Australian Government
Civil Aviation Safety Authority

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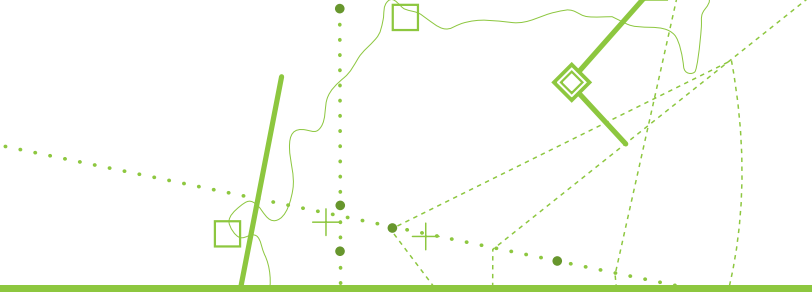


CONTENTS

Visit **www.casa.gov.au/pbn** to view a range of case studies.

02

WHAT IS PBN?

Performance-based Navigation, or PBN, is area navigation that uses on-board systems and will be based on global navigation satellite systems (GNSS) in Australia. This is in contrast with traditional sensor-specific navigation based largely on fixed ground-based beacons guiding aircraft along published routes via waypoints defined by these beacons.

PBN defines aircraft navigation requirements in terms of the accuracy, integrity, continuity and functionality required for the proposed operations.

Navigation using legacy ground aids is 'relative navigation' since aircraft are

always operating relative to the navaids — whether tracking to or from aids, or flying to a point defined by a VOR radial and DME distance from a ground station. PBN, on the other hand, is 'absolute navigation'

— the aircraft operates by first determining its present position in terms of latitude and longitude, and then where this position is in relation to the intended flight path.

This has the major advantage of flexibility: providing the aircraft has a means of determining its current position, it can operate anywhere that positioning system will operate.

PBN encompasses two types of navigation specifications:

» RNAV (aRea NAVigation), and

» RNP (Required Navigation Performance).

The difference between the RNAV and RNP navigation specifications is that on-board performance monitoring and alerting is required for RNP but not for RNAV operations.

In an aircraft utilising a stand-alone GNSS, RNP is achieved through the use of Receiver Autonomous Integrity Monitoring (RAIM). Area navigation systems often integrate several sources of navigation information e.g. inertial and GNSS, to provide highly accurate navigation solutions.

These systems may use alternate means of aircraft autonomous integrity monitoring systems that are the equivalent of RAIM.

The on-board performance monitoring and alerting function ensures the integrity of the navigation solution i.e. the system is meeting the required accuracy.

Information from the GNSS calculates its position from the satellites in view.

A timely warning is provided when the accuracy of that position falls outside an acceptable limit, alerting the pilot of the need to discontinue the approach.

For example, setting an RNP value of 0.3 NM means the on-board performance monitoring will alert the pilot if it estimates the error of the navigation system exceeds 0.3 NM.

Under PBN, airspace and route design take into account the aircraft operations in the region, and the capability of aircraft flying there.

Both aircraft and flight crew must meet performance standards for that route, which may change according to the flight phase (en route, approach etc.) and the class of airspace in which the aircraft is flying.

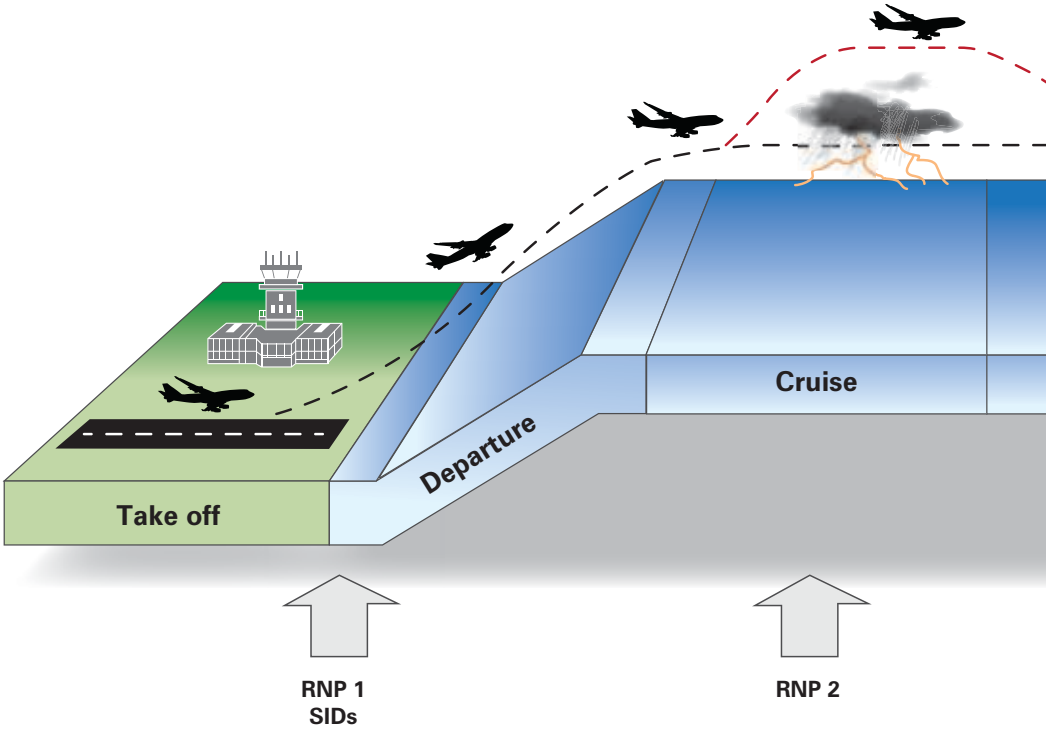
Under PBN, common Australian operational navigation specifications will be:

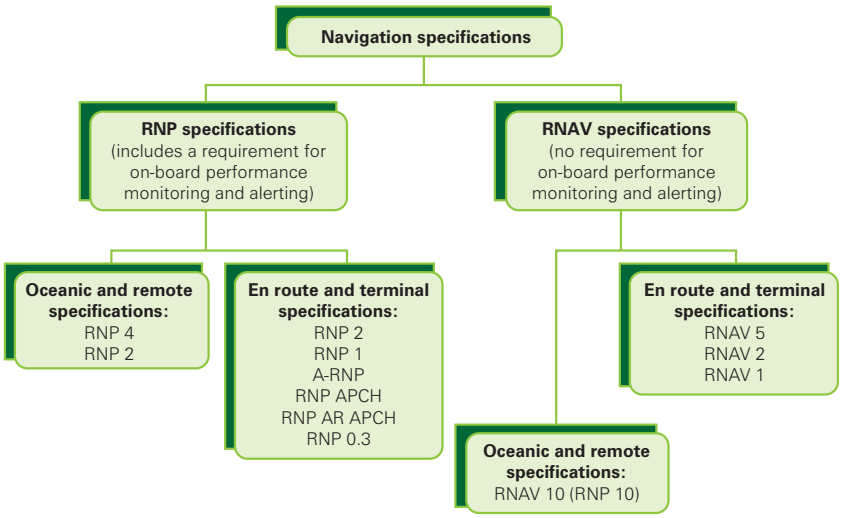
» RNP 2—en route

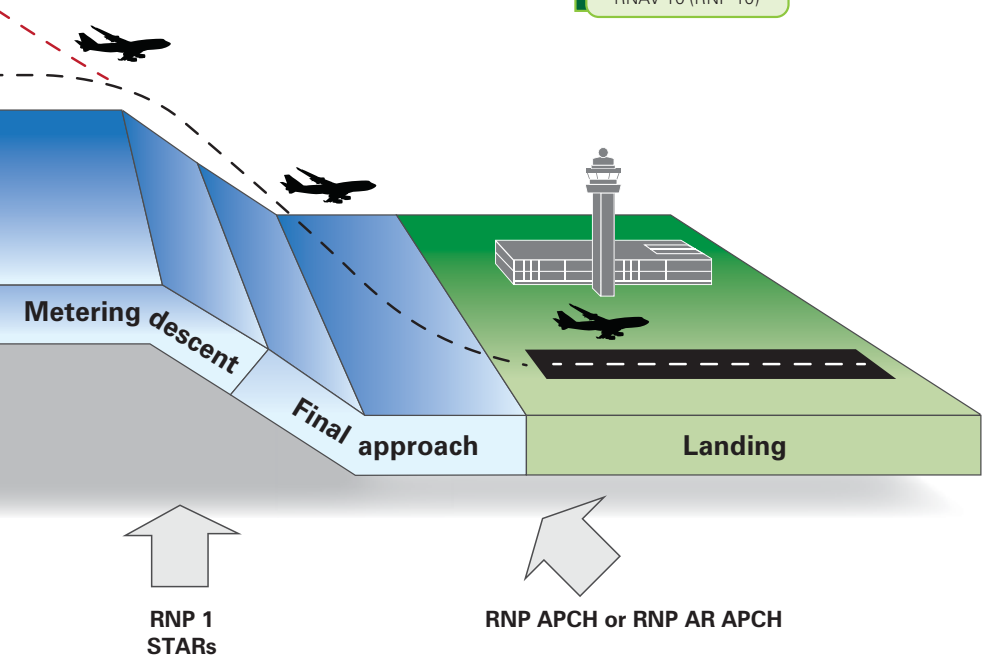
» RNP 1—for Standard Instrument Departures (SIDs), and Standard Terminal Arrival Routes (STARs)

» RNP–APCH—LNAV approach

(Under GNSS-RNAV, these were en route, terminal, and non-precision approach.)




Navigation specifications
RNP specifications
(includes a requirement for on-board performance monitoring and alerting)
RNAV specifications
(no requirement for on-board performance monitoring and alerting)
Oceanic and remote specifications:
RNP 4
RNP 2
En route and terminal specifications:
RNP 2
RNP 1
A-RNP
RNP APCH
RNP AR APCH
RNP 0.3
Oceanic and remote specifications:
RNAV 10 (RNP 10)
En route and terminal specifications:
RNAV 5
RNAV 2
RNAV 1


Metering descent
Final approach
Landing
RNP 1
STARs
RNP APCH or RNP AR APCH

BENEFITS OF PBN

The introduction of PBN allows pilots, operators and air traffic control to make the best use of recent huge advances in navigation technology, and brings increased safety, efficiency and environmental benefits, including:

» Reduced separation standards for all phases of flight. As the skies become busier, PBN allows the most efficient use of available airspace, through appropriately managed reductions in separation standards and track miles flown during the en-route, approach and landing phases. Australia's airways system will be able to handle more aircraft and do this more safely within time and airspace constraints.

» Reduced track miles/fuel burn/carbon dioxide emissions during landing approaches. PBN technology has the real potential to reduce unproductive flight time, unnecessary delays and fuel burn, providing obvious economic benefits to operators, and the environment. Advanced PBN applications now under development will deliver further efficiencies through time-of-arrival control and continuous descent arrivals. In a few years, 4D air traffic management will bring even more efficiency, with aircraft operating on direct routes at optimum altitudes, thus avoiding the dreaded arrival holding pattern.

» PBN and GNSS allow straight-in approaches to be designed for most runways. International Civil Aviation Organization (ICAO) data shows that straight-in approaches are 25 times safer than circling approaches. Adding vertical guidance to the approach brings a further safety gain.

- Approaches with vertical guidance, where the aircraft has both lateral and vertical navigation capability, are a further eight times safer than approaches without vertical guidance, so are a significant safety enhancement. Currently the only approaches with vertical guidance available in Australia (apart from ILS) are Baro-VNAV, where aircraft barometric altitude is used to control the aircraft to a defined vertical path. These approaches are limited to aircraft that have accurate barometric altimetry systems and to aerodromes that have barometric pressure measurement and broadcast systems.

- Lack of vertical guidance during instrument approach to land operations is a major contributing factor to accidents involving controlled flight into terrain (CFIT). Such accidents almost always result in 100 per cent fatalities. Recent accidents in Australia, or involving Australians, include Lockhart River, Queensland (2005): 15 killed; and Kokoda, PNG (2009): 13 killed.

» Reduced reliance on terrestrial radio-navigation aid infrastructure through widespread use of GNSS-enabled PBN will permit a widespread reduction of ground navigation aids. Approaches at the majority of the 300 aerodromes in Australia that have radio-navigation aids are flown with lateral guidance only, using non-directional beacons (NDB) and VHF omni-range (VOR) radio-navigation aids. These navigation aids are 70-year-old technology, which is becoming increasingly expensive to install and maintain.

» Global harmonisation—ICAO's PBN navigation standards are being applied worldwide for use by any authorised operator from any ICAO state. This means that certifying both operators and aircraft will be much easier, and aircraft will be built to common global standards.

WHAT IS HAPPENING?

After extensive consultation with industry on navigation authorisations through processes such as issuing notices of proposed rulemaking (NPRM 1002AS— July 2011 and NPRM 1320AS— July 2014), and formal consultation with companies and industry associations, CASA published Civil Aviation Order (CAO) 20.91 (Instructions and Directions for Performance Based Navigation) on 13 July 2012, with a revised version expected in November 2014.

This CAO allows for the implementation of PBN in Australia, and affects all IFR operators in Australia. Many such operators have been doing PBN for years, just under different names. The current GNSS RNAV will become RNP 2 (en route); RNP 1 (terminal); and RNP APCH-LNAV [RNAV(GNSS)].

The new rules are now in force.

The two year **transition provisions** for existing users of certain legacy navigation authorisations expired on 12 July 2014.

There are also **deeming provisions** incorporated into CAO 20.91, which mean that:

» aircraft equipped with stand-alone GNSS systems with Aircraft Flight Manual entries for RNP 2, RNP 1 or RNP APCH-LNAV, or installed in accordance with AC 21-36 or CAAP 35-1, and flown by suitably qualified pilots, meet the equivalent PBN requirements.

» aircraft equipped with integrated avionics systems using GNSS only for the area navigation are also covered by the deeming provisions.

(See also page 12 for the deeming provisions table.)

CAO 20.91 and its associated advisory circular provide operating instructions and airworthiness requirements for IFR pilots flying aircraft using PBN.

Pilot and operator obligations

» Pilots in command of IFR flights must not use a particular PBN specification unless they satisfy the pilot requirements detailed in the relevant appendix for that specification.

» The aircraft operator must also:

- Hold, or be deemed to hold, a navigation authorisation for the particular PBN specification
- ensure that each member of the flight crew satisfies the requirements in the relevant appendix (1–13)
- ensure that each member of the flight crew conducts the flight according to the navigation authorisation.

For a table showing how legacy authorisations transitioned into CAO

20.91 PBN authorisations, see page 14 of this booklet.

Civil Aviation Order 20.18: Equipment mandates

A related civil aviation order, CAO 20.18 (Aircraft equipment–basic operational requirements), which deals with the equipment required for PBN and ADS-B, came into effect on 22 August 2012.

Note: ADS-B in Australia is based on the 1090 MHz Extended Squitter system. The US Universal Access Transceiver version of ADS-B will not work in Australia.

WHY IS IT HAPPENING?

» Global aviation calls for global standards. As PBN becomes more common worldwide, the need for standardisation becomes more urgent. The advantages brought by PBN can be undone by confusion in terminology and standards.

» This process began in the 1990s in the continental airspace of Europe and North America, but lack of worldwide harmonisation has hindered the global implementation that would allow the many benefits of PBN to be realised.

» For over 15 years, Australia, in common with many other States, has been moving away from traditional and ground-based navaids such as VOR and NDB for the en-route, terminal and approach phases of flight, and adopting GNSS-based area navigation. Traditional air routes as we know them will soon be superseded, not just for the major airlines, but for general aviation as well. Advances in technology are rapidly making old navigation standards (as defined by traditional, ground-based navaids) constrained and obsolete.

» PBN allows for more straight-in approaches, which are safer. It also allows for vertical guidance, which further improves approach safety.

» By facilitating optimal flight routes PBN can save fuel. It also allows higher traffic densities to be managed safely.

HOW WILL I BE AFFECTED?

The introduction of PBN involves all stakeholders involved in IFR flight operations. In Australia, **if you have a GNSS-equipped aircraft approved for IFR operations, you do not need to make any changes.** That is why there are deeming provisions in the Civil Aviation Orders.

The deeming provisions say if you have a TSO-certified, stand-alone navigation or integrated navigation systems that have been fitted according to the regulations and you are a suitably qualified pilot, you are deemed to hold the required navigation authorisations.

Legacy navigation authorisations remained valid for two years under CAO 20.91, unless they lapsed or were replaced. Now that the two years has expired, PBN navigation authorisations are required.

However, aircraft with flight management systems (FMS), such as some newer commuter/regional aircraft, will need to obtain navigation authorisations from CASA. The PBN standards also provide for IFR helicopter-specific operations such as in metropolitan areas and for offshore support.

Deemed authorisations

The deeming provisions are based on already demonstrated compliance, so re-examination of approvals is not necessary.

Sections 9, 10 and 11 of CAO 20.91 state that operators of certain Australian aircraft equipped with stand-alone GNSS or integrated avionics systems are deemed to hold authorisations for certain navigation specifications addressed by CAO 20.91, providing certain criteria are met.

In all cases:

a) have statements of compliance for the navigation specifications in the Aircraft Flight Manual or Rotorcraft Flight Manual; or

b) the aircraft installation must meet the criteria specified in AC 21-36 (on or after 13 April 2005) or CAAP 35-1 (before 13 April 2005); and

c) pilots have completed training on the use of GNSS in accordance with CASR Part 61 (or the preceding CAO 40.2.1 or 40.2.3) and are authorised for GNSS based operations.

A summary of the CAO 20.91 deeming provisions are on page 12 of this booklet.

Pilot qualifications required

To be deemed to hold navigation authorisations for these navigation specifications (Appendix 1–5 as applicable), you must also meet certain pilot qualifications.

Navigation Databases

Since navigation under PBN relies on area navigation, the aircraft navigation system must carry a navigation database. Under the requirements of the CAO:

» the database must be valid for the current AIRAC cycle (refer to AIP GEN 3.1 4 for further information);

» all terminal routes (SIDs, STARs and approaches) must be loaded from the database and may not be modified by the pilot except as provided for in CAO 20.91.

Installation Notes

The following items concerning installations have come to CASA's attention and operators need to be aware of them:

» TSO C129 GPS systems do not meet the requirements for ADS-B.

» Aircraft for sale in the US are advertised as having ADS-B; buyers need to ensure that the ADS-B in such aircraft uses the Mode S transponder with Extended Squitter (commonly referred to as 1090 MHz Extended Squitter). Many aircraft in the US have ADS-B through the use of Universal Access Transceivers (UAT) – these will not work in Australia.

» Modern electronic display systems and other avionics systems have micro electro-mechanical systems (MEMS) inertial sensors fitted. To function correctly, these systems often need either GNSS or pitot-static inputs (or both). When installing modern equipment, installers need to install systems in accordance with the manufacturer's Installation Manual and include all relevant interfaces.

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PBN DEEMING PROVISIONS FOR GNSS-EQUIPPED AIRCRAFT

Aircraft GNSS equipment	PBN authorisation:	Previously known as:
TSO C129 ( ) Class A1 or A2 TSO C146 ( ) Class Gamma Operational Class 1, 2 or 3 ETSO C146 ( ) Class Gamma Operational Class 1, 2 or 3 Note: TSO C129 systems require an alternate not based on GNSS	RNAV 5 RNAV 1 and RNAV 2 RNP 2 RNP 1	GPS en-route GPS terminal GPS en-route GPS terminal
TSO C129a Class A1 TSO C129a Class A1 Note: TSO C129 systems require an alternate not based on GNSS	RNAV 5 RNAV 1 and RNAV 2 RNP 2 RNP 1 RNP APCH LNAV	GPS en-route GPS terminal GPS en-route GPS terminal GPS non-precision approach
TSO C146 ( ) Class Gamma Operational Class 1, 2 or 3 ETSO C146 ( ) Class Gamma Operational Class 1, 2 or 3	RNAV 5 RNAV 1 and RNAV 2 RNP 2 RNP 1 RNP APCH LNAV	GPS en-route GPS terminal GPS en-route GPS terminal GPS non-precision approach

Note: ( ) refers to any numbered version of the order.
You should always use the current version of the order.

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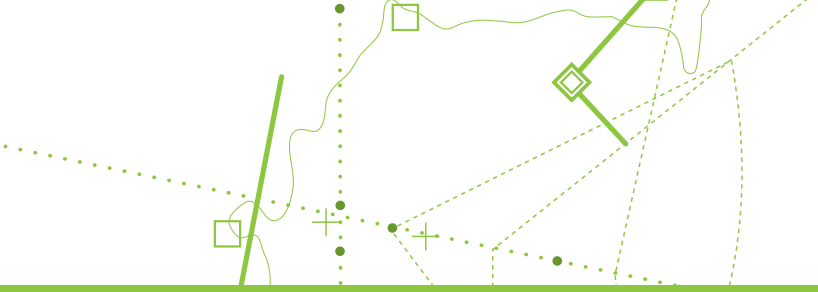
TRANSITIONAL PROVISIONS

The table below shows how legacy authorisations transitioned into CAO 20.91 PBN authorisations. The validity of these authorisations ceased on 12 July 2014.

PBN transitional arrangements		
Legacy authorisation	**Comments**	**PBN authorisation**
Australian RNAV (AUSEP)	En-route navigation will transition to RNAV 5 or RNP 2 over time.	RNAV 5
B-RNAV	European operations only.	RNAV 5
P-RNAV	Aircraft approved for US-RNAV-only will require additional changes to operate on P-RNAV routes. If the aircraft is approved for both P-RNAV and US-RNAV, no further changes needed.	RNAV 1
US-RNAV types A and B	Aircraft approved for P-RNAV-only will require additional changes to operate on US-RNAV routes. Aircraft approved for both P-RNAV and US-RNAV require no further changes.	RNAV 1 or RNAV 2
GPS RNAV	En-route navigation will transition to RNP 2 over time.	RNP 2
GPS Oceanic see note 3	RNP 4 oceanic/remote continental operations navigation element only.	RNP 4 or RNP 10

Notes:

1. This table addresses the navigation element only; aircraft will also have to meet communications and surveillance system requirements.
2. Aircraft operating in oceanic Flight Information Regions but not within RNP 10 or RNP 4 airspace require a GPS Oceanic authorisation in accordance with CASA 80/14 Instructions – use of Global Navigation Satellite System (GNSS).



AIRCRAFT EQUIPMENT

The new Civil Aviation Order (CAO) 20.18, which became effective on 22 August 2012, applies to all IFR aircraft in Australia. It requires:

» ADS-B for all aircraft operating at or above FL290 after 12 December 2013

» TCAS II Version 7.1 for aircraft registered on or after 1 January 2014 with a MCTOW >5700 kg or >19 passengers

» ADS-B for all IFR aircraft by 2 February 2017 (4 February 2016 for the area 500 NM north and east of Perth WA)

- ADS-B for IFR aircraft new to the Australian register after 6 February 2014

» the carriage of GNSS for all IFR aircraft by 4 February 2016

- GNSS for IFR aircraft new to the Australian register after 6 February 2014

There may also be pilot licensing or training requirements associated with the installation and use of the equipment.

This applies to all IFR aircraft (currently around 3500 in Australia).

Decommissioning of around 200 legacy navaids will commence in February 2016, by which time all IFR aircraft will need to be GNSS equipped.

How will industry be affected by the decommissioning of these navaids?

» TSO C145/146 GNSS-equipped aircraft will no longer need to carry an alternate non-GNSS means of navigation; alternates can be planned on the basis of using GNSS.

Note: ADS-B requires TSO C145a, C146a or C196 GNSS.

» TSO C129 GNSS-equipped aircraft must plan for an alternate that has a conventional navigation aid. The aircraft must carry equipment suitable for any designated alternates (i.e. at least an ADF or VOR depending on the navigation aid at the designated alternate.)

- For GA aircraft, this means they will have to carry ADF or VOR equipment as well as GNSS.

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AIRCRAFT EQUIPMENT

Effective Date	Applicable to
12 December 2013	Aircraft operating at or above FL 290
1 January 2014	New aircraft registered on or after 1 January 2014 • MCTOW >5700 kg or >19 passengers
6 February 2014	New aircraft registered in Australia on or after 6 February 2014
	Existing aircraft modified on or after 6 February 2014 and:
	Operating in class A, B, C, or E airspace, or Operating above 10,000ft in class G airspace. Note: Not applicable to aircraft operating in class E airspace or above 10,000ft in class G airspace if the aircraft has no engine or insufficient electrical power capacity to operate a transponder.
	New aircraft operating in RPT or charter operations
	New aircraft operating in aerial work or private operations
	Existing aircraft operating in RPT or charter operations, if modified on or after 6 February 2014
	Existing aircraft operating in aerial work or private operations if modified on or after 6 February 2014
4 February 2016	Aircraft operating in class A, B, C or E airspace in the 500nm quadrant north and east of Perth
	Aircraft operating at Brisbane, Sydney, Melbourne, or Perth aerodromes
	Existing aircraft operating in RPT or charter operations
	Existing aircraft operating in aerial work or private operations
2 February 2017	Existing aircraft on the Australian register before 6 February 2014

Notes

1. Requirements are applicable to aircraft conducting IFR operations only.
2. Refer to CAO 20.18 and 20.91 for full details of requirements.

	Requirement
	ADS-B required
	TCAS II Version 7.1
	ADS-B required
	Mode S transponder with ADS-B capability
	Two independent TSO C145/146 or TSO C196 GNSS (with CAO 20.91 nav authorisation), or
	One TSO C145/146 or TSO C196 GNSS, and One ADF or VOR (TSO'd) and CAO 20.91 nav authorisation
	One independent TSO C145/146 or TSO C196 GNSS (with CAO 20.91 nav authorisation)
	Two independent TSO C145/146 or TSO C196 GNSS (with CAO 20.91 nav authorisation); or
	One TSO C145/146 or TSO C196 GNSS; and One ADF or VOR (TSO'd) and CAO 20.91 nav authorisation
	One independent TSO C145/146 or TSO C196 GNSS (with CAO 20.91 nav authorisation)
	ADS-B required
	Mode S transponder with ADS-B capability
	Two independent TSO C145/146 or TSO C196 GNSS (with CAO 20.91 nav authorisation), or
	One TSO C129, TSO C145/146 or TSO C196 GNSS, and One ADF or VOR (TSO'd) and CAO 20.91 nav authorisation
	One TSO C145/146 or TSO C196 GNSS (with CAO 20.91 nav authorisation), or
	One TSO C129, TSO C145/146 or TSO C196 GNSS, and One ADF or VOR (TSO'd) and CAO 20.91 nav authorisation
	ADS-B required

Notes

3. Aircraft with stand-alone GNSS may be covered by the deeming provisions of CAO 20.91.

4. TSO C145a, C146a or C196 GNSS is required for ADS-B per CAO 20.18 Appendix XI.

ICAO FLIGHT PLAN CHANGES

On 15 November 2012, changes to the ICAO flight notification form and flight planning procedures were implemented. They affect all airspace users who file flight plans and the air traffic management (ATM) systems that process those flight plans.

What you need to know

Operators need to be aware of the new flight planning form and the changes to the descriptors used in the various equipment fields. In particular, Flight Notification Block 10 indicates that:

» designated equipment is fitted to the aircraft and is serviceable

» equipment and flight crew are qualified for the intended operation

» the crew (or AOC holder) hold the required navigation authorisations.

Smaller operators who use the flight planning capability on the Airservices website should be aware of the changes.

In particular, changes to STS/entries in 'Item 18 Other Information' will be significant; for example, SARTIME. Additionally, Estimated Time of Departure will be replaced by Estimated Off-Block Time (EOBT).

The following documents will help you to prepare for flight planning in the new format:

» Flight Notification Form

» Flight Planning Guidance Notes

These can be found in the November 2012 AIP update.

For more information, see the ICAO flight plan 2012 section on the Airservices website **www.airservicesaustralia.com/projects/icao-flight-planning-amendment-1/** or email **flightplan2012@airservicesaustralia.com**

GNSS flight plan entries

For aircraft equipped with stand-alone GNSS and meeting the requirements for GPS RNAV en route, terminal and non-precision approaches, the following is a guide to the flight plan entries required for the navigation elements:

Item 10a:

G is required to indicate GNSS and R is required to indicate PBN; R requires corresponding entries in Item 18.

S for standard equipment now does not include ADF; F must be added separately if the aircraft is equipped with ADF.

Z for other equipment carried or other capabilities.

Item 18:

Add PBN/ O2S1 for RNP 1 and RNP APCH—LNAV.

Add NAV/ RNP2 for RNP 2.

FAQS

1. How is the airspace changing?

Under conventional navigation, aircraft flew from ground aid to ground aid using VORs or NDBs. With area navigation, a GNSS provides the aircraft with the location of where it is. In the database of the on-board navigation system are waypoints that, unlike the steel and concrete of ground aids, are virtual (only in numbers). The aircraft flies between the waypoints and is freed from having to navigate between fixed points on the ground.

2. If the satellites already exist and aircraft have GPS in them, what is changing?

PBN sets standards for safe satellite-based navigation, taking advantage of the accuracy satellite systems can provide. In PBN, the navigation specifications are navigation performance standards an aircraft must meet to operate on a specific route or in particular airspace. They are all GNSS based, but differ in their accuracy and functional requirements. For many operators, who have been doing PBN for years, there will be minimal change.

3. Do pilots' licences or instrument rating endorsements on pilots' licences need to change?

- For already-qualified pilots, there are no changes. Pilots wanting to qualify for a GNSS instrument rating must:
- complete the training specified in CASR Part 61; and
- obtain a licence Instrument Rating.

4. I'm a private IFR pilot. Can't I just fly using VORs, NDBs and DME, as I've always done?

Yes, but be aware that you will have to fit a TSO-approved GNSS unit to your aircraft by 4 February 2016. You should also know there will be fewer ground-based navaids. In 2016, about

200 ground aids (VOR, NDB, DME) will be turned off. Decommissioning these will leave the remaining navaids to form the back-up navigation network (BNN), which is intended to run until 2025. Many of the navaids that will be decommissioned are already at the end of their operational lives.

5. What are the impacts to aircraft operators of the navigation aids being turned off?

Aircraft equipped with TSO C145/146 GNSS will not need to carry a non-GNSS alternate means of navigation. In these aircraft, alternates can be planned for using GNSS. But aircraft equipped with TSO C129 GNSS must carry an alternate means of navigation that is not GNSS. Their planning for alternates must not be based on GNSS. For general aviation aircraft this means that they will have to carry ADF or VOR equipment in addition to GNSS.

6. Where are the official instructions and directions for performance based navigation?

They can be found in CAO 20.91.

7. Is CASA going to provide any other instructions or directions?

Yes. Advisory circulars and other advisory material have been published. See **www.casa.gov.au/cns** for further information.

8. There are more navigation specifications in the PBN Manual than in CAO 20.91. Are these going to be implemented in Australia?

Yes. The 2014 version of CAO 20.91 will have these additional specifications.

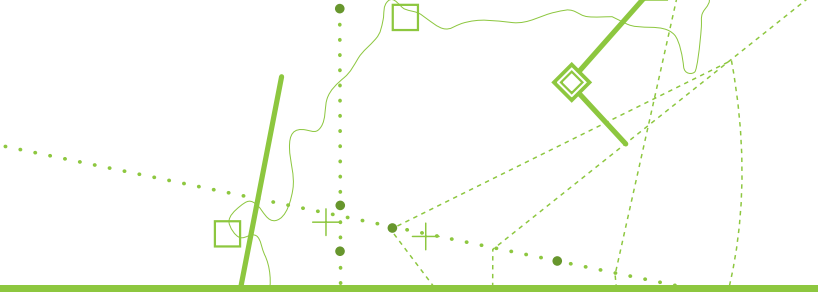
9. Australian RNAV routes have no PBN designations, so how is PBN being implemented?

An airspace/route structure transition plan is in development with Airservices that will transition Australian airspace to PBN by February 2016. The plan will be published in an updated PBN Implementation Plan Version 2.

GLOSSARY

A	
AC	Advisory circular
AFM	Aircraft flight manual
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AOC	Air Operator's Certificate
Approval	Approved by CASA. (See also subregulation 2(1) of CAR 1988. Unless otherwise indicated, CASA issues approvals in writing.)
APV	Approach with vertical guidance
AR	Authorisation required
ARINC 424 path terminator	Aeronautical Radio Incorporated Specification 424 format for coding airborne navigation databases
ARP	Aerodrome reference point
ATC	Air traffic control
ATM	Air traffic management
B	
B-RNAV	Basic area navigation
Baro-VNAV	Barometric vertical navigation

C	
CAAP	Civil Aviation Advisory Publication
CAO	Civil Aviation Order
CAR 1988	Civil Aviation Regulations 1988
CBT	Computer-based training
CDI	Course deviation indicator
Cross-track error/ deviation	Perpendicular distance between the planned flight path of an aircraft and the computed aircraft position as displayed by the aircraft's navigation instruments
D	
DA	Decision altitude
DME	Distance measuring equipment
E	
EASA	European Aviation Safety Agency
(E)HSI	Electronic horizontal situation indicator
EOBT	Estimated Off-Block Time
ETD	Estimated time of departure
ETSO	European technical standard order
F	
FAA	US Federal Aviation Administration
FAF	Final approach fix
FAP	Final approach point
FCC	Flight control computer
FMC	Flight management computer
FMS	Flight management system
FTE	Flight technical error

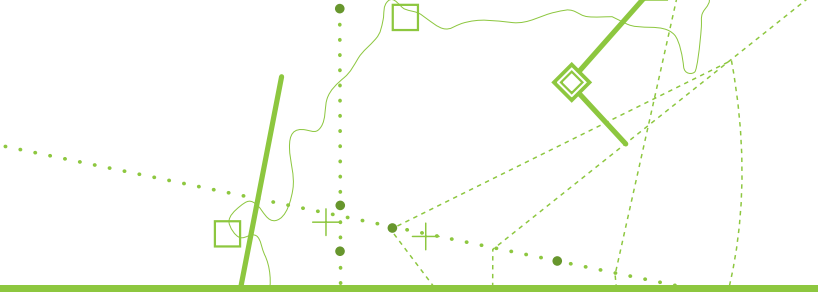


G	
GNSS	Global navigation satellite system
GPS	Global positioning system
H	
HSI	Horizontal situation indicator
I	
IAF	Initial approach fix
IAL	Instrument approach to land
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
INS	Inertial navigation system
IRS	Inertial reference system
IRU	Inertial reference unit
L	
L/DEV	Lateral deviation
LNAV	Lateral navigation
Long range navigation system	Navigation system comprising an INS, an IRS, or a GNSS capable for use in oceanic or remote airspace
LP	Localiser performance
LPV	Localiser performance with vertical guidance
M	
MCTOW	Maximum certified take-off weight
MDA	Minimum descent altitude
MEL	Minimum equipment list
MMR	Multi-mode receiver
MNPS	Minimum navigation performance specifications
MOC	Minimum obstacle clearance

N	
Navaid	Navigation aid; for example, VOR
Navigation specification	One of the PBN navigation specifications mentioned in subsection 11 of CAO 20.91
NDB	Non-directional beacon
NOTAM	Notice to airmen
NPA	Non-precision approach
O	
OEI	One Engine Inoperative
OEM	Original equipment manufacturer
P	
PBN	Performance based navigation
PF	Pilot flying
Pilot in command	When used in the CAO 20.91 appendix, means the pilot in command of the PBN operation to which the appendix applies
PNF/PM	Pilot not flying/pilot monitoring
P-RNAV	Precision area navigation
Q	
QNH	Barometric pressure setting which will cause an altimeter to read altitude relative to mean sea level
QRH	Quick reference handbook

R	
RADALT	Radio altimeter
RF	Radius to fix
RNAV	Area navigation
RNP	Required navigation performance
RNP AR APCH	RNP AR approach
RNP AR DEP	RNP AR departure
S	
SBAS	Satellite-based augmentation system
SCNS	Self-contained navigation system (IRS or GNSS)
SID	Standard instrument departure
SIS	Signal in space
STAR	Standard terminal arrival route

T	
TAWS	Terrain awareness and warning system
TSE	Total system error
TSO	Technical standard order
U	
UAT	Universal access transceiver
US	United States
V	
V/DEV	Vertical deviation
VIP	Vertical intercept point
VNAV	Vertical navigation
VOR	Very high frequency (VHF) omni-range
VPA	Vertical path angle
VSD	Vertical situation display



KEY DATES FOR PBN AND ADS-B

Date	Applicable to	Requirement
6 June 2007	All aircraft	Non-complying ADS-B must be disabled (Equipment standards and operational requirements)
12 December 2013	Aircraft operating at and above FL290	ADS-B required
1 January 2014	Turbine-powered commercial aeroplanes first registered on or after 1 January 2014 with MTOW > 5,700 kg but < 15,000 kg or > 19 passengers but < 31	TCAS II Version 7.1 required
	Turbine-powered commercial aeroplanes with MTOW > 15,000 kg or > 30 passengers	TCAS II Version 7.1 required (or approved TCAS II if fitted before 1 January 2014)
6 February 2014	Turbine-powered commercial aeroplanes first registered on or after 1 January 2014 with MTOW > 5,700 kg but < 15,000 kg or > 19 passengers but < 31	ADS-B required
	All aircraft first registered and existing aircraft modified on or after 6 February 2014 and: Operating in Class A, B, C, or E airspace; or Operating above 10,000 ft in Class G airspace	ADS-B capable Mode S transponder
	IFR aircraft first registered or existing aircraft modified on or after 6 February 2014 engaged in RPT or CHTR operations	2 × TSO C145/146 or TSO C196 GNSS required; or 1 × TSO C145/146 or TSO C196 GNSS plus 1 × ADF or VOR
	IFR aircraft first registered or existing aircraft modified on or after 6 February 2014 engaged in AWK or private operations	1 × TSO C145/146 or TSO C196 GNSS
4 February 2016	Existing IFR aircraft in RPT or CHTR operations	2 × TSO C145/146 or TSO C196 GNSS required; or 1 × TSO C129, TSO C145/146 or TSO C196 GNSS plus 1 × ADF or VOR
	Existing IFR aircraft engaged in AWK or private operations	1 × TSO C145/146 or TSO C196 GNSS required; or 1 × TSO C129 plus 1 × ADF or VOR
	IFR aircraft operating in Class A, B, C or E airspace within 500 NM quadrant north and east of Perth airport	ADS-B required
	All aircraft operating at Brisbane, Sydney, Melbourne or Perth aerodromes	ADS-B capable Mode S Transponder required
	Airspace becomes GNSS based PBN exclusive	RNP 2 en route and RNP 1 for terminal procedures
2 February 2017	Existing IFR aircraft on the Australian register before 6 February 2014	ADS-B required

Notes:

1. Refer to CAR Part 14 Division 5 for full details of ACAS requirements.
2. Refer to CAO 20.18, CAO 82.1, CAO 82.3, CAO 82.5 and CASA 521/09 for full details of ADS-B, GNSS and Mode S requirements.
3. Refer to CAO 20.91 for full details of PBN requirements.
4. Navigation authorisations are required for PBN operations.
5. Aircraft with stand-alone GNSS may be covered by the deeming provisions of CAO 20.91.

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