

Australia's Policy Approach to Baro-VNAV Implementation

1. Objective

This document outlines Australia's approach to the implementation of Barometric Vertical Navigation (Baro-VNAV) procedures to improve aviation safety, by reducing the risk of Controlled Flight into Terrain (CFIT) whilst on approach to landing. An expanded availability of Approach Procedures with Vertical Guidance (APV) through the introduction of Baro-VNAV procedures will also reduce the risk of runway overruns by enhancing stability in the approach.

Greater use of APV complements other actions being taken by aviation agencies to improve safety for all aircraft and aerodrome operations, such as the implementation of straight-in lateral navigation (LNAV) approaches (referred to as RNAV GNSS approaches in Australia's Aeronautical Information Publications suite) where practicable.

2. Background

In 2007, International Civil Aviation Organization (ICAO) Resolution A36-23 urged Member States to put in place measures aimed at mitigating the threat of CFIT during approach and landing for Instrument Flight Rules (IFR) aircraft.

The risk of CFIT whilst on approach to landing is considered a significant aviation safety hazard. ICAO supports implementation of APV as mitigation against CFIT on approach to landing. The adoption of APV complements other aviation safety measures, in that it increases the likelihood that an approach to land will be flown in a stabilised manner with attendant reduction to the risk of CFIT. APV also provides effective mitigation against runway overrun by optimising the point of touchdown.

The enabling technology for the vertical guidance component of APV currently is through the Global Positioning System (GPS) with Satellite Based Augmentation Systems (SBAS) or appropriate Baro-VNAV avionics supported by facilities and services providing an accurate aerodrome barometric pressure reading (QNH) for each approach.

It is important to note that the addition of vertical guidance through Baro-VNAV to an otherwise laterally guided approach does not necessarily improve the landing minima available for a particular approach. However, in many cases the landing minima (i.e. the Decision Altitude – DA – in the case of a Baro-VNAV approach) may be lower (i.e. better) than that for a runway aligned RNAV GNSS approach (i.e. the Minimum Decision Altitude - MDA) at the same location.

Safety is improved through significant gains in pilot situational awareness and less intense workload and operating techniques as a result of incorporating a stabilised descent rather than the stepped 'dive and drive' descent profiles otherwise common with laterally guided approaches.

In October 2010, recognising that not all aerodromes or IFR aircraft would become suitably equipped for APV, ICAO superseded Resolution A36-23 with Resolution A37-11. This Resolution supported Member States implementing the use of straight-in LNAV approach procedures at those aerodromes where an APV Approach Procedure could not be designed to meet ICAO Design Criteria.

Specifically, Resolution A37-11 calls for the implementation of straight-in LNAV procedures, as an exception to APV, for instrument runways at aerodromes where there is no local altimeter setting available and where there is no aircraft suitably equipped for APV operations with a maximum certified take-off mass of 5,700kg or more.

Noting that most air transport jet and many turbo-prop aircraft operating in Australia (estimated to be carrying more than 95 percent of fare-paying passengers) are already equipped with Baro-VNAV avionics, there is a strong safety rationale for implementing Baro-VNAV approaches across Australia where it is practicable to do so.

In this regard, Australia has already introduced some RNP-AR approach procedures utilising barometric vertical guidance. These are currently in use at approximately 20 Australian airports for specific airframes and operators.

3. Barometric Vertical Navigation Systems

APV Baro-VNAV procedures may be used by IFR aircraft equipped with avionics certified for Baro-VNAV approach operations.

The aircraft position is continuously determined compared to the Approach Path defined in the Approach Procedures, and deviation from path (lateral and vertical) are displayed to the pilot and may be used to drive the autopilot.

Specifically, a certified flight management system (FMS) or other suitably certified area navigation system capable of constantly computing barometric VNAV paths and displaying the relevant deviations on the instrument display is required.

APV Baro-VNAV operations require accurate aerodrome QNH (not area QNH) and temperature to be available. The QNH and temperature is measured by sensors on an Automatic Weather Station (AWS) and provided to the aircraft through an Aerodrome Weather Information Service (AWIS) with a VHF broadcast capability (referred to as an AWIS-VHF) or through an Automatic Terminal Information Service (ATIS) generally associated with Control Tower operations.

The adoption of Baro-VNAV is seen as providing a safety benefit, at a reasonable cost, at airports served by regular public transport (RPT) and other passenger transport operations (PTO) with aircraft that are equipped and where crews are trained for Baro-VNAV approaches.

However there are a number of smaller regional airports at which Baro-VNAV approach procedures are not immediately possible because they are used by aircraft which do not have Baro-VNAV capability; the required broadcast QNH or temperature data is not available; and/or other operational or geographical factors preclude implementation of a Baro-VNAV approach.

At these airports Australia has in place straight-in LNAV approaches for at least one runway and is moving to expand the availability of these approaches to include both runway ends, where this is practicable (see Section 7).

APV procedures contribute to a stabilized approach that is characterised by a stable airspeed and a stabilized rate of descent. The APV flight path places the aircraft in a landing configuration at the optimum point where the aircraft would commence the flare manoeuvre for landing. The conduct of an APV procedure contributes positively to situational awareness by reducing flight crew workload at a critical stage of flight. This in turn reduces the risk of CFIT.

An APV procedure is a safety enhancement but also provides the potential for improved fuel efficiency by minimising the flight time at low altitudes. A stabilised approach also reduces noise levels and the probability of infringement of the required obstacle clearance during the final approach segment of the flight.

4. Implementation Steps

The key steps required in facilitating the introduction of Baro-VNAV approach procedures at Australian aerodromes and the entities responsible for each part are as follows:

a. Identification of Airports (CASA and Airservices)

Candidate airports for the introduction of Baro-VNAV procedures have been identified in the first instance, by applying the following criteria:

- Airports that have the necessary AWIS-VHF or ATIS or a combination of both providing accurate aerodrome QNH and temperature.
- An ICAO Design Criteria-compliant Baro-VNAV Approach Procedure can be designed for at least one runway end.
- Domestic and/or Regional airports that support Regular Public Transport (RPT) and/or Passenger Transport Operations (PTO) activity.

A full list of candidate airports, based on these criteria, is provided through the Airservices Australia website.

The list identifies more than 100 locations for the roll out of Baro-VNAV approach procedures in the first instance. Other locations are also identified for implementation of Baro-VNAV procedures subject to final confirmation that these meet the necessary requirements for supporting Baro-VNAV procedures.

The list includes Australia's international airports as well as a significant number of regional airports.

In addition to mitigation against CFIT events at regional airports, implementation of Baro-VNAV procedures at Australia's international airports would also provide a direct response to incidents where aircraft have descended below the prescribed minima whilst the ground-based Instrument Landing System (ILS) was out of service.

Baro-VNAV approach procedures would provide a backup approach procedure with vertical guidance at these airports if the precision approach is not available due to outage of the ILS, noting that ICAO Resolution A37-11 called for implementation of APV, including LNAV-only minima, for all instrument runway ends, either as the primary approach or as a back-up for precision approaches.

The roll out of Baro-VNAV procedures at candidate airports has been developed by CASA and Airservices, following consideration of industry comments, and taking into account Airservices' regular cycle of approach procedures design and maintenance and CASA's revalidation programme, as well as specific safety considerations including terrain issues, weather patterns, previous incidents, aircraft types and equipage, and aircraft and passenger movements at each airport location.

The roll out of Baro-VNAV procedures at candidate airports does not preclude the elevation of an individual airport to a higher level of priority in response to a clear safety imperative.

b. Design of Baro-VNAV Approach Procedures (Airservices or other Procedure Designers)

Airservices will produce Baro-VNAV approach procedures for those airports assessed as suitable candidates, having the required ATIS and/or AWIS-VHF capability, as part of Airservices regular cycle of approach procedures design and maintenance.

Some airports may choose to fund implementation of necessary infrastructure and services, required to support the introduction of Baro-VNAV approach procedures. In these circumstances, other instrument flight procedure design organisations approved under Part 173 of the Civil Aviation Safety Regulations 1998, may also be used to produce Baro-VNAV procedures.

c. Streamline the Methodology for Validating Baro-VNAV Approaches (CASA)

CASA currently undertakes the initial validation of new instrument approaches, while the revalidation is conducted under contract on a three-year rolling programme.

CASA has now finalised their position on the methodology for validation of Baro-VNAV procedures in Australia. Details of the methodology to be applied is available on the CASA website at <https://www.casa.gov.au/files/validationbarovnavpdf>. The methodology outlines CASA's two stage approach to flight validation in addition to a comparative precis of the methodology applied by other overseas administrations to Baro-VNAV procedure validation.

The procedure validation methodology that will be applied by CASA for Baro-VNAV requires validation of the flyability and navigation database coding in an aircraft simulator (validation in an aircraft that is suitably equipped for Baro-VNAV may also occur); and validation of obstacles and aerodrome infrastructure in an aircraft at the aerodrome.

This methodology has been applied due to *inter alia* Baro-VNAV approaches introducing new (generally lower) obstacle assessment surfaces that differ from the LNAV surfaces on which the Baro-VNAV procedure is based. As the controlling obstacles may differ between the LNAV and Baro-VNAV procedures, there is a need to validate obstacles relevant to each procedure at a location.

Within its safety mandate, CASA will continue to consider opportunities for streamlining the Baro-VNAV validation methodology. Generally, as the roll out of Baro-VNAV approaches continues and as CASA, operators and designers gain more experience with Baro-VNAV, CASA will continue to review the validation method for initial and revalidation of Baro-VNAV approaches.

As CASA has now finalised the validation methodology for the implementation of Baro-VNAV approaches at each location, more accurate estimates of the associated costings are now possible in the context of the proposed implementation schedule for Baro-VNAV.

It is intended that Baro-VNAV validation requirements will be aligned with the current revalidation cycle to access time and cost benefits and form part of the existing rolling three-year flight revalidation program for conventional and GNSS instrument approach procedures at airports nationally, which will continue to be funded from en route or terminal navigation charges collected by Airservices from industry.

However, in the event that a special case is made for the early introduction of Baro-VNAV at a particular aerodrome, then tailored arrangements could be made for procedure design validation where there is industry funding support, as any additional costs would need to be borne by the sponsoring organisation/ entity.

d. Measuring of QNH, Temperature and Provision of AWIS (BoM, Aerodrome Operators and CASA)

The Meteorological Authority (MA) is responsible for ensuring that the provision of aviation meteorological services within their State comply with international standards provided by ICAO and World Meteorological Organization (WMO) and in accordance with user requirements, including the measurement of pressure (QNH) for aviation.

In Australia the Bureau of Meteorology (BoM) is designated as the MA and is also responsible for the provision of meteorological services in support of international air navigation. The BoM's aviation meteorological services are funded on a cost recovery basis to aviation industry and are legislated under the *Meteorology Act 1955*. BoM provides the majority of QNH observations and AWIS systems (mostly without broadcast capability) at Australian aerodromes.

Additionally, the Director of Meteorology also has a role, under Civil Aviation Regulations 1988, specifically Regulation 120 (CAR 120), in authorising meteorological observations provided to pilots, including data from non-BoM AWS (i.e. data from third party service providers).

Meteorological observations, such as AWIS, may be provided by a third party authorised by either the Director of Meteorology or someone approved by CASA under CAR 120. Apart from the BoM, there are a number of third party service providers authorised in Australia to supply, install, maintain and monitor AWS systems in support of AWIS and for use by aviation.

e. Broadcasting of AWIS or ATIS at an Airport (Airservices, the Aerodrome Owner/Operator and CASA)

An AWIS-VHF or ATIS is required to transmit meteorological data collected by the AWS to enable an APV utilising Baro-VNAV procedures.

There are over 100 aerodromes around Australia, which have an AWIS-VHF or ATIS capability.

Whilst the BoM currently installs and maintains the majority of AWS and AWIS, where a VHF broadcast capability is installed, the VHF broadcast is typically operated by the aerodrome operator rather than BoM.

BoM's aviation AWS and AWIS service is mainly funded by the aviation industry through the Meteorological Service Charge (MSC) on a cost recovery basis, with some individual AWIS locations funded on a user-pays basis.

Other locations requiring an AWIS with VHF broadcast functionality are the responsibility of the aerodrome owner.

The BoM's observation network is under continuous review with the aviation industry. The BoM's current AWIS unit has reached the end of its design life and BoM is implementing a new centralised solution where all AWIS-phone services and AWIS logic will be centralised. Aerodromes requiring VHF broadcast capability will require reliable communications to the BoM, a small embedded computing platform and VHF broadcast equipment.

Responsibility for the VHF broadcast equipment under this new centralised AWIS solution is being discussed with industry at the Australian Strategic Air Traffic Management Group (ASTRA).

Airservices also provides ATIS at its controlled aerodromes during the tower hours of operation and provides broadcast of AWIS on navigation aids (NavAids) at a number of locations. As many of these NavAids were recently retired as Australia moves to a Backup Navigation Aid Network (BNN) air traffic system environment, responsibility for transitioning these services to AWIS-VHF broadcast will need to be ascertained, on a case-by-case basis between CASA, Airservices and the aerodrome operator and other industry stakeholders.

To support a Baro-VNAV approach, accurate aerodrome QNH and temperature has to be available during the published hours of availability of the approach through an AWIS-VHF, ATIS or combination of both (e.g. QNH/ temperature may be available via AWIS-VHF outside of tower hours to support a Baro-VNAV approach).

Subject to identification of any safety risks, CASA will also consider the scope for extending the provision of aerodrome QNH and temperature supporting Baro-VNAV procedures to other transmission means (e.g. AWIS phone service). Examination of this issue will be undertaken in consultation with BoM and other stakeholders once BoM's initiative, implementing a centralised solution for all AWIS-phone services and AWIS logic, is fully operational.

f. Installation of the Necessary Equipment on Aircraft to be Able to Undertake Baro-VNAV Approaches (Aircraft Owner/Operators)

Aircraft operators need to have the necessary equipment in their aircraft (i.e. an approved flight management system with a compliant barometric system) to conduct a Baro-VNAV approach.

g. Flight Instrument Ratings Requirements for Baro-VNAV have been addressed in Civil Aviation Safety Regulation (CASR) Part 91.

CASR Part 91 provides for various matters relating to the technical, training, operational and monitoring standards that form the basis of navigation authorisations, including authorisation of Baro-VNAV non-precision approach procedures.

h. Ensuring that the Flight Management Systems (FMS) Data Base Content and Amendment Processes are Adequate (CASA).

CASA regulates aeronautical data and information under CASR Part 175. Aircraft operators are required to obtain their navigation databases through an authorised service provider in accordance with Civil Aviation Order (CAO) 20.91.

i. Undertake Required Flying Operations, Airworthiness, ATC and Industry Training to Allow Implementation of Baro-VNAV Approaches. (Airservices/CASA /Industry).

Airservices, CASA, and industry (including aircraft and aerodrome operators) will need to develop and coordinate a training and education strategy and undertake aircraft certification and approval processes where needed, to allow the implementation and continued roll out of Baro-VNAV approaches.

5. Implementation Priorities (Airservices/ CASA)

The initial focus of implementation planning is to roll out Baro-VNAV approaches at those aerodromes where there is already an AWIS-VHF capability; an ATIS or a combination of both.

A list of candidate aerodrome locations is provided on the Airservices' website. The list will be updated regularly to report on progress with the rollout of Baro-VNAV procedures, including the incorporation of any additional candidate locations should these be identified as meeting the requirements for supporting Baro-VNAV procedures.

Implementing Baro-VNAV at all of the candidate locations would eventually result in more than an estimated 95% of the travelling public being covered, noting there are some runways where it is not possible to implement Baro-VNAV approach procedures.

This approach does not preclude case-by-case consideration of the integration of a broadcast capability at other certified and registered aerodromes where there is an existing AWS or AWIS currently without VHF broadcast capability.

At these locations, aerodrome operators might consider (in conjunction with BoM, Airservices, CASA and aircraft operators) the case for introducing Baro-VNAV and where agreed, undertake the planning necessary to achieve an AWIS with VHF broadcast capability for those aerodromes. This would include resourcing and funding arrangements.

Further roll out of Baro-VNAV to aerodromes without an AWS is not planned at this time.

The cost, resource and logistical requirements on the industry, BoM, Airservices and CASA to provide the capability do not currently justify such an extension, particularly when Airservices is currently working on straight-in approaches at such locations, which provide a more significant safety benefit in the first instance.

CASA also does not support an aerodrome or aircraft mandate for Baro-VNAV, at this time.

6. Funding

The implementation of Baro-VNAV approaches is to be funded through normal industry cost recovery arrangements administered by Airservices using the same mechanism as that used to fund procedures maintenance.

7. Other Measures to prevent Controlled Flight into Terrain (CFIT)

(a) Straight-in lateral navigation (LNAV) approaches

In line with the ICAO Resolution A37-11, Airservices is aiming to increase the coverage of straight-in LNAV approaches from approximately 70 percent of aerodromes currently, to all certified and registered aerodromes capable of having such approaches over the next three years.

This will provide a safer approach to landing than a circling approach and reduce the risk of CFIT, moving towards meeting the requirements of the ICAO Resolution A37-11.

Preferably a straight-in approach will be provided at all runway ends, acknowledging that at some locations this is not possible due to operational or geographical factors.

(b) Terrain Awareness Warning Systems

A reliance on Terrain Awareness Warning Systems (TAWS) is not seen as a primary means of preventing CFIT accidents. However, collision avoidance systems do play a critical role.

The system safety approach to aviation has always been to prevent the hazardous condition developing in the first place, with TAWS as the last point of intervention alert for the crew to take immediate action.

TAWS can provide an awareness of the proximity of terrain in the vicinity of the aircraft, which provides a tool to mitigate against CFIT. The presence of TAWS does not guarantee prevention of a CFIT accident; however, it requires the pilot and aircrew to respond to warnings issued by the system and to take evasive action.

The ICAO Global Air Traffic Management Operational Concept (GATMOC) identifies the role of collision avoidance systems as an important aspect of the safety design of the ATM system and is therefore considered as part of meeting the level of safety required by the ATM design.

The importance of collision avoidance systems, including TAWS, is that they provide an additional and independent level of conflict management to that provided by positive separation (and any higher level strategic conflict management).

While most General Aviation aircraft do not have TAWS installed and this aircraft category has the highest CFIT accident rate worldwide, the number of aircraft equipped with terrain awareness systems is increasing.

Currently, only aircraft carrying more than nine passengers are required to have TAWS.

However, CASA has previously issued a Notice of Proposed Rule Making that proposes all aircraft that operate under the IFR, when carrying six or more passengers, be equipped with Class B TAWS.

Further consultation on extending the mandated carriage of Class B TAWS to smaller aircraft will be undertaken by CASA as it finalises the remainder of its regulation reform program, in consultation with industry (including in relation to CASR Part 135).