KENYA CIVIL AVIATION AUTHORITY (KCAA)

PERFORMANCE BASED NAVIGATION (PBN) IMPLEMENTATION PLAN

KENYA

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LIST OF AMENDMENTS

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EXECUTIVE SUMMARY

The ICAO 37th General Assembly agreed on Resolution A37-11 with the requirement that Member States submit national PBN implementation plan. Kenya has set its strategic objectives in the PBN implementation in accordance with the ICAO's Global Air Navigation Plan (GANP), the Aviation System Block Upgrades (ASBUs), AFI Planning and Implementation Regional Group (APIRG) resolutions, AFI Procedures handbook, AFI Air Navigation Plan, Kenya ANS Master plan 2015-2030 and the KCAA strategic plan.

This PBN implementation plan for Kenya has been developed with the participation of the Air Navigation Service Provider (ANSP), airline operators and other major stakeholders. The PBN Implementation Plan shall provide guidance to air navigation service providers, airline operators and airspace users. It will assist the main stakeholders of the aviation community to plan the transition and their investment strategies.

The strategic objectives of the plan include: To ensure that the implementation of the Communication Navigation Surveillance/ Air Traffic Management (CNS/ATM) system are based on clearly established operational requirements; To avoid unnecessarily imposing mandate for multiple equipment on board or multiple systems on ground; To address current and forecast airspace capacity and operational in efficiency issues through application of the ICAO PBN concept; and To utilize PBN to reduce environmental impact from aviation through moreefficient operations that result in less fuel burn and noise emissions.

This Kenya PBN Implementation Plan undertook assessment of fleet equipage and CNS/ATM infrastructure within Nairobi Flight Information Region (FIR), which resulted in selection of appropriate PBN navigation specifications, infrastructure, and implementation strategies for En-route oceanic, continental and Terminal Area operations applications. It also explains some tangible operational benefits, derived from actual PBN implementation.

The phased approach implementation of the PBN plan in Nairobi FIR at the end state will lead to the following: in the Oceanic, RNP4 PBN Specifications implemented; Continental RNAV5/2, RNP2; Terminal RNAV1, RNP1; and RNP approaches. The ICAO objective of A37-11, envisages improvements in safety, efficiency and capacity while realizing environmental benefits from reduced fuel burn and noise emissions through optimised flight trajectories will be achieved.

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GLOSSARY OF DEFINITIONS/ACRONYMS/ABBREVIATIONS

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

Term	Definition
ANSP	Air Navigation Service Provider
APCH	Approach
ATM	Air Traffic Management
A-SBAS	Africa-Satellite Based Augmentation System
CCO	Continuous Climb Operations
CDO	Continuous Descent Operations
CNS	Communication, Navigation, Surveillance
GANP	Global Air Navigation Plan
GASP	Global Air Safety Plan
ICAO	International Civil Aviation Organization
NAVAID	Navigation Aid
PBN	Performance-based navigation
RNAV	Area Navigation
RNP	Required Navigation Performance
SARPs	Standards and Recommended Practices
SBAS	Satellite Based Augmentation System

SID	Standard Instrument Departure
STAR	Standard Terminal Arrival

CHAPTER 1-OVERVIEW OF PBN PLAN

1.1. BACKGROUND

1.1.1 ICAO Assembly Resolution A37-11 calls for each State to develop a national Performance Based Navigation (PBN) implementation plan by 2009, Kenya developed the initial plan which was first revised in 2012 and subsequently reviewed in 2020. The 2020 plan is hereby being amended to incorporate the Global Air Navigation Plan (GANP), AFI Planning and Implementation Regional Group (APIRG) resolutions, AFI Procedures handbook, AFI Air Navigation Plan, Kenya Airspace Master plan 2015-2030 and the KCAA strategic plan.

1.1.2 The Performance Based Navigation (PBN) plan details the framework within which the ICAO PBN concept continue to be implemented in the State in the foreseeable future. The PBN plan is guided by ICAO Doc 9613, relevant SARPs and the AFI Regional PBN Roadmap. The primary driver for this plan is to maintain and increase safety, air traffic demand capacity, services and technology in consultation with the relevant stakeholders. The PBN plan supports national and international interoperability and global harmonization of procedures.

1.1.3 The plan highlights achievements during the two terms and focusses on the integration of relevant elements of the Aviation System Block Upgrades (ASBU) into the national PBN implementation plan. The plan captures the organizations strategy for continued development of PBN infrastructure through implementation of airspace planning and procedure design units, building capacity through training and playing a key role as a member of the African Flight Procedure Program.

1.1.4 Additionally, the airspace concept is defined, and sets out the specific requirements for navigation applications, specifications and infrastructure applicable in respective phases of flights. This is to ensure that both flight crew and ATC are aware of the requisite on- board area navigation (RNAV) system capabilities, performance and infrastructure applicable to the defined

airspace concept; and, to enable the Flight Operations and Airworthiness units to develop the accompanying Operations approval requirements.

1.2. PURPOSE OF THE PLAN

1.2.1 The National PBN Implementation Plan (NPIP) is intended to assist the main stakeholders of the aviation community plan future transition and their investment strategies. This is to help airlines and operators have a clear roadmap to plan for future equipage and additional navigation capability investments. The Air Navigation Service Provider can plan for continued maintenance of transition evolving from ground infrastructure to space based. The regulating agency will be able to anticipate and plan for criteria that will be needed in the future as well as regulatory framework.

1.2.2 This PBN implementation plan is developed in consultation with the aviation community in Kenya and all stakeholders concerned. It is intended to assist the main stakeholders of the aviation community to plan for transition to the PBN concepts. These stakeholders include but not limited to:

a) The Air Navigation Service Provider
b) The Kenya Civil Aviation Authority
c) Air Operators
d) Airspace users
e) The Military

1.2.3 The revised PBN Implementation Plan is intended to support aviation stakeholders in continuing the progressive evolution and optimization of Performance-Based Navigation (PBN), in alignment with the Global Air Navigation Plan (GANP) and their long-term investment strategies.

The airlines and service operators can use the plan/roadmap to guide ongoing and future equipage enhancements, ensuring alignment with advancing PBN requirements and operational benefits. Air Navigation Service Provider (ANSP) can leverage the plan to build on existing near- and mid-term PBN infrastructure, facilitating a structured progression toward long-term performance objectives and increased reliance on satellite-based navigation.

Regulatory agencies will be better positioned to anticipate and plan for emerging criteria, including updated technical guidance, oversight responsibilities, and the associated workforce training and capacity requirements necessary to sustain and enhance PBN operations.

1.3. GUIDING PRINCIPLES

1.3.1 The guiding principle for this Plan is based on the need to ensure:

a) The continued application of conventional air navigation procedures during the transition period in order to guarantee the availability of air navigation services to users that are not RNAV and/or RNP equipped.
b) The development of airspace concepts, which identify the navigation applications, specification and the infrastructure applicable in the given airspace concept.
c) That cost benefit analysis is conducted to justify the implementation of the RNAV and /or RNP concept in a particular airspace.
d) The conduction of a pre- and post-implementation safety assessment to ensure the application and maintenance of the established target levels of safety.
e) That the Plan does not conflict with the regional PBN implementation plan and the global Plan.
f) Avoidance of unnecessary imposition of the mandate for multiple equipment on board or multiple systems on the ground.
g) Avoidance of the need for multiple airworthiness and operational approvals for intra- and inter-regional operations.

1.4 STRATEGIC OBJECTIVES

1.4.1 The strategic objectives of the reviewed plan are to:

a) achieve a total performance-based area navigation environment as defined by ICAO PBN Concept guidance;

b) address current and forecast airspace capacity and operational efficiency issues through application of the ICAO PBN concept;
c) maximize the use of current and emerging navigation (GBAS and SBAS), air traffic management and aircraft avionics systems;
d) utilize PBN to reduce environmental impact from aviation through more efficient operations that result in a less fuel burn and noise emissions; and
e) achieve efficiency and capacity in the implementation of PBN routes, SIDs, STARs and Instrument Approach Procedures (IAPs) in en-route and terminal airspace redesign.

1.5. ASSUMPTIONS

1.5.1 In the development, implementation and post implementation of this PBN Plan, the following assumptions were adopted:

a) the aircraft fleet capability data is accurate representation of the capability within Nairobi FIR.
b) the AFI PBN Road map as adopted by this NPIP remains as it is.
c) aircraft PBN capability within Nairobi FIR will continue to increase.
d) the Implementation of PBN plan will improve the airspace capacity and efficiency.
e) the main Navigation Aid and Infrastructure will be GNSS equipment.
f) implementation of PBN Plan will accrue environmental and economic benefits.
g) the existing and emerging technologies of CNS/ATM system will be adequate for achievement of end state of this plan.

CHAPTER 2-PERFORMANCE BASED NAVIGATION (PBN) OVERVIEW

2.1. PBN CONCEPT

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

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

2.1.3 For Kenya, the application of the PBN concept is important mainly for safety where the RNP Approach procedures with Baro-VNAV for the vertical guidance have been adopted in terminal approach operations at all the international airports. This safeguards against safety and reduces cases of Controlled Flight into Terrain (CFIT). The use of PBN Standard Instrument Departures (SIDs) and Standard Arrival Routes (STARs) within the TMAs of Kenya will increase flight efficiency, capacity, while addressing the environmental emission concerns, and creating redundancy to the conventional flight procedures.

2.1.4 The adoption of the PBN routes for en-route application in Kenya, including unidirectional parallel routes between city pairs underscores crosscutting benefits from safety, capacity, efficiency, environmental protection as well economic benefits to the airlines.

2.1.5 Additionally, the implementation of Free Route Airspace (FRA) in Kenya, within the Nairobi FIR upper airspace, is firmly anchored in the principles and operational applications of Performance-Based Navigation (PBN). The evolution

from controller-initiated tactical directs and flight-plannable directs, through User Preferred Routing (UPR) trials, has culminated in the full operationalization of FRA.

FRA operations now enable airspace users to plan and operate user-preferred trajectories within defined airspace limits, thereby enhancing efficiency, flexibility, and flight predictability, while maximizing the benefits derived from established PBN capabilities.

2.2. PBN APPROACHES WITH AND WITHOUT VERTICAL GUIDANCE

2.2.1 PBN enables the implementation of instrument approach procedures with vertical guidance (APV) to all runway ends, resulting in a significant improvement in safety. This allows for the progressive elimination of non-precision "dive-and-drive" approaches that lack vertical guidance. Studies have shown that approach procedures with vertical guidance are approximately 25% safer than those without. In addition, PBN supports the design and implementation of APV procedures at runways that currently lack approach capabilities, thereby enhancing airport accessibility and improving overall efficiency of flight operations.

2.2.2 Therefore, Kenya accords high priority to the design and implementation of PBN approach procedures with vertical guidance, in accordance with Assembly Resolution A37-11, with the aim of enhancing both safety and operational efficiency.

2.3. CURRENT STATUS OF PBN IMPLEMENTATION

Kenya has implemented PBN procedures at all major airports and terminal areas in the country. At the enroute level, both the enroute oceanic and enroute continental airspaces are served by the RNP and RNAV routes. The details of the PBN implementation status are provided for respective areas of PBN applications.

2.3.1 Oceanic and Continental En Route

The oceanic airspace of the Nairobi FIR is served by RNP 10 routes and has been integrated into the Free Route Airspace (FRA) concept. A portion of this airspace is designated as User Preferred Route (UPR) airspace, enabling airline operators to utilize direct routing, thereby improving fuel efficiency and contributing to a reduction in aviation carbon emissions.

Within the continental airspace, Kenya has transitioned from User Preferred Route (UPR) trials to the implementation of Free Route Airspace (FRA) based on RNAV 5 specifications. This allows airspace users to plan and operate user-preferred trajectories within defined airspace limits, enhancing operational flexibility, efficiency, and predictability, while supporting the regional vision of cross-border FRA.

The continental airspace of the Nairobi FIR continues to be supported by RNAV 5 route structures for the regional network and RNAV 2 routes for domestic operations. To further enhance safety and efficiency, Kenya has established city-pair, parallel, unidirectional routes, including RNAV 5 between Nairobi and Entebbe, and RNAV 2 between Nairobi and Mombasa, as well as Nairobi and Wajir.

Table 1: PBN Implementation Status in the Enroute

Enroute Applications		
Navigation Specifications	**Enroute Oceanic**	**Enroute Continental**
RNAV10/RNP10	Achieved ✓	N/A
RNP4	To be implemented	N/A
RNAV5	N/A	Achieved ✓
RNAV2	N/A	Achieved ✓
RNP2	To be implemented	N/A

Future plans include the implementation of RNP 4 and RNP 2 operations within the oceanic airspace to enhance efficiency and optimize separation standards. However, in the continental airspace, the availability of adequate surveillance coverage negates the need for RNP 2 route implementation, and such operations are therefore not planned for Kenya.

2.3.2 Terminal Areas (SIDs and STARs)

The two terminal areas (TMAs) in the Nairobi FIR with surveillance services-Nairobi and Mombasa TMAs cover HKJK, HKNW, HKMO, and HKML airports and are served by RNAV 1 SIDs and STARs. Eldoret and Wajir TMAs, operating under procedural control and covering HKEL, HKKI, and HKWJ airports, currently use RNP 1 SIDs and STARs due to limited surveillance.

Kenya is restructuring its terminal airspace by transitioning STARs to Continuous Descent Operations (CDOs) and SIDs to Continuous Climb Operations (CCOs). Selected STARs and SIDs at HKMO airport have already been redesigned as CDO STARs and CCO SIDs to enhance traffic deconfliction and operational efficiency.

In the Nairobi TMA, which hosts HKJK, the country's largest international airport and HKNW, one of the region's busiest general aviation airports, PBN STARs and SIDs are being redesigned to incorporate CDOs and CCOs. The successful implementation of strategically deconflicted STARs and SIDs across all TMAs in the Nairobi FIR will enhance safety, increase capacity, improve operational efficiency, and contribute to reduced fuel burn, lower CO_2 emissions, and decreased aircraft noise.

As a precursor to the planned integration of the TMAs with the FRA in the Nairobi FIR upper airspace, the redesign of Entry and Exit waypoints at the TMA boundaries is underway. This will enable seamless transitions between CCO SIDs and CDO STARs and the FRA airspace, ensuring operational continuity and efficiency.

Table 2: PBN Implementation Status in the Terminal Areas

Terminal Applications		
Navigation Specification / TMAs & Airports	RNAV1	RNP1
Nairobi TMA (HKJK, HKNW)	Achieved ✓	N/A
Mombasa TMA (HKMO, HKML)	Achieved ✓	N/A
Eldoret TMA (HKEL, HKKI)	N/A	Achieved ✓
Wajir TMA (HKWJ)	N/A	Achieved ✓

The Eldoret TMA is in the final stages of conversion to full surveillance, upon which RNP 1 procedure serving Kisumu (HKKI) and Eldoret (HKEL) will be upgraded to RNAV 1 specifications in line with the KCAA strategic plan.

2.3.3 Approach

All instrument runways in Kenya are served by RNP approach procedures with Baro-VNAV vertical guidance (APV), including LNAV/VNAV minima expressed as Decision Altitude/Height (DA/H). At other unmanned airstrips where altimeter settings (QNH) are not available, non-precision approaches (NPAs) with LNAV Minimum Descent Altitude/Height (MDA/H) are provided. Additionally, RNAV transitions to ILS approaches are implemented at HKJK and HKMO, enhancing access and operational flexibility.

2.3.4 Helicopter Operations

Kenya has experienced an increase in helicopter operations, predominantly conducted under VFR in Class G airspace. Within the busy Nairobi control zone comprising Class C and D airspace sectors, visual helicopter routes have been established for operations in and out of HKJK and HKNW airports, using visual reference points supplemented by GNSS waypoints to enhance safety and traffic management.

The implementation of IFR PBN helicopter routes will be undertaken on need basis, particularly where enhanced obstacle clearance criteria is required, such as for access to hospitals in congested areas of the CBD.

2.3.5 Military Operations

Outside military Special Use Airspaces (SUAs), military aircraft operate alongside civilian traffic. In such areas, general PBN operational requirements apply to military aircraft when operating within civilian airspace.

2.4. AIRCRAFT FLEET CAPABILITIES

2.4.1 The percentage of aircraft with PBN capability equipage flying within and over the Nairobi Flight information Region (FIR) was determined through a survey of flight plans filed for Instrument Flight Rule (IFR) operations.

2.4.2 The revised fleet equipage as per 2022-2025 survey on PBN is as follows:

Table 3: PBN Equipped Aircraft - All Traffic (Kenyan Registered & Non-Kenyan Registered)

State - ANSP: Kenya – Kenya Civil Aviation Authority's Air Navigation Services FIR: HKNA (Nairobi FIR)		
Percentage of Registered Fleet equipped with PBN	51%	All Kenya registered aircraft from January 2022 to December 2025.
Percentage of Fleet flying the airspace, equipped with PBN	69%	All traffic from January 2022 to December 2025.

Table 4: PBN Equipped Aircraft - All Traffic except General Aviation and Military

State - ANSP: Kenya – Kenya Civil Aviation Authority's Air Navigation Services FIR: HKNA (Nairobi FIR)		
Percentage of Registered Fleet equipped with PBN	71%	Kenya registered aircraft – **excluding general aviation and Military – from January 2022 to December 2025**.
Percentage of Fleet flying the airspace, equipped with PBN	83%	All aircraft – **excluding general aviation and Military – from January 2022 to December 2025.**

Table 5: PBN equipped aircraft-General Aviation Traffic

State - ANSP: Kenya – Kenya Civil Aviation Authority's Air Navigation Services FIR: HKNA (Nairobi FIR)		
Percentage of Registered Fleet equipped with PBN	7%	Kenya registered – **general aviation aircraft – from January 2022 to December 2025.**
Percentage of Fleet flying the airspace, equipped with PBN	11%	**All general aviation aircraft from January 2022 to December 2025.**

2.4.3 According to the 2019 aircraft fleet assessment, the number of PBN-equipped aircraft operating within the Nairobi FIR has steadily increased. As of the December 2025 fleet capability survey, 83% of aircraft flying in the Nairobi FIR are PBN-equipped, while the remaining 17% consist primarily of general aviation and military aircraft (see Table 2). The proportion of PBN-equipped aircraft is expected to continue rising in the coming years.

2.5. CNS/ATM CAPABILITIES

2.5.1. Kenya's PBN implementation is primarily enabled by Global Navigation Satellite System (GNSS) infrastructure within the ICAO CNS/ATM framework, providing the core navigation capability for en-route (oceanic and continental) and terminal operations. GNSS supports RNP approach procedures, including approaches with vertical guidance (APV) based on Baro-VNAV.

This navigation capability is integrated with Communication, Navigation and Surveillance/Air Traffic Management (CNS/ATM) systems to ensure the safe, efficient, and seamless provision of air navigation services.

2.5.2. To enhance the provision of precision approach capabilities based on GNSS infrastructure, the State is participating in the Africa Satellite-Based Augmentation System (A-SBAS) project, which is assessing the feasibility and implementation of SBAS services within the AFI region.

Upon the operationalization of the A-SBAS service area, Kenya will, in addition to existing RNP approach procedures, implement SBAS-based instrument approach procedures with performance comparable to ILS Category I precision approaches.

2.5.3. As part of enhancing Position, Navigation and Timing (PNT) resilience, Kenya is considering the implementation of DME/DME-based RNAV navigation infrastructure as a complementary and contingency capability to mitigate potential GNSS signal outages for en-route continental and terminal operations. The existing DME infrastructure does not currently meet the constellation and geometry requirements necessary to support DME/DME RNAV operations.

2.5.4. The State intends to undertake a detailed assessment to determine the required DME/DME network geometry to provide adequate coverage across the continental airspace and meet RNAV operational performance requirements. The implementation of DME/DME RNAV procedures will be based on a cost–benefit analysis, in line with ICAO guidance on resilient PNT service provision.

In addition, Kenya will maintain a minimum VOR network as part of the conventional navigation infrastructure to support contingency operations, including RNAV 5 positioning in combination with onboard inertial navigation systems (INS), thereby further strengthening overall PNT resilience.

2.5.5. The ATM surveillance and communication infrastructure supporting operations within the Nairobi FIR includes:

a) Secondary Surveillance Radar (SSR) providing surveillance coverage for continental and terminal airspace.
b) Primary Surveillance Radar (PSR) supporting surveillance within terminal airspace.
c) Very High Frequency (VHF) voice communication systems for air–ground communications.
d) Automatic Dependent Surveillance – Broadcast (ADS-B) providing surveillance coverage in continental airspace; and
e) Automatic Dependent Surveillance – Contract (ADS-C) and Controller–Pilot Data Link Communications (CPDLC) supporting operations in oceanic and continental airspace.

2.6. PBN BENEFITS AND GLOBAL HARMONIZATION

2.6.1 PBN offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria such as:

a) It reduces the need to maintain sensor-specific routes and procedures and the associated costs (e.g. VOR, NDB, DME);
b) Enhances safety by allowing for straight-in approach procedures with vertical guidance as a primary approach or back up to existing precision approach procedures;
c) Improves airport accessibility under all weather conditions;
d) Allows for more efficient use of airspace, thus increasing capacity;
e) Improves operational efficiency through user preferred routings, reduced delays and holds, and enables continuous descent and continuous climb operations;
f) Lessens the environmental impact by contributing to reduced aircraft fuel burn and noise emissions
g) Facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global application.

2.6.2 For Kenya, the primary focus is on utilizing RNAV and RNP specifications to enable more efficient airspace and procedure design, resulting in enhanced safety, access, capacity, predictability, operational efficiency, and environmental benefits, including noise mitigation. Specifically, RNAV and RNP flight procedures will:

a. Enhance safety through three-dimensional (3D) approach operations with precise course guidance to the runway, thereby reducing the risk of controlled flight into terrain (CFIT);
b. Improve airport and airspace accessibility under reduced visibility and adverse weather conditions, while providing the capability to address environmental and obstacle clearance constraints.

2.6.3 Enhance reliability and reduce delays by defining more precise terminal area procedures that feature parallel routes and environmentally optimized airspace corridors. Flight management systems can then utilize these procedures to reduce flight distances, resulting in time savings, lower fuel consumption, and reduced CO_2 emissions

CHAPTER 3-IMPLEMENTATION CHALLENGES

3.1. SAFETY

3.1.1 Safety challenges revolve largely around the safe operation of the ATM system during transition to PBN operations. Gaps may occur within the CNS/ATM system noting that PBN addresses only the navigation tenet of the system and advances in navigation may out pace advances in communication and/or surveillance infrastructure. Safety challenges therefore include:

a) Mixed fleet operations
b) Maintenance of the Acceptable Level of Safety Performance (ALoSP)
c) Continued evolution of PBN navigation specifications and their deployment in the ATM system.
d) Training of stakeholders.
e) GNSS system performance and prediction of the availability of continuous service
f) Management of change for ATC and Aircrew.

g) Multiple airspace designs if conventional routes are kept as the back-up network.

3.1.2 The State addresses the challenges through continuous sensitization and training in PBN operations for stakeholders, conduct of safety assessment and reviews of the PBN flight procedures.

3.2. AIRCRAFT EQUIPAGE

3.2.1 Challenges related to aircraft equipage in implementing Performance Based Navigation (PBN) in Kenya include: varied capabilities across different aircraft fleets, outdated or incompatible Flight Management Systems (FMS), lack of necessary RNAV/RNP capabilities on older aircraft, inconsistencies in navigation equipment, and the need for significant upgrades to utilize new PBN procedures effectively; essentially, ensuring all aircraft within an airspace have the necessary technology to fly complex PBN routes remains a significant hurdle.

3.2.2 Different aircraft models within an airline or airspace may have varying levels of navigation capability, requiring selective implementation strategies or fleet upgrades to fully utilize PBN, which some air operators have not achieved across the fleet.

3.2.3 Old generation FMS might not be capable of processing complex PBN procedures or may require software upgrades to comply with new navigation specifications. Additionally, older aircraft may not have the necessary hardware to support advanced navigation capabilities like A-RNP.

3.2.4 Upgrading an entire fleet with necessary PBN equipment can be a significant financial burden for airlines. Majority of the older generation aircraft forming a larger percentage of aircraft fleet in the domestic operations are not PBN equipped.

3.3. INFRASTUCTURE

3.2.1 ICAO PBN airspace concept can be supported by terrestrial radio navigation aids or self-contained aircraft navigation systems (GNSS and/or INS), however the existing network of terrestrial navigation aids in Kenya is not of sufficient density to support PBN DME/DME constellation navigation requirements. Therefore, PBN implementation in Kenya is exclusively supported by self-contained aircraft navigation systems for GNSS and/or INS.

3.3 CONTINGENCY PLANNING

3.3.1 There are currently no major challenges on infrastructure in the implementation of PBN. However, there is presently no ATM mechanism in place to monitor the availability, integrity, strength and outages of the GNSS signals including spoofing and jamming. The air traffic controllers only rely on pilot reports in case of GNSS signal outages.

3.3.2 As a contingency measure, Kenya will maintain adequate network of terrestrial radio navigation aids to provide an alternative means of navigation using conventional navigation procedures.

3.3.3 The GNSS prediction services that significantly enhance GNSS aircraft navigation by providing critical information about the expected availability and performance of GNSS signals may be used when available. This will help pilots and flight planners to anticipate potential issues like signal outages or degradation due to space weather interference. By leveraging on this information, Kenya proactively mitigates risks and ensure safer, more efficient flight operations using provided conventional navigation infrastructure.

3.4. CAPACITY AND EFFICIENCY

3.4.1 The challenges presented by demand, capacity and efficiency in the Kenya aviation industry have an important role in the development of the new airspace concept enhanced by the implementation of PBN.

3.4.2 The PBN coordinating committee consisting of the regulator, ANSP, airline operators, airport authority, military authority, meteorological authority and other stakeholders, aims to create open dialogue on key industry issues and find the necessary solutions to meet the increasing traffic demand.

3.5. ENVIRONMENT (GAS AND NOISE EMISSIONS)

3.5.1 The normal PBN design of SIDs and STARs leads to levelling-off of flights when there is conflict between arrivals and departures resulting in increased fuel burn, CO_2 emission and aircraft noise due to aircraft operations at sub-optimal altitudes.

3.5.2 The airspace design concept of Continuous Climb Operations (CCOs) and Continuous Descent Operations (CDOs) being implemented in Nairobi FIR TMAs will assist in the reduction of fuel burn, CO_2 emission and aircraft noise since the aircraft will be flying at the minimum thrust.

3.5.3 Permanently segregated airspaces require aircraft to fly longer routes resulting in increased CO_2 emission. There is continuous engagement with the military to avail these airspaces for flexible use for civil aviation.

3.6. REGULATORY

3.6.1 **Air Navigation Services**

Kenya has developed regulations on implementation of Performance Based Navigation within designated airspaces and aerodromes. Additionally, Technical Guidance has been developed and provided to guide Air Navigation Service providers on implementation of PBN in Kenya.

The State also requires the air navigation service provider to provide training (both initial and recurrent) to technical personnel involved in PBN operations to ensure continued qualification in view of the changing PBN operational environment.

3.6.2 **Flight Operations/Airworthiness**

The State has developed regulations and technical guidance governing requirements for operation within the PBN airspaces. The State issues operation approvals to adequately equipped aircraft to operate within PBN airspaces in

accordance with prescribed operational requirements. The State requires air operators to suitably equip their aircraft so as to benefit from operations in the PBN environment.

The State requires operators to provide training (both initial and recurrent) to their technical personnel as may be necessary from time to time.

3.7. RESOURCES

3.7.1 KCAA has automated the IFP and airspace design process.

3.7.2 KCAA continues to build human capital in PANS-OPS and airspace design for the design and approval of PBN flight procedures.

3.7.3 KCAA provides specialised training for ANS technical personnel and regulatory personnel, pilots, and Air Operator Certificate (AOC) holders responsible for implementation of PBN.

3.7.4 Regarding PBN operational approval for aircraft equipage and pilot competency, KCAA continuously builds capacity for Flight Operations and Airworthiness Inspectors for the PBN operational approval.

3.8. AIR NAVIGATION SERVICE PROVIDER (ANSP)

3.8.1 The ANSP will continually build capacity on IFP Design, especially recurrent training to ensure that qualified IFP designers are appraised of any changes in the PANS-Ops criteria that supports PBN.

3.8.2 Training of ATM officers in PBN and basic procedure design concepts is key to the successful implementation of the PBN procedures. Additionally, training of AIM officers on PBN concept for flight planning is key to the successful implementation.

3.8.3 Kenya continuously trains and provides recurrent training on PBN to officers.

CHAPTER 4-IMPLEMENTATION TARGETS

4.1 GENERAL

4.1.1 Kenya has already achieved significant milestones in the implementation of PBN procedures which commenced over a decade ago. This plan provides a high-level strategy for the evolution of PBN navigation capabilities tobe implemented in two phases: Short Term (2026-2028) and Long Term (2029-2031) with "End state' expected to be achieved from 2032 and beyond. The strategy is anchored on two key navigational specification: RNAV and RNP. It also encompasses instrument approaches, Standard Instrument Departure (SID) and Standard Terminal Arrival (STAR) procedures operations, as well as en-route continental and oceanic operations. The section on longterm initiative discusses integrated navigation, communication and surveillance and automation strategies.

4.1.2 To avoid proliferation of new navigation standards, Kenya will adhere to the AFI region PBN implementation plan guideline.

4.2. SHORT TERM TARGETS (2026-2028)

4.2.1. Oceanic and Continental Enroute

4.2.1.1 Currently, the oceanic airspace is served by RNP10 routes. To further increase airspace capacity and promote global harmonization, Kenya will work closely with its international partners in implementing RNP4 regional oceanic routes in consideration of the operational requirements. Safety assessment will be conducted to evaluate reduced oceanic lateral separation minima between aircraft approved for RNP4 operations.

4.2.1.2 In the continental airspace, Kenya successfully implemented RNAV5 routes through close collaboration with its international partners. To accommodate mixed equipage of aircraft, Kenya has maintained adequate ground navigations aids to support non-PBN equipped aircraft operations and for contingency purposes.

4.2.1.3 In line with the AFI Region PBN plan, Kenya has implemented RNAV2 domestic continental routes on dictates of capacity operational requirements.

The use of RNAV 2 in the continental regional routes, is a subject Kenya remains open to in discussions with its neighbours under auspices of regional ICAO office, and can be achieved, if operational requirements dictate.

4.2.1.4 For airspace and corridors requiring structured routes for flow management, Kenya will review existing RNAV routes to redesign them into RNAV 5/2 and where operationally required, RNP 2.

4.2.1.5 The Free Route Airspace (FRA) in the Nairobi FIR has been implemented with RNAV 5 specification in the continental upper airspace and RNP 10 specification in the oceanic airspace. RNP4 will be implemented for FRA in the oceanic.

4.2.1.6 Generally, Kenya is in compliance with the AFI region PBN guidance in regard to the regionally adopted route specifications.

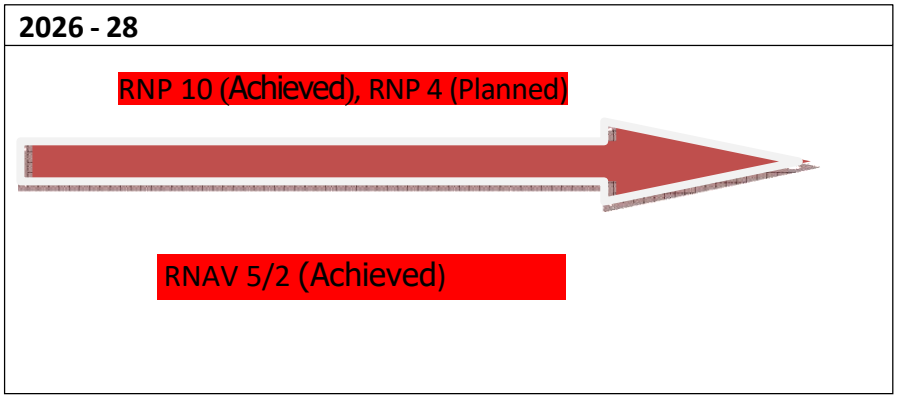

Figure 1: Short term PBN Implementation Target - Enroute and Oceanic

4.2.2. Terminal Areas (SIDs and STARs)

4.2.1.1 RNAV procedures reduce conflict between traffic flows by consolidating flight tracks. RNAV1/RNP1 SIDs and STARs improve safety, capacity and flight efficiency.

4.2.1.2 Kenya has implemented RNAV1 and RNP1 SIDs and STARs in the terminal areas of Nairobi, Mombasa, Wajir and Eldoret covering HKJK, HKMO, HKML, HKNW, HKEL , HKWJ and HKKI.

4.2.1.3 Regarding PBN terminal area applications Kenya is compliant to the regional guidance.

Where there are operational challenges and for traffic conflicts resolution, CCO SIDs and CDO STARs will be implemented in the terminal areas to provide strategic de-confliction.

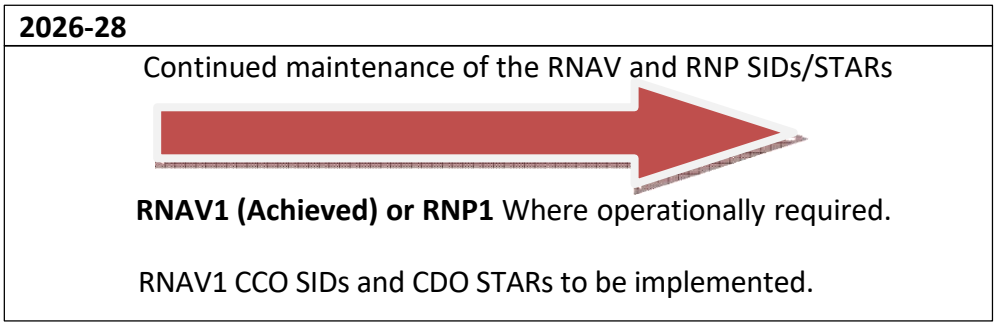

Figure 2: Short Term PBN Implementation Targets - Terminal

4.2.1.4 RNP APCH procedures to all instrument runways with Baro-VNAV for vertical guidance have been implemented at international airports and some domestic airports.

4.2.1.5 Currently, Kenya does not have operational or obstacle constraints requiring implementation of RNP AR Approach procedures.

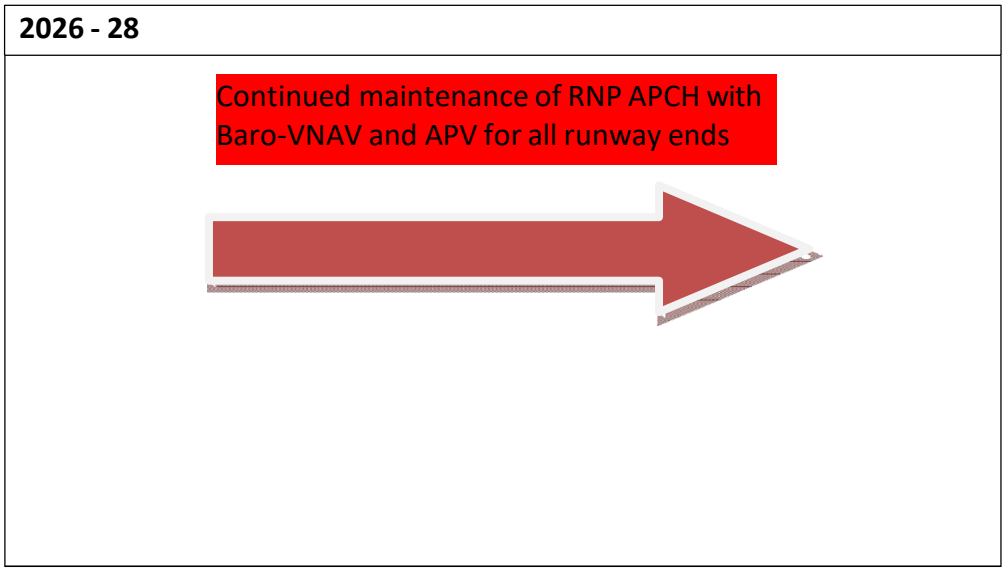

Figure 3: Short term PBN Implementation Target - Approach

4.2.4. Helicopter Operations

4.2.1.6 Currently, most helicopter operations in Nairobi FIR are visual. The helicopter RNP 0.3 PBN procedures will be considered for implementation with increased IFR helicopter operations, requiring tighter obstacle protection areas; and support helicopter operations within dense metropolitan areas by providing more efficient terminal area routings to avoid noise-sensitive areas.

2026-2028

RNP0.3 Where operationally required.

Figure 4: Short Term PBN Implementation Targets - Helicopter Operations

4.2.5. Military Operations

The PBN equipped military aircraft will comply with the PBN procedures when operating within the civil airspace.

4.2.6 Short Term Strategy Summary

The table below provides a summary of short-term implementation PNB plan for Nairobi FIR.

Table 6: Short Term Strategy Summary

Airspace	**Nav. Specification**	**Nav. Spec where operationally required**
En-route Oceanic	RNP 10 (Achieved);	RNP 4 (2026-2028)
En-route Remote Continental	N/A	NA
En-route Continental	RNAV5 (Achieved)	RNAV 2, RNP 2 (Achieved)
TMA-Arrival and Departure	RNAV1(Achieved)	RNP 1 (Achieved)
TMA-Arrival and Departure	RNAV 1-CDO-STARs & CCO SIDs (2026-2028)	
Approach	RNP APCH with (BARO-VNAV) (Achieved)	RNP AR APCH (N/A)
Helicopter operations		RNP 0.3 (N/A)

4.3. LONG TERM TARGETS (2029-2031)

4.3.1 Continental En Route

All the PBN Implementation targets would have been achieved within short term period of 2026-2028. Therefore, there are no targets for this long-term period.

4.3.2 Terminal Areas (SIDs and STARs)

All the PBN Implementation targets would have been achieved within short term period of 2026-2028. Therefore, there are no targets for this long-term period.

4.3.3 Approach

Implement SBAS precision approach for all runways with availability of SBAS Service Area for Africa.

4.3.4 Helicopter Operations

RNP-0.3 routing applicable to en-route, arrival, departure, and approach phases, excluding the final approach segment operations will be developed on need basis subject to helicopter equipage with requisite Flight Guidance System (FGS) and requisite crew training and approval.

4.3.5 Military Operations

The PBN equipped military aircraft will comply with the PBN procedures when operating within the civil airspace.

4.3.6 Long Term Strategy Summary

The table below provides a summary of long-term implementation PNB plan for Nairobi FIR.

Table 7: Long Term PBN Implementation Strategy Summary

Airspace	**Nav. Specification**	**Nav. Spec where operationally required**
En-route Oceanic	RNP 4 (Achieved)	NA
En-route Remote Continental	NA	NA
En-route Continental	RNAV 5 (Achieved), RNAV 2 (Achieved)	RNP2 N/A
TMA-Arrival and Departure	RNAV-1 (Achieved)	RNP1 (Achieved)
Approach	RNP APCH with (BARO-VNAV) (Achieved)	RNP AR (when need arises) SBAS Approaches (Subject to availability of service area)
Helicopter operations		RNP 0.3 (when need arises)

4.4. END STATE (2032 and Beyond)

The implementation of the PBN plan will lead to:

a) PBN Specs implemented in the oceanic RNP 4; Continental RNAV 5/2 ; Terminal RNAV1, RNP1 (where necessary); and RNP approaches, SBAS Approaches subject to availability of SBAS Service Area and RNP AR, if operational constraints will dictate.
b) Meeting the objectives of Assembly Resolution A37-11.
c) Improvements to safety, efficiency and capacity through implementation of CCO-SIDs and CDO-STARs, APV approaches.

   Environmental benefits resulting from efficient trajectories such as improved air quality; reduction in CO_2 emissions; and reduced noise footprint.

CHAPTER 5-PLAN COORDINATION

5.1. COORDINATION AND CONSULTATION

5.1.1 This PBN implementation plan will allow for the deployment of PBN operations commensurate with Kenya's international commitments and other aviation operational issues. However, there is a need for the interests of all civil and military aviationstakeholders to be duly taken into consideration through a concerted implementation process.

5.1.2 Coordination of PBN activities nationally and internationally is undertaken by a committee consisting of the following:

a) Air Navigation Service Provider;
b) The Regulator ;
c) Airports operators;
d) Airline operators;
e) General Aviation operators;
f) Military Authority;
g) Meteorological Authority;
h) Environment experts; and
i) Other stakeholders.

5.1.3 This committee periodically reviews the past, present and future actions regarding the implementation of PBN operations in Kenya.

5.2. PLAN RESPONSIBILITY

5.2.1 The Director General of the Kenya Civil Aviation Authority has the responsibility for the effective and efficient performance of Kenya's PBN implementation plan.

5.2.2 The PBN implementation plan also places responsibilities on;

a) The Regulator - responsible for development of technical guidance materials for the approval of PBN flight procedures, aircraft and aircrew operational approval for implementation of PBN.
b) The Director Air Navigation Services - responsible for the fulfilment of the

requirements with respect to the integration, installation and maintenance of NAVAIDs, training of relevant personnel, providing experts to the airspace and flight procedure design team and publication of charts.

c) Air Operators - responsible for equipping their aircraft with the appropriate avionic systems, requisite training and proper demonstration of PBN procedures.

5.3. PLAN REVIEW

Plan review is a fundamental component of an airspace change. The continued implementation of PBN will introduce new technologies, new procedures or systemic changes that affect aviation operations. Plan review is under the responsibility of PBN Plan Implementation Committee.

The Plan will be reviewed at maximum three (3) years periodicity or anytime when changes in the ICAO GANP or AFI Air Navigation Plan dictates. Amendments will be sought from all stakeholders, and the plan will be amended as required by the Committee.

CHAPTER 6-SAFETY

6.1. PRELIMINARY SAFETY ASSESSMENT, REVIEW AND RISK ANALYSIS

Prior to operationalization of any design for PBN implementation, a formal safety risk assessment will be conducted to proactively identify hazards and manage associated risks. This involves listing potential hazards, evaluating risks based on their likelihood and severity (as per the KCAA Safety Management guidelines), and determining if they are acceptable. A diverse safety assessment team, including pilots, airspace planners, procedure designers, Air Traffic Controllers, Air Traffic Safety Electronics Personnel (ATSEP) and other experts, will undertake this evaluation. The team will recommend specific mitigation strategies for any unacceptable risks. Operations may only begin once risks are reduced As Low As Reasonably Practicable (ALARP) or to an otherwise acceptable level defined by safety requirements.

6.2. IMPLEMENTATION SAFETY ASSESSMENT

6.2.1 As a core component of post-implementation safety performance monitoring, flight track data analysis will be conducted to verify that PBN procedures meet safety requirements in the operational environment.

6.2.2 Complementing data analysis, periodic safety review sessions will be conducted as part of the safety assurance process. These sessions, involving a multidisciplinary team (including pilots, procedure designers, and air traffic controllers), will focus on identifying any emergent hazards, operational issues, or potential non-compliance with safety regulations related to the PBN implementation. Findings indicating an unacceptable level of safety will trigger a formal review and potential redesign of the affected airspace elements, with outcomes documented within the Safety Management System. The review process may be iterative until an acceptable level of safety is demonstrably maintained.

6.2.3 To ensure continued safety, particularly following significant changes introduced by new navigation specifications, a comprehensive safety risk assessment meeting may be convened. This assessment aims to verify the safety of the entire

operational environment affected by the PBN implementation. It will systematically identify, and document all observed hazards or operational concerns, including those initially assessed as minor, for tracking and potential inclusion in the ongoing risk management process.

APPENDIX A-Assembly Resolution A37-11

PERFORMANCE BASED NAVIGATION GLOBAL GOALS

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

{Preamble Removed}

The Assembly

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

2. *Resolves* that:

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

        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% by 2010, 70% 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 and where there are no aircraft suitably equipped for APV operations with a maximum certificated take-off mass of 5700 kg or more;

    b) ICAO develop a coordinated action plan to assist States in the implementation of PBN and to ensure development and/or maintenance of globally harmonized SARPs, Procedures for Air Navigation Services (PANS) and guidance material including a

global harmonized safety assessment methodology to keep pace with operational demands;

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

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

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

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

APPENDIX B-PBN Implementation Schedule for En-route, Terminal and Approach

PBN Specification	En-Route (Continental)		Terminal Airspace SIDs, STARs	Approach Procedures
	Continental	Oceanic		
RNP 10	N/A	Completed (Oceanic)	N/A	N/A
RNAV 5	Completed (Regional routes)	N/A	N/A	N/A
RNAV 2	Completed (Domestic)	N/A	N/A	N/A
RNAV 1	N/A	N/A	Completed (HKJK, HKMO, HKEL, HKNW, HKKI, HKML. & HKWJ)	N/A
RNP 4	N/A	2026-2028 (Oceanic)	N/A	N/A
RNP 2	N/A	N/A	N/A	N/A
RNP 1	N/A	N/A	Completed (HKEL & HKKI)	N/A
Advanced RNP	N/A	N/A	N/A	N/A
RNP APCH	N/A	N/A	N/A	Completed (HKJK, HKMO, HKEL, HKNW, HKKI, HKML. & HKWJ)
RNP AR APCH	N/A	N/A	N/A	On need basis
RNP 0.3 Helicopter	N/A	N/A	On need basis	On need basis

APPENDIX C-References

The following table summarizes the documents referenced in this document.

Document Name	Description	Location
ICAO Assembly Resolutions	Assembly Resolution A37-11	Icao.int.net
Global Air Navigation Plan (GANP)	ICAO Doc 9750	Icao.int.net
Performance BasedNavigation Manual	ICAO Doc 9613	Icao.int.net
Procedures for Air Navigation Service, AirTraffic Management (PANS-ATM)	ICAO Doc 4444	Icao.int.net
Procedures For Air Navigation Services, Operations (PANS- OPS)	ICAO Doc 8168	Icao.int.net
Quality Assurance Manual for ProcedureDesign	ICAO Doc 9906	Icao.int.net
ICAO, State PBN Implementation Plan Template	Version 1	Icao.int.net
Continuous Descent Operations (CDO) Manual	ICAO Doc 9931	Icao.int.net
Continuous Climb Operations (CCO) Manual	ICAO Doc 9993	Icao.int.net
Manual on the Use of Performance-based Navigation (PBN) in Airspace Design	ICAO Doc 9992	Icao.int.net
Procedures for Air Navigation Services — Air Traffic Management	ICAO Doc 4444	Icao.int.net
AFI-Air navigation Plan	ICAO Doc 7474	Icao.int.net
KCAA Air Navigation Master Plan 2015-2030		KCAA document repository
KCAA Advisory Circular on PBN	CAA-AC-ATM005C	KCAA document repository

APPENDIX D-Miscellaneous

NIL.