DEFENCE COMPLIANCE WITH CIVIL ADS-B AND PBN REQUIREMENTS

References:

A. Civil Aviation Order 20.91 – (Instructions and directions for performance-based navigation) Instrument 2014 of 11 Dec 14

B. Minute – DACPA – ADS–B Airspace of 24 Feb 16 (AB26455761)


D. Aeronautical Information Circular (AIC) H10/2016 – Australia’s Transition to a Performance Based Navigation Environment of 27 Apr 16

E. Civil Aviation Order 20.18 – (Aircraft equipment – basic operational requirements) Instrument 2014 of 29 Aug 16

F. AAP 7001.054 – Electronic Airworthiness Design Requirements Manual (eADRM)


Purpose

1. This Advisory Circular (AC) provides advice regarding Defence conformance with civil aviation Communication, Navigation and Surveillance (CNS) requirements, specifically Automatic Dependent Surveillance – Broadcast (ADS–B) and Performance Based Navigation (PBN) requirements.

2. IAW Reference A, CASA is implementing ADS–B and PBN as legislated requirements using a phased approach. While Reference B provides formal advice that Defence has retained the right of the exemption for State aircraft, any non-compliance with Reference A may impact on Defence aviation operations, particularly in airspace not managed by Airservices Australia. Accordingly Defence compliance, where practicable, is required in order to maintain operational focus and mission flexibility. The advice contained within this AC provides direction on achieving required performance outcomes.

3. This AC addresses the requirements for Australian airspace, however, international obligations may also require consideration. Should compliance be achieved for Australian airspace, it is likely the determinations achieved would also address the majority of international obligations. The research paper Mission Effectiveness and European Airspace: U.S. Air Force CNS/ATM Planning for Future Years covers many of the European

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1 Directions issued under regulation 11.245 of the Civil Aviation Safety Regulations 1998 have a period of effect up to a prescribed specific day (on which it ceases to be in force) or for 1 year after the day it commences.


3 A copy of this study conducted by the MITRE Corporation is available at Objective ID D5575572.
CNS/ATM topics and includes specific reference to foreign requirements and USAF operational tasking areas.

Scope

4. This AC applies to all Defence registered aircraft. For non-Defence registered aircraft operated by or on behalf of Defence, the expectation is that those aircraft will have achieved compliance via the civil system of assessment and approval.

Acronyms and definitions

5. The acronyms and definitions used in this AC are provided at Annex A.

Background

6. Air Traffic Management (ATM) systems progressively moved from a reliance on ground based surveillance (RADAR) and non-surveillance based controls (procedural separation) toward aircraft based equipment providing the aircraft’s position to ground receiving stations (ADS–B).

7. Traditional sensor-specific navigation was based largely on fixed ground based beacons (NAVAIDs) guiding aircraft along published routes via waypoints defined by these beacons. Navigation using legacy ground aids is ‘relative navigation’ since aircraft are always operating relative to NAVAIDs. PBN is area navigation utilising on-board systems based on global navigation satellite systems (GNSS). PBN is ‘absolute navigation’, in that the aircraft system first determines its position in terms of latitude and longitude, and then where this position is in relation to the intended flight path. The navigation requirements are defined in terms of the accuracy, integrity, continuity and functionality required for the proposed operations.

8. PBN encompasses two types of navigation specifications: RNAV (aRea NAVigation), and RNP (Required Navigation Performance). The difference between RNAV and RNP is that onboard performance monitoring and alerting is required for RNP but not for RNAV operations.

9. Under PBN, common Australian operational navigation specifications are:
   a. RNP – Approach (APCH)
   b. RNP 1—for Standard Instrument, Departures (SID) and Standard Terminal Arrival Routes (STAR)
   c. RNP 2—en route.

Civil ADS–B and PBN compliance timelines

10. ADS–B. All existing Australian civil registered instrument flight rules (IFR) aircraft must be ADS–B compliant by 02 Feb 17. Defence aircraft are expected to comply with ADS-B carriage in accordance with (IAW) Reference C.

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4 Refer CASA Advisory Circulars – AC 91.U-01 Navigation authorisations v1.0 of May 2015 provides more detailed PBN requirements.

5 Under RNAV–GNSS, these were en route, terminal and non-precision approach.

6 Aircraft not capable of RNP 2 will have limitations concerning LSALT altitudes depicted on ERC Australia.
11. **PBN.** From February 2014, all new Australian civil registered aircraft additions that operate IAW IFR must be equipped with European Technical Standing Order (ETSO) C145, C146 or C196 compliant GNSS, unless equipped with a CASA approved multi-sensor navigation system that includes GNSS – inertial integration. The RNP 1 and RNP 2 navigation specifications have been developed on the basis of these ETSO, consequently the **GNSS mandate** implies that all Australian registered IFR aircraft will be RNP 1 and RNP 2 capable.

12. **RNP 1 and RNP 2 ICAO PBN Nav Specs** will become the standard navigation specifications for terminal area (SID and STARS) and continental enroute operations within Australia. CASA will progressively implement RNP 2 exclusive routes and RNP 1 exclusive SID and STARS from May 2016. Operations under other **PBN Nav Specs** will be permitted in accordance with, and subject to, the Operating Specification requirements defined for those PBN Navigation Specifications.

13. As advised at Reference D, the **GNSS mandate** has allowed Airservices Australia to implement the Navigation Rationalisation Project (NRP), with a reduction in ground based navigation aids capability by approximately 50% with the decommissioning of about 190 ground based aids. While the remaining network of navigation aids will form the Backup Navigation Network (BNN), the limited number and wide geographical spacing of BNN navaids may not be capable of sustaining navigation services to all flight planned destinations.7


15. Reference E, 9B.5 states if an aircraft carries serviceable ADS-B transmitting equipment that complies with an approved equipment configuration, the equipment must be operated continuously during the flight in all airspace at all altitudes, unless the pilot is directed or approved otherwise by ATC. As noted in Reference C, Defence may have operational requirement to disable ADS-B in flight. When ADS-B is disabled, the Aircraft Captain should ensure that appropriate advice is provided to ATC or other operational mitigations are applied. As advised in Reference D, some ATC discretion at or above FL290 for ADS-B disabled aircraft may be required dependent upon traffic management considerations at the time. If not operationally urgent, State aircraft should accept delays as appropriate.

**Defence Compliance**

**ADS-B**

16. Reference C provided CASA assurance that Defence was cognisant of the impending civil ADS-B requirements and that required ADS–B equipment would be fitted to Defence aircraft by 2018, with the exception of those aircraft scheduled for withdrawal from service between 2018 and 2020.9 Some recent aircraft acquisitions may already be compliant at acquisition.

17. Airworthiness design requirements for Defence aircraft required to operate in ADS-B airspace are defined in Reference F, Section 3, Chapter 5 **Surveillance and Avoidance**

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9 JP90 manages ADS–B compliance for some aircraft upgrades.
As noted in Reference G, the focus of this AC is on Defence aircraft compliance for ADS-B operations in Australian airspace, however, there remains a possibility that technical requirements for ADS-B operations in foreign airspace may not be satisfied through compliance with CASA mandated ADS-B requirements. Consequently, before a decision is made on the minimum technical capabilities for a Defence aircraft – for example, transmitted ADS-B data messages – the need for capability in excess of the minimum CASA requirements to facilitate operations in foreign airspace should be established.

18. Position and other flight parameters derived from GNSS are critical to the effective operation of ADS-B. Operational ADS-B approvals therefore rely on the provision of position data from an accurate data source, usually a TSO certified GNSS, however, the requirements for ADS-B are more stringent than the navigation requirement. Options other than technical compliance through a Mode S transponder with ADS–B capability may not be viable. In those circumstances where Defence aircraft do not have an appropriately certified GNSS installed, ADS-B compliance based on assessment of a GNSS ‘equivalency’ may be possible and should be investigated before modifying the aircraft to install a TSO certified system.

PBN

19. Reference G provides direction for Defence aircraft to conform to civilian PBN requirements at Reference E and sought support from capability providers to achieve this outcome. Unlike ADS–B, in addition to technical compliance, PBN compliance may be demonstrated by a statement of PBN equivalence for the relevant navigation performance. The statement could be based on the ability of the aircraft’s overall performance, including flight crew contributions that can mitigate technical deficiencies and deliver the expected PBN performance outcome. For example, onboard performance monitoring and alerting by the non-flying pilot.

20. Should evaluation of the ‘complete aircraft system’ demonstrate compliance with the RNP outcome sought, flight approval could be issued. Such approval should be identified in the aircraft’s Statement of Operating Intent and Usage (SOIU). Once approved, no civil notifications are required other than standard flight plan notification.

PBN Assessment of Defence Aircraft

21. The airworthiness design requirements for PBN operations in civil airspace are defined in Reference E. In all cases where access to civil PBN airspace is sought for a Defence aircraft, PBN compliance of the aircraft’s technical capabilities should initially be established against the prescribed airworthiness design requirements in Reference F. Where a Defence aircraft exhibits shortfalls against these requirements, appropriate treatment should be implemented, including potential operational treatment.

22. The GNSS equipment performance standards determine the PBN capability of an aircraft. The GNSS equipment required for PBN operations is influenced by a number of factors which may vary between individual routes, therefore while the equipment fitted to the aircraft may be suitable for a particular operation, specific equipment configurations and/or additional approvals may be required (e.g. oceanic approval). To determine the level of compliance for Defence aircraft an assessment should include:

a. Evaluation of operational and technical options, as well as organisational options.

10 MilSTD 461 also holds PBN requirement that may be equivalent to TSO.
12 Flight Information Handbook Australia (FIHA) Enroute (ENR) also lists CAO 20.91 information.
b. Consideration of the ATM objectives and supporting CNS elements that are most suitable for each scenario.

c. PBN systems technology including the technical feasibility of installing required equipment in the relevant platform.

d. Global and regional CNS/ATM plans, including regional air navigation plans for the designated areas of operation.

e. The State's principle objectives in implementing CNS/ATM systems, especially current and planned infrastructures including airports, airspace, air routes and CNS elements.

f. National implementation timelines for new systems and decommissioning timelines for current ground systems.

g. The expected operational benefit offered by implementing PBN systems.

h. The expected operational impact of not implementing PBN systems.

i. The frequency of operation in airspace requiring PBN capabilities and the national ATM authorities expected prioritisation of non-compliant aircraft.\(^\text{13}\)

j. Planned upgrade or platform replacement/PWD schedules.

k. The acquisition, approval and manipulation of aeronautical digital data for use in mission planning systems that is regularly uploaded to Defence aircraft that utilises appropriate procedural restrictions and operation requirements.

l. The personnel, training, maintenance, engineering, aeronautical, performance monitoring/report information and logistic support infrastructure, and airworthiness certification required to support introduction and use of selected CNS/ATM compliant aircraft and ground mission planning systems.

23. The preceding PBN considerations provide a holistic framework for establishing conformance with PBN requirements through assessment of all factors to determine the suitability of a Defence aircraft for PBN operations.

24. The outcomes of this analysis should be subjected to a cost-benefit analysis to determine the most appropriate solution. A safety case should also be developed as part of, or separate to, the cost-benefit analysis.

**PBN Approval**

25. Approvals for the conduct of PBN operations by Defence aircraft in Australian or International airspace are the responsibility of operational commanders (COMAUSFLT, COMD FORCOMD and ACAUST)\(^\text{14}\). Such approvals should consider the following:

a. Certification to an appropriate standard of all relevant CNS and PBN systems is complete, approved and authorised

\(^{13}\) Reference A provides formal advice regarding priorities for State aircraft not yet ADS-B equipped.

\(^{14}\) Any delegation of approval authority to a Military Air Operator (MAO) may be controlled by the SOIU approval process.
b. the minimum equipment required to be fitted and serviceable on the aircraft is documented in a Minimum Equipment List (MEL), and that:

1. the MEL identifies any unserviceability that affects the conduct of any PBN operation
2. the MEL identifies the systems that GNSS interfaces with, so that in the event of GNSS being inoperative, the full impact of the failure can be readily determined.

c. the minimum information required for Defence mission planning systems that upload digital data for autonomous navigation and Autonomous Approach (AAP) is documented for the conduct of any PBN operation.

d. PBN operational procedures, including normal and emergency, are approved and published in OIP.

e. any aircraft and operational limitations to be documented in OIP.

f. training requirements for aircrew and aircrew competencies and currency

g. management and training of mission planning specialists for aircraft specific mission planning systems.

h. digital navigation data (including map and chart data) coverage, acquisition, manipulation and management to encompass areas of Defence aircraft operations.

i. management of Electronic Flight Bags (EFB)

j. monitoring, review and incident reporting.

Summary

26. Defence harmonisation with the civil PBN system ensures the retained level of risk presented to civil aircraft due Defence aircraft operating within civil PBN airspace is mitigated So Far As is Reasonably Practicable (SFARP). Defence aircraft may be equipped with systems that, while not identical to a specific civil certification, may obtain an equivalent navigational outcome to provide operational approval to conduct RNP 1, RNP 2 or both. Where PBN equivalence may not be achievable, Defence will strive to obtain civil compliance. Where aircraft modifications are not considered value for money due to aging platforms and prohibitive costs, Defence will use the Civil Aviation Act State aircraft provision in order to operate as non-compliant aircraft within PBN airspace, noting some operational delays may be incurred in such cases.

27. Further advice may be obtained from ACPA or DGTA–ADF as appropriate.

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Defence Aviation Authority
Related documents:
1. AC 91.U-04 Airworthiness requirements for performance based navigation
3. CAO 20.18 Aircraft Equipment - basic operational requirements
5. AIC H11/16 – Airservices Navigation Aid Rationalization Project (NRP)
6. FAA Global Navigation Satellite System Update – ICG–6 Deborah Lawrence FAA of 05 Sep 11
ACRONYMS AND DEFINITIONS

Automatic Dependent Surveillance – Broadcast (ADS–B): a surveillance technology in which an aircraft determines its position via satellite navigation and periodically broadcasts it, enabling it to be tracked. The information can be received by air traffic control ground stations as a replacement for secondary radar. It can also be received by other aircraft to provide situational awareness and allow self separation. ADS–B is "automatic" in that it requires no pilot or external input. It is "dependent" in that it depends on data from the aircraft's navigation system.

Aircraft address: a unique code of 24 binary bits assigned to an aircraft.

Alternate Means of Navigation: the use of information from an area navigation system in lieu of that from conventional ground based navigation aids and navigation equipment that is installed, operational and compatible with conventional navigation aids.

Autonomous Navigation (ANAV) A method of navigation which permits aircraft operation on any desired flight path utilising self contained systems (INS/IRS).

Autonomous Approach (AAP) A method of conducting an instrument arrival procedure independent of any ground or GPS based landing system.

APCH: Approach

Area Navigation: A method of navigation using systems which permits aircraft operation on any desired flight path within the coverage of ground or space-based navigation aids, or within the limits of the capability of self contained aids, or a combination of these.

AR: Authorisation Required

ATSO: Australian Technical Standard Order of CASA

Communications, navigation, surveillance and air traffic management systems (CNS/ATM): Communications, navigation, and surveillance systems, employing digital technologies, including satellite systems together with various levels of automation, applied in support of a seamless global air traffic management system.\(^{15}\)

Ground based augmentation system (GBAS). A satellite based precision landing system that provides very precise horizontal and vertical positioning guidance during the final stages of an approach. GBAS are commonly composed of one or more accurately surveyed ground stations, which take measurements concerning the GNSS, and one or more radio transmitters, which transmit the information directly to the end user from the ground up thus avoiding the constraints associated with GEO Satellites at high latitudes. Generally, GBAS is localised, supporting receivers within 23 nautical miles, and transmitting in the very high frequency (VHF) band. The shorter the distance between the ground station that calculates the differential corrections to the inbound plane, the higher the accuracy is likely to be.

Ground based regional augmentation system (GRAS). A system that supports augmentation through the use of terrestrial radio messages.

Global Navigation Satellite System (GNSS): A GNSS installed in an aircraft to continually determine precise position and time of the aircraft by use of the GPS. Navigation systems to be named GNSS are assessed against a US Federal Aviation Administration (FAA) Technical Standard Order (TSO).

Global Positioning System (GPS): a GNSS created and maintained by the United States government freely accessible to anyone with a GPS receiver.

Inertial Navigation / Reference System (INS/IRS): A self-contained navigation system that continually measures the accelerations acting upon the vehicle of which it is part. Suitably integrated, these forces provide velocity and thence position information.

Long range navigation system: a navigation system comprising an INS, an IRS or a GNSS capable of use in oceanic or remote airspace.

Mode S: a monopulse radar interrogation technique that improves the accuracy of the azimuth and range information of an aircraft, and uses a unique aircraft address to selectively call individual aircraft.

Navigation specification: a set of aircraft and flight crew requirements needed to support PBN operations within a defined airspace, of which there are two types: RNAV and RNP.

Performance-based Navigation (PBN): area navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace.

PBN Airspace: an area, route or procedure (the designated environment) in respect of which all or any of the following requirements must be satisfied, before an aircraft to which PBN applies is able to use PBN:

a. aircraft navigation equipment requirements that the aircraft must satisfy

b. aircraft navigation equipment installation that the aircraft must satisfy

c. aircraft navigation system functional and performance requirements that the aircraft must satisfy

d. navigation specifications (RNAV or RNP) applicable in the designated environment, for which the aircraft must hold an authorisation or approval

RAIM: Receiver Autonomous Integrity Monitoring (RAIM) provides integrity by detecting the failure of a GNSS satellite. RAIM may be either Fault Detection (FD) or Fault Detection & Exclusion (FDE).

RNAV: a method of navigation which permits an aircraft to operate on any desired flight path within one or both of the following:

a. the coverage of ground-based or space-based navigation aids

b. the limits of the capability of a self-contained navigation system with which the aircraft is equipped.
**RNAV Specification**: a navigation specification based on area navigation that does not include the requirement for on-board performance monitoring and alerting, designated by the prefix RNAV. For example, RNAV 5, RNAV 1.

**RNP Specification**: a navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, designated by the prefix RNP. For example, RNP 4 or RNP APCH. Minimum Aviation System Performance Standards (MASPS) EUROCAE/RTCA ED-75/DO-236 details the requirements for accuracy, integrity, and continuity for RNP.

**RNP APCH**: An aircraft conducting a GNSS Arrival will transition from Terminal Mode (RNP-1) to Approach Mode at the Initial Approach Fix (IAF). At the Final Approach Fix (FAF) the GNSS equipment transitions to Final Approach Mode (RNP APCH) to the Missed Approach Point (MAPt). The RNP values associated with the phases are IAF–FAF (1.0NM), FAF–MAPt (0.3NM) and MAPt–IAF or within Terminal area (1.0NM). RNP AR values are coded into all approach segments.

**RNP-AR**: a specialised approach characterised by RNP values less than or equal to 0.3NM and/or curved flight path before and after the FAF or FAP. The protection areas are laterally limited to 2 x RNP value without any additional buffer. These approach procedures are always designed to be flown with baro–VNAV capability.

**RNAV System**: a navigation system using positioning inputs from GNSS or an inertial reference unit.

**Satellite based augmentation system (SBAS)**. A system that complements existing GNSS to compensate for certain disadvantages of GNSS in terms of accuracy, integrity, continuity and availability. An example of SBAS is the European Geostationary Navigation Overlay Service (EGNOS). There are stricter safety requirements on GBAS systems relative to SBAS systems since GBAS is intended mainly for the landing phase where real-time accuracy and signal integrity control is critical, especially when weather deteriorates to the extent that there is no visibility (CAT-I/II/III conditions), for which SBAS is not intended or suitable.\(^\text{16}\)

**Self-contained navigation system**: one of INS, IRS or GNSS.

**Non-TSO GNSS**: Non-TSO GPS receivers are not required to meet any regulatory standards for power supply, installation, lighting, database, integrity monitoring or performance.

**TSO-C129**: TSO-C129 and the later C129a version specify minimum performance standards for approved GPS equipment and include integrity monitoring. Not all TSO-C129 receivers meet the requirements for non-precision approaches, and TSO-C129 receivers are not able to take advantage of enhanced GNSS capabilities enabled by SBAS, GBAS or GRAS.

**TSO-C145a and TSO-C146a**: TSO-C145a is a standard for airborne GPS sensors providing data to a flight management system, while TSO-C146a is for stand-alone GPS receivers. The principal improvements over the TSO-C129 standard are RAIM (FDE), the capability to use SBAS augmentation, and a greater standardisation of displays and controls. TSO-C145a and C146a receivers are approved for the same IFR applications as the TSO-C129 generation, but not subject to the same contingency requirements when supported by a suitable prediction of FDE.

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\(^{16}\) FAA Global Navigation Satellite System Update – ICG–6 Deborah Lawrence FAA of 5 Sep 11