GARMIN

Garmin Performance-Based Navigation Capabilities

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RECORD OF REVISIONS

Revision	Revision Date	Description
1	1/31/17	Initial Release
2	4/24/17	Added B-RNAV and P-RNAV
3	10/6/17	Changed all AMC 20-27 references to AMC 20-27A
4	10/21/19	Added the GPS 175, GNC 355, and GNX 375
5	3/17/20	Added the GTN Xi Series

1 INTRODUCTION

The purpose of this document is to provide background information on Performance-Based Navigation (PBN) and reference tables on the related capabilities of Garmin systems. Garmin can provide an example AFM(S) document that includes equipment approvals and navigation system limitations on request.

Section 2 gives a brief background on the PBN concept. This includes definition of terms and information needed to understand the basic differences and uses of the various navigation specifications within PBN. More detailed information can be found in the ICAO PBN Manual (ICAO 9613, Performance-based Navigation (PBN) Manual).

Section 3 provides tables that describe the equipment capabilities of fielded Garmin systems. Each RNAV (Area Navigation) and RNP (Required Navigation Performance) navigation specification and each Advanced-RNP (A-RNP) function are listed with an indication whether they are supported by the Garmin system's equipment and software.

Section 4 provides a list of acronyms used throughout the document with definitions.

NOTE

The terms RNAV and RNP have had several historical uses but as used in this document, RNAV and RNP are as defined in the ICAO PBN Manual (4th Edition) and as used in RTCA DO-283B, Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation.

2 PBN BACKGROUND

The **Performance-Based Navigation (PBN)** concept describes the standards and performance requirements for navigation equipment along an ATS route, instrument procedure, or in a defined airspace. These standards determine the basis for designing flight plan trajectories and the aircraft's capabilities determine if it can meet the performance requirements (in terms of accuracy, integrity, continuity, availability, and functionality) to safely fly the operations. PBN consists of both RNAV and RNP specifications.[1]

1. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume I, Explanation of Terms

2.1 RNAV Specifications

The **Area Navigation (RNAV)** specifications allow flight along custom flight paths, as opposed to being limited to airways, and utilize navigation sensors other than just traditional NAVAIDs. These specifications are designated with the prefix *RNAV:* RNAV 10, RNAV 5, RNAV 2, and RNAV 1.

RNAV 10: Designated and authorized as *RNP 10*, this specification supports the 50 NM lateral and the 50 NM longitudinal distance-based separation minima in oceanic or remote area airspace. RNAV 10 does not require on-board performance monitoring and alerting, but the designation of the airworthiness and operational approval as well as airspace/route designation remains *RNP 10* in order to retain the validity of existing publications and approvals. For operations in airspace or on routes designated as RNP 10, both the lateral total system error and the along-track error must each be within ±10 NM for at least 95 percent of the total flight time.[2]

RNAV 5: This specification supports the en-route phase of flight in airspace where 5 NM lateral accuracy is required. For operations in airspace or on routes designated as RNAV 5, both the lateral total system error and the along-track error must each be within ±5 NM for at least 95 percent of the total flight time.[3]

In this document, the **Basic Area Navigation (B-RNAV)** specification is termed the RNAV 5 specification. RNAV 5 is sufficient to allow navigation in European airspace designated for B-RNAV.[4]

RNAV 2: This specification is applicable to all ATS routes, including the en-route phase of flight as well as SID and STAR procedures and IAPs up to the FAF. They support operation in airspace where 2 NM lateral accuracy is required. For operations in airspace or on routes designated as RNAV 2, both the lateral total system error and the along-track error must each be within ±2 NM for at least 95 percent of the total flight time.[5]

RNAV 1: This specification is applicable to all ATS routes, including the en-route phase of flight as well as SID and STAR procedures and IAPs up to the FAF. They support operation in airspace where 1 NM lateral accuracy is required. For operations in airspace or on routes designated as RNAV 1, both the lateral total system error and the along-track error must each be within ±1 NM for at least 95 percent of the total flight time.[6]

In this document, the **Precision Area Navigation (P-RNAV)** specification is termed the RNAV 1 specification. RNAV 1 is sufficient to allow navigation in European airspace designated for P-RNAV.[7]

2. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part B, Chapter 1
3. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part B, Chapter 2
4. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part B, Chapter 2 and FAA AC 90-96A CHG 1.
5. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part B, Chapter 3
6. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part B, Chapter 3
7. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part B, Chapter 3, FAA AC 90-96A CHG 1, and FAA AC 90-100A CHG 2.

2.2 RNP Specifications

The **Required Navigation Performance (RNP)** specifications are similar to the RNAV specifications with the addition of onboard navigation performance monitoring and alerting. These specifications are designated with the prefix *RNP:* RNP 4, RNP 2, RNP 1, A-RNP, RNP APCH, RNP AR APCH, or RNP 0.3.

RNP 4: This specification supports 30 NM lateral and 30 NM longitudinal distance-based separation minima in oceanic or remote airspace. For operations in airspace or on routes designated as RNP 4, both the lateral total system error and the along-track error must each be within ±4 NM for at least 95 percent of the total flight time.[8]

RNP 2: This specification supports en-route airspace navigation, including continental and oceanic/ remote applications. For operations in airspace or on routes designated as RNP 2, both the lateral total system error and the along-track error must each be within ±2 NM for at least 95 percent of the total flight time.[9]

RNP 1: This specification supports developing routes for connectivity between the en-route structure and terminal airspace. The specification can be applied to SID and STAR procedures and IAPs up to the FAF. For operations in airspace or on routes designated as RNP 1, both the lateral total system error and the along-track error must each be within ±1 NM for at least 95 percent of the total flight time.[10]

RNP 0.3: Per ICAO 9613 and AC 90-105A, the RNP 0.3 specification applies mainly to rotorcraft operations. This specification supports applications across all phases of flight, including operations to and from heliports, in remote mountainous areas, or in high traffic density airspace. For operations in airspace or on routes designated as RNP 0.3, both the lateral total system error and the along-track error must each be within ±0.3 NM for at least 95 percent of the total flight time.[11]

RNP APCH (RNP Approach): This specification supports GNSS approach applications down to the approach minima. RNP APCH applies only to approaches with straight final approach segments. During RNP APCH operations, the 95 percent lateral accuracy requirements for both the lateral total system error and the along-track error are:[12]

- ±1 NM for operations in the initial and intermediate segments and for the missed approach.
- ±0.3 NM for operations on the final approach segment down to the LNAV or LNAV/VNAV approach minima.
- Based on the horizontal alert limit (HAL) extracted from the final approach segment data block (FASDB) on the final approach segment down to the LPV or LP approach minima.

8. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part C, Chapter 1
9. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part C, Chapter 2
10. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part C, Chapter 3
11. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part C, Chapter 7
12. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part C, Chapter 5

RNP AR APCH (RNP Authorization Required Approach): This specification supports approaches to airports where limiting obstacles exist and/or where significant operational efficiencies can be gained and includes advanced functional elements. Aircrews are required to have additional training and authorization to fly an RNP AR APCH procedure. For aircraft operating on RNP AR APCH procedures, both lateral total system error and the along-track error must each be within the applicable accuracy for at least 95 percent of the total flight time: [13]

- ±0.1 NM to ±1.0 NM for the initial, intermediate, and missed approach segments.
- ±0.1 NM to ±0.3 NM for the final approach segment.

A-RNP (Advanced RNP): This specification builds upon other specifications with the addition of advanced functional elements such as radius-to-fix legs and scalable RNP. A-RNP can be applied to oceanic/remote, en-route, terminal area (SIDs and STARs), and approach operations. A system qualified and approved for A-RNP is considered to have met the requirements of RNAV 5, RNAV 1, RNAV 2, RNP 2, RNP 1, and RNP APCH in full. For operations in airspace or on routes designated as A-RNP, both the lateral total system error and the along-track error must each be within the applicable accuracy (±0.3 NM to ±2.0 NM) for at least 95 percent of the total flight time.[14]

13. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part C, Chapter 6

14. Derived from ICAO 9613, Performance-based Navigation (PBN) Manual (4th Edition). Volume II, Part C, Chapter 4

3 EQUIPMENT CAPABILITIES

3.1 RNAV Specifications

Table 1 RNAV Specifications

Specification	RNAV 10 [RNP 10] (1)	RNAV 5 B-RNAV (Europe)	RNAV 2	RNAV 1 P-RNAV (Europe)
Reference Document	**FAA AC 90-105A, FAA AC 91-70B, EASA AMC 20-12**	**FAA AC 90-96A CHG 1, EASA AMC 20-4A**	**FAA AC 90-100A CHG 2, JAA TGL 10**	**FAA AC 90-96A CHG 1, FAA AC 90-100A CHG 2, JAA TGL 10**
ICAO Flight Plan Code	A1	B2	C2	D2
Airspace	Oceanic/Remote	En-route	En-route, Terminal	En-route, Terminal, Approach (2)
Integrated Flight Decks				
G5000	Yes	Yes	Yes	Yes
G3000				
G2000				
G1000 NXi	Yes	Yes	Yes	Yes
G1000 w/SBAS	Yes	Yes	Yes	Yes
G1000 w/o SBAS	Yes	Yes	Yes	Yes
Panel Mount				
GTN Series	Yes	Yes	Yes	Yes
GTN Xi Series	Yes	Yes	Yes	Yes
GPS 175 GNC 355 GNX 375	Yes	Yes	Yes	Yes
GNS 400W/500W Series w/ SBAS	Yes	Yes	Yes	Yes
GNS 480	Yes	Yes	Yes	Yes
Legacy GNS 400/500 Series w/o SBAS	Yes	Yes	Yes	Yes
GPS 155/155XL	No	Yes	No	No
GPS 165	No	Yes	No	No
GNC 300/300XL	No	Yes	No	No

(1) Higher continuity requirements from the Advanced RNP Functions table apply.

(2) Specification is applicable to approach procedures up to the FAF.

3.2 RNP En-route/Terminal Specifications

Table 2 RNP En-route/Terminal Specifications

Specification	RNP 4 (1)	RNP 2 (2)	RNP 1	RNP 0.3 (Rotorcraft only) (4)
Reference Document	**FAA AC 90-105A FAA AC 91-70B**	**FAA AC 90-105A FAA AC 91-70B**	**FAA AC 90-105A**	**FAA AC 90-105A**
ICAO Flight Plan Code	L1	None at time of publication	O2	None at time of publication
Airspace	Oceanic/Remote	Oceanic/Remote, En-route	En-route, Terminal, Approach (3)	En-route, Terminal, Approach
Integrated Flight Decks				
G5000	Yes	Yes	Yes	Yes
G3000				
G2000				
G1000 NXi	Yes	Yes	Yes	Yes
G1000 w/SBAS	Yes	Yes	Yes	Yes
G1000 w/o SBAS	Yes	Yes	Yes	No
Panel Mount				
GTN Series	Yes	Yes	Yes	Yes
GTN Xi Series	Yes	Yes	Yes	Yes
GPS 175 GNC 355 GNX 375	Yes	Yes	Yes	Yes
GNS 400W/500W Series w/ SBAS	Yes	Yes	Yes	Yes
GNS 480	Yes	Yes	Yes	Yes
Legacy GNS 400/ 500 Series w/o SBAS	Yes	Yes	Yes	No
GPS 155/155XL	No	No	No	No
GPS 165	No	No	No	No
GNC 300/300XL	No	No	No	No

(1) Higher continuity requirements from the Advanced RNP Functions table apply.

(2) Higher continuity requirements from the Advanced RNP Functions table apply in oceanic/remote airspace.

(3) Specification is applicable to approach procedures up to the FAF.

(4) For software/equipment not supporting Advanced RNP Scalable RNP capability, pilot must manually select 0.3 CDI scale.

3.3 RNP Approach Specifications

Table 3 RNP Approach Specifications

Specification	RNP APCH LNAV	RNP APCH LNAV/VNAV (1)	RNP APCH LP	RNP APCH LPV	RNP AR APCH (2)
Reference Document	**FAA AC 90-105A, EASA AMC 20-27A**	**FAA AC 90-105A, EASA AMC 20-27A**	**FAA AC 90-107**	**FAA AC 90-107, EASA AMC 20-28**	**FAA AC 90-101A CHG 1, EASA AMC 20-26**
ICAO Flight Plan Code	S1	S2	None at time of publication	None at time of publication	T1 (with RF) T2 (without RF)
Integrated Flight Decks					
G5000	Yes	Yes (2)	Yes	Yes	Yes (7)*
G3000					
G2000					
G1000 NXi	Yes	Yes (2)	Yes	Yes	No
G1000 w/SBAS	Yes	Yes (3)	Yes (4)	Yes	No
G1000 w/o SBAS	Yes	No	No	No	No

Table 3 RNP Approach Specifications

Specification	RNP APCH LNAV	RNP APCH LNAV/VNAV (1)	RNP APCH LP	RNP APCH LPV	RNP AR APCH (2)
Reference Document	**FAA AC 90-105A, EASA AMC 20-27A**	**FAA AC 90-105A, EASA AMC 20-27A**	**FAA AC 90-107**	**FAA AC 90-107, EASA AMC 20-28**	**FAA AC 90-101A CHG 1, EASA AMC 20-26**
Panel Mount					
GTN Series	Yes	Yes	Yes	Yes	No
GTN Xi Series	Yes	Yes	Yes	Yes	No
GPS 175/GNC 355/GNX 375	Yes	Yes	Yes	Yes	No
GNS 400W/500W Series w/ SBAS	Yes	Yes	Yes (5)	Yes	No
GNS 480	Yes	Yes	Yes (6)	Yes	No
Legacy GNS 400/500 Series w/o SBAS	Yes	No	No	No	No
GPS 155/155XL	Yes	No	No	No	No
GPS 165	Yes	No	No	No	No
GNC 300/300XL	Yes	No	No	No	No

*Contact Garmin program manager.

(1) Unless otherwise noted, vertical guidance supported only via Satellite-Based Augmentation System (SBAS) vertical position source.

(2) Vertical guidance supported via SBAS or barometric vertical position sources.*

(3) Vertical guidance supported via SBAS or barometric vertical position sources when GDU software v13.00 or later installed.*

(4) When GDU software v13.00 or later is installed.

(5) When main processor software v3.30 or later is installed.

(6) When main processor software v2.3 or later is installed.

(7) When GDU software v6.50 or later is installed.

3.4 Advanced RNP Functions

Table 4 Advanced RNP Functions

Function	RNAV Holding	RF Legs	Parallel Offsets	Higher Continuity	Scalable RNP	Fixed Radius Transitions (FRT)	Time of Arrival Control (TOAC)
Reference Document	**FAA AC 90-105A, FAA AC 20-138D**						
Integrated Flight Decks							
G5000	Yes	When GDU software v3.00 or later is installed *	Yes	With dual GNSS (GPS/SBAS) receivers (2)	When GDU software v4.00 or later is installed (4) *	When GDU software v4.00 or later is installed	No
G3000							
G2000							
G1000 NXi	Yes	Yes*	Yes	With dual GNSS (GPS/SBAS) receivers (2)	No (5)	Yes	No
G1000 w/SBAS	Yes	When GDU software v13.00 or later is installed *	Yes	With dual GNSS (GPS/SBAS) receivers (2)	No (5)	When GDU software v13.00 or later is installed	No
G1000 w/o SBAS	Yes	When GDU software v13.00 or later is installed *	Yes	With dual GNSS (GPS) receivers (3)	No (5)	When GDU software v13.00 or later is installed	No
Panel Mount							
GTN Series	Yes	When GTN software v6.01 or later is installed (1)	Yes	With dual GNSS (GPS/SBAS) receivers (2)	No (5)	No	No
GTN Xi Series	Yes	Yes (1)	Yes	With dual GNSS (GPS/SBAS) receivers (2)	No (5)	No	No
GPS 175 GNC 355 GNX 375	Yes	Yes (1)	Yes	With dual GNSS (GPS/SBAS) receivers (2)	No (5)	No	No

Table 4 Advanced RNP Functions

Function	RNAV Holding	RF Legs	Parallel Offsets	Higher Continuity	Scalable RNP	Fixed Radius Transitions (FRT)	Time of Arrival Control (TOAC)
GNS 400W/ 500W Series w/ SBAS	Yes	No	Yes	With dual GNSS (GPS/SBAS) receivers (2)	No (5)	No	No
GNS 480	Yes	No	Yes	With dual GNSS (GPS/SBAS) receivers (2)	No (5)	No	No
Legacy GNS 400/500 Series w/o SBAS	Yes	No	No	With dual GNSS (GPS) receivers when main and GPS software v3.00 or later is installed (3)	No (5)	No	No
GPS 155/ 155XL	No	No	No	No	No (5)	No	No
GPS 165							
GNC 300/ 300XL							

*Contact Garmin program manager.

(1) *See Install Manual for information on qualified installations.*

(2) *Supported when both GPS/SBAS receivers are operating and providing GPS navigation guidance to the display.*

(3) *Supported when both GPS receivers are operating and providing GPS navigation guidance to the display.*

(4) *RNP airways are supported with software v20.50 or later installed.*

(5) *Applies only to automatic selection. RNP level may be manually selected as the CDI scale.*

4 ACRONYMS

The following acronyms are used within this document:

AFM:	Aircraft Flight Manual
AFMS:	Aircraft Flight Manual Supplement
ATS:	Air Traffic Service
B-RNAV:	Basic Area Navigation
CDI:	Course Deviation Indicator
EASA:	European Aviation Safety Agency
FAA:	Federal Aviation Administration
FAF:	Final Approach Fix
FASDB:	Final Approach Segment Data Block
FRT:	Fixed Radius Turn
GDU:	Garmin Display Unit
GNC:	Garmin Nav/Comm
GNS:	Garmin Navigation System
GNSS:	Global Navigation Satellite System
GNX:	Garmin Navigator-Transponder
GPS:	Global Positioning System
GTN:	Garmin Touchscreen Navigator
HAL:	Horizontal Alert Limit
IAP:	Instrument Approach Procedure
ICAO:	International Civil Aviation Organization
LNAV:	Lateral Navigation
LNAV/VNAV:	Lateral/Vertical Navigation
LP:	Localizer Performance
LPV:	Localizer Performance with Vertical Guidance
NAVAID:	Navigation Aid
NM:	Nautical Mile
PBN:	Performance Based Navigation
P-RNAV:	Precision Area Navigation
RF:	Radius to Fix
RNAV:	Area Navigation
RNP:	Required Navigation Performance
RTCA:	RTCA, Inc., formerly Radio Technical Commission for Aeronautics
SBAS:	Satellite Based Augmentation System
SID:	Standard Instrument Departure
STAR:	Standard Terminal Arrival Route
TOAC:	Time of Arrival Control