace elements/routes and ICAO specifications to be implemented and determine deadlines for these specifications to be mandatory in accordance with EUR Regional Air Navigation Plan (EUR ANP).*
- 5) *Review of the safety case carried out by air navigation service providers of new PBN approach, arrival and departure procedures in accordance with ICAO Doc 9906 AN/472 “Quality Assurance Manual for Flight Procedure Design” volume 5 “Validation of Instrument Flight Procedures”.*
- 6) *Encourage APV implementation by ANSP and aerodrome operators.*
- 7) *Ensure sufficient SAA staff has been trained in PBN Flight Procedure Design validation.*
- 8) *Establish oversight procedures to ensure suppliers of navigation databases are accredited.*

- 9) *Establish oversight procedures to ensure quality of published aeronautical information on behalf of Ukraine.*

7.3 Action by Air Navigation Service Providers

For a successful implementation of PBN the following actions should be taken by air navigation service providers (ANSP):

- 1) *Ensure sufficient staff has successfully completed the basic training for criteria of ICAO Doc 8168 OPS/611 “Procedures for Air Navigation Services — Aircraft Operations” volume 2 “Construction of Visual and Instrument Flight Procedures” and complementary training for criteria of ICAO Doc 9613 AN/937 “Performance-based Navigation (PBN) Manual” on ICAO specifications RNAV 5, RNAV 1, A-RNP, RNP APCH and RNP AR APCH.*
- 2) *Ensure the availability of all coordinate information in WGS-84 datum at all international and domestic aerodromes.*
- 3) *Coordinate activities of the Airspace Design Team in accordance with the principles and timelines of this document and operational need:*
 - *redesign of routes in Ukrainian FIRs based where identified as providing operational benefit and sufficient aircraft PBN equipage;*
 - *redesign of arrival and departure procedures based on the implementation roadmap, which is defined in this document, depending on level of aircraft equipage;*
 - *design of PBN approach procedures according to the implementation roadmap, which is defined in this document.*
- 4) *Install sufficient DME navigation aids to ensure required navigation performance in TMA’s and en-route to support operations with defined ICAO specifications, in particular outside GNSS coverage.*
- 5) *Establish quality assurance process for designed flight procedures (en-route, TMA and approach) according to ICAO Doc 9906 volume 5 “Validation of Instrument Flight Procedures”.*
- 6) *Publish in AIPs newly designed routes and procedures and all relevant coordinate information in WGS-84 datum and ensure they meet the quality requirements set out in ICAO Annex 15.*
- 7) *Adapt ATS automated systems to ensure the availability of information regarding aircraft PBN equipage for display to relevant ATCo positions.*

7.4 Action by the aircraft operators

For a successful implementation of PBN the following actions should be taken by aircraft operators:

- 8) **Airworthiness Certification.** *The operator shall submit a compliance statement to SAA that shows evidences that appropriate navigation features, functionality, performance and integrity criteria have been satisfied, in particular:*
 - *equipment qualification;*
 - *system safety analysis;*
 - *software assurance level;*
 - *performance Analyses;*
 - *system failure/contingency procedures;*
 - *human interface usability;*
 - *data on navigation system and Autopilot/Flight Director coupling;*
 - *execution of leg types that can be performed by onboard system.*

9) **Operational approval**

- *valid certificate of airworthiness is a prerequisite for operational approval.*
- *list of normal and contingency procedures for a particular navigation equipment to be included in the Aircraft Operations Manual (AOM) documentation, evidences for appropriate training of crews and ground staff, the content of data quality assurance procedure, the description of the system for investigating events affecting the safety of operations in order to determine their origin are to be presented to the SAA to confirm the adequacy of actions taken by an aircraft operator to be granted with operational approval.*
- *operational approval by the SAA shall be stated in the applicable Air Operator Certificate, or issued in accordance with established procedures, as appropriate.*

10) **Crew training.** Operators shall provide for a crew training program, containing:

- *pre-flight planning and database checks;*
- *departure and arrival procedures, flight progress monitoring;*
- *contingency procedures and incident reporting system;*
- *contents of training manuals.*

11) **Navigation database.** The navigation database should be obtained from an approved by SAA supplier complied with EUROCAE/RTCA standard ED-76/DO-200A, “Standards for Processing Aeronautical Data”.

7.5 Actions by the PBN Taskforce

For a successful implementation of PBN the following actions should be taken by the PBN Taskforce:

1) **Coordinate PBN Implementation Roadmap realization and planning:**

- *prepare and submit to SAA for approval a PBN Strategic implementation Plan and appropriate roadmap in cooperation with representatives of civil and military authorities, ANSP's, Airlines, Aerodrome operators and other parties concerned.*

2) **Coordinate the development of PBN Implementation Roadmap with other strategic projects:**

- *WGS-84 implementation for all relevant coordinate information (navigation aids, all international and domestic aerodromes) and data published in the Ukraine AIP;*
- *legislation and regulation improvement (including scope of amendments required, publication alternatives, approval processes and timelines);*
- *The introduction of new standards and procedures including certification of ANSPs, Aircraft Operators, airworthiness certification and operational approval processes;*
- *Global Navigation Satellite Systems (GNSS) recognition to be the primary source of navigation signals;*
- *PBN training addressing ATS, pre-flight and in-flight procedures, airworthiness and operational approval requirements.*

3) **Determine current status and perform gap analyses for:**

- *WGS-84 datum used in airspace designing and charting;*
- *Electronic Terrain and Obstacle Data (e-TOD) to be implemented;*
- *aircraft operators' equipage and current PBN approvals for ICAO specifications RNAV 5 and RNAV 1;*
- *aircraft fleet navigation capacity operating in the airports/airspace planned for PBN implementation.*
- *Current legislation and regulations that support PBN implementation.*
- *Existing PBN implementation in the ATM automated systems, if any, including flight plan provisions.*
- *Training level status for ATCos, instrument flight procedure designers, pilots, engineers.*

- *PBN flight procedure design capabilities (designer competencies, capacities, tools and data).*
- 4) **Reporting.** *Establish initial target time frames for PBN implementation(s) and provide periodic progress reports to management of participating organizations:*
 - *quarterly;*
 - *annual.*

8. Action plan for authorities and stakeholders

The following Action plan identifies timelines for actions to be taken by appropriate authorities and aviation organizations to support the transition towards PBN in Ukrainian airspace.

The PBN implementation will affect the following organizations:

- *national regulator: Ministry of Infrastructure (MoI);*
- *aviation authority: State Aviation Administration of Ukraine (SAA);*
- *Air Navigation Service providers: Ukrainian State Air Traffic Service Enterprise (UkSATSE);*
- *Aeronautical Information Service: Aeronautical Information Service, UkSATSE (AIS);*
- *aircraft operators: airlines, state aircraft, business/corporate aviation, general aviation;*
- *airport operators: international and domestic aerodrome administrations;*
- *training organizations: Training and Certification Centre of UkSATSE (TCC), National Aviation University;*
- *international bodies;*
- *manufactures of Aircraft and suppliers of on-board equipment and aeronautical database suppliers.*

The implementation of PBN, being the main technology enablers in future ATM, shall impact the airspace concept in Ukrainian FIRs considerably. The PBN Taskforce, in cooperation with the aviation stakeholders, shall develop an airspace concept to accommodate transit traffic growth and continuously increasing number of flights to/from international and domestic airports up to 2025 by optimized use of PBN and simplified route system. In further perspective operational needs will dictate introduction of 4-D business trajectories and Continuous Climb/Descent Operations (CCO/CDO).

Action plan for authorities and stakeholders for implementation of PBN					
Prime actor	Cooperating actor	Subject	Start	Ready	Remarks
National regulator					
MoI	SAA, UkSATSE, A/c operators	Recognize GNSS as a primary mean of navigation.	2013	2014*	- usage of GPS for all phases of a flight; - propagation of EGNOS signal coverage to the airspace of Ukraine.
MoI	SAA, A/c operators	Establish a legal basis and procedures to apply for airworthiness certification and operational approval for PBN operations.	2013	2014*	- aircraft navigation equipment / operational procedures. Link to EASA documents.
MoI	SAA, A/c operators, UkSATSE	Establish requirements for qualification of aircrew and ATCO's.	2013	2014*	- link to EASA documents.

Implementation of Performance Based Navigation (PBN)
Ukraine strategy and roadmap 2013 – 2025

MoI	SAA, Ministry of Ecology and natural resources of Ukraine	Determine environmental impact of PBN implementation.	2014	2016*	
Aviation authority					
SAA/ATM	UkSATSE A/c operators	Determine the scope for PBN implementation: airspace/ routes, ICAO specifications, required navigation infrastructure.	2013	2020+	- design of airspace concept in accordance with the global policy of ICAO and the roadmap presented in this document; - permanent task.
SAA/ATM	UkSATSE	Safety review and approval of redesigned airspace / PBN routes and terminal procedures.	2013	2020+	- permanent task.
SAA/AIR	A/c operators, A/c manufacturers Equipment Suppliers	Procedures to certify a/c airworthiness & equipment.	2013	2014*	- JAA Temporary Leaflet 10 /TGL-10; - appropriate EASA AMC.
SAA/OPS	Operators	Procedures to issue operational approval to carry out PBN operations.	2013	2014*	- JAA Temporary Leaflet 10 /TGL-10; - appropriate EASA AMC.
SAA/OPS	A/c operators, Training institutes	Procedures to qualify aircrew.	2013	2020+	- depends of designed ICAO specification; - permanent task.
SAA/OPS	Database suppliers, A/c operators	Procedures for accreditation of suppliers of NAV databases.	2013	2014*	- check present procedures to ICAO SARPS.
SAA/ATM	AIS, UkSATSE	Procedures to ensure quality of published navigation data.	2013	2014*	- check present procedures to ICAO SARPS.
Air Navigation Service Providers					
UkSATSE	PBN Taskforce SAA	Submit proposals for development of PBN implementation roadmap.	2013	2020+	- permanent task; - link to European PBN implementation concept.
UkSATSE	PBN Taskforce, SAA, EUROCONTROL, EC Twinning project	Develop an Air space concept for PBN: En-route, TMA and Approach procedures.	2012	2020+	- permanent task on case by case basis; - based on Europe's high level Airspace concept; - to be approved by SAA.
UkSATSE	PBN Taskforce, SAA.	Monitor quality of GNSS signals in Ukrainian airspace to be compliant with ICAO requirement.	2013	2016*	- support by EUROCONTROL and National Space Agency. should be considered.
UkSATSE	SAA	Carry out a safety assessments and submit their results to SAA.	2013	2020+	- permanent task; - airspace modelling / design tools, Fast-time simulation, Real-time simulation, Flight trial could be used to accomplish this task.

Implementation of Performance Based Navigation (PBN)
Ukraine strategy and roadmap 2013 – 2025

UkSATSE	SAA	Preparation and publication amendments to aeronautical documents (AIP).	2013	2020+	- permanent task.
UkSATSE	TCC, SAA	Training of ATCo's.	2013	2020+	- permanent task.
<i>Aircraft Operators</i>					
A/c Operator	SAA/AIR	Prepare an application and supported documents for Airworthiness certification PBN.	2013	2016*	
A/c Operator	SAA/OPS	Prepare an application and supported documents for Operational approval.	2013	2016*	- supported documents should include evidence for a navigation database supplier accreditation.
A/c Operator	SAA/FCL	Training of aircrew.	2013	2020+	- permanent task.
<i>Airport operators</i>					
International aerodromes	A/c operators	Aerodrome Strategic planning shall include PBN operations.	2013	2020+	

**Note: to be discussed by the Ukraine PBN taskforce and agreed by Aviation Authorities.*

Abbreviations

4D	Four dimensions (lateral, longitudinal, vertical and time)
ACC	Area Control Center
AFIZ	Aerodrome Flight Information Zone
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AIS	Aeronautical Information Service
ANSP	Air Navigation Service Provider
AP	Auto Pilot
APP	Approach Control Unit
APV	Approach Procedure with Vertical guidance
APV SBAS	PBN approach procedures with vertical guidance
A-RNP	Advanced RNP
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air traffic management
ATS	Air traffic services
B-RNAV	Basic RNAV (RNAV-5)
Baro-VNAV	Barometrical Vertical Navigation
CDO	Continuous Descent Operations
CNS	Communication, Navigation, Surveillance
DFL	Division Flight Level
DH	Decision Height
DME	Distance Measuring Equipment
EASA	European Aviation Safety Agency
ECAC	European Civil Aviation Conference
EGNOS	European Geostationary Navigation Overlay Service
ETA	Estimated Time of Arrival
EUR ANP	European Air Navigation Plan
e-TOD	Electronic Terrain and Obstacle Data
FD	Flight Director
FIR	Flight Information region
FL	Flight Level
FMS	Flight Management Systems
FOSA	Functional operational Safety assessment
FRA	Free route airspace
GALILEO	European satellite based radio navigation system
GBAS	Ground-based Augmentation System
GEO	Geostationary Orbit
GLS	GBAS Landing System
GLONASS	Global Navigation Satellite System (Russia)
GNSS	Global Navigation Satellite System (GPS, GLONASS, GALILEO)
GPS	US Global Positioning System
IAF	Initial Approach fix
ICAO	International Civil Aviation Organization
ILS	Instrument landing system
INS	Inertial-navigation system
JAA	Joint Aviation Authorities
LNAV	Lateral Navigation
LCIP	Local Convergence and Implementation Plan
LSSIP	Local Single Sky ImPlementation
LT	Long Term
LVP	Lateral precision with Vertical guidance (APV SBAS I/II)
MEL	Minimum Equipment List

MMEL	Master Minimum Equipment List
MT	Medium Term
NAV03	Implementation of Precision Area Navigation RNAV (P-RNAV)
NAV10	Implement Approach Procedures with Vertical Guidance (APV)
NDB	Non-Directional Beacon
Next Gen	Next Generation Air Transportation System
NOTAM	Notice to airman
NPA	Non-Precision Approach
NSA	National Supervisory Authority
OPS	Operations
PA	Precision Approach
PANS-OPS	Procedures for air navigation services – aircraft operations (ICAO)
PBN	Performance Based Navigation
P-RNAV	Precision RNAV (RNAV-1)
RNAV	Area navigation
RIMS	Ranging and Integrity Monitor Stations
RNP	Required Navigation Performance
RNP APCH	RNP Approach
RNP AR	RNP Approach which require authorisation
RVSM	Reduced Vertical Separation Minima
SAA	State Aviation Administration
SBAS	Satellite-based Augmentation System
SES	Single European Sky programme
SESAR	Single European Sky ATM Research programme
SID	Standard Instrument Departure
SIS	Signal in Space
SMS	Safety Management System
ST	Short term
STAR	Standard Arrival Route
TMA	Terminal Manoeuvring control Area
UIR	Upper Flight Information Region
VHF	Very high frequency
VNAV	Vertical Navigation
VOR	Very High Frequency Omnidirectional Radio Range
WGS	World Geodetic System

General principles for implementation of PBN in Ukraine

The ICAO Global ATM operational concept provided the basis for the introduction of PBN and outlines the technical recommendations regarding harmonized transition towards satellite navigation, curved RNAV approaches and implementation of approaches with vertical guidance to replace non-precision approaches. The SESAR ATM research program was developed based on the ICAO Global ATM Concept.

It is the ultimate goal to allocate to each flight in the ECAC airspace a 4D Business Trajectory which is defined by position and time. In parallel, the EUROCONTROL Navigation Strategy calls for GNSS as the primary positioning sensor and ultimately as the sole positioning sensor.

Taking into account these international policies, the PBN implementation in Ukraine will be based on the following basic principles:

- *in high traffic areas the PBN will allow for smaller lateral separation;*
- *during transition to PBN, sufficient ground infrastructure for conventional navigation systems must remain available;*
- *users should be given reasonable transition time to allow them to equip appropriately to attain appropriate PBN-based navigation performance;*
- *grant benefits to aircraft certified to perform PBN operations in accordance with Operational concept if proved to be feasible (following to the principle "best equipped - best served");*
- *the transition phase from conventional to PBN based operations should accommodate mixed-aircraft equipage in a PBN and non-PBN environment;*
- *conventional non-precision approaches (VOR and NDB) will be withdrawn from 2015 to 2025 dependent on fleet capability;*
- *coordination with the neighboring states on PBN implementation planning;*
- *avoiding equipage of multiple on-board or ground based equipment, avoidance of multiple airworthiness and operational approvals;*
- *DME is expected to remain in the long term to provide backup for PBN operations in the event of loss of GNSS through jamming or other disruption;*
- *implementation of (augmented) GNSS CAT I approaches on the short term and CAT II/III in the medium term on a restricted bases for suitably equipped aircraft, based on a Cost Benefit Analysis;*
- *ILS will remain a back-up to cater for loss of GNSS;*
- *when a multi-GNSS constellation (e.g. GPS & Galileo) is fully operational and aircraft fleet readiness reaches a particular level, then sole GNSS operations without a corresponding DME/DME infrastructure becomes possible (2020+);*
- *specific arrangements should be considered to accommodate State aircraft to operate as General Air Traffic.*