AUSTRALIA'S AIRCRAFT NAVIGATION MODERNISATION PROGRAM

With the rapid growth in air traffic and a resulting need to ensure our airspace is managed as safely and efficiently as possible, Australia is at the forefront of a navigation modernisation effort to transition pilots from using ground-based navigation aids to satellites as their primary means of navigation.

Mandated by the Civil Aviation Safety Authority (CASA) since 4 February 2016, all aircraft operating under Instrument Flight Rules (IFR) are required to navigate primarily using satellite-based means within Australian airspace.

In accordance with the CASA mandate, Airservices is redesigning some of its landing approaches at every airport around the country to ensure we continue to have the safest and most efficient air traffic management system possible, meeting the expectations of airspace users and the travelling public into the future.

As part of this transition, nearly half of the 400 ground-based navigation aids will be decommissioned over time with the remaining to operate as a back-up network to the satellite navigation system.

Types of ground-based navigation aids include Non-Directional Beacon (NDB), a radio transmitter that sends a low frequency signal containing no inherent directional information; VHF (Very High Frequency) Omni-Directional Range (VOR) that sends short-range radio signals enabling an aircraft to locate its position and stay on course between airfields; and Instrument Landing System (ILS), a highly accurate navigation aid used when landing at an airport in poor weather or low visibility.

Airservices current air traffic management system relies on ground-based navigation aids. This restricts aircraft to flying direct paths over ground-based radio beacons and has shaped the way we manage air traffic. Inefficiencies stemming from this create unnecessary fuel consumption, excess carbon emissions, longer flight time and increased noise impact.

In the last decade, a range of new satellite-based navigation systems have been introduced making air travel safer, cleaner and more dependable. These new systems require little or no ground infrastructure. The type of navigation technology and the level of sophistication used by airlines and commercial operators varies greatly.

ON APPROACH

On average, commercial aircraft spend just four percent of their total flying time in the final approach and landing phases of flight (last 18 km before landing).

Landing is the most challenging phase of flight for pilots as they descend to a runway. Automated flight management systems in conjunction with high-precision navigation technology help to reduce pilot workload greatly and increase safety.

Airports have a range of navigation systems in place for pilots to use, with larger airports generally having more systems available. These systems can be a mix of both ground-based and satellite-based technology. Some navigation systems with a lower level of lateral and vertical accuracy can use the same flight path corridor, while others systems with higher precision are more likely to have their own flight path corridor which is sometimes affords shorter approach paths.

The type of navigation system used by an aircraft when landing will depend on variables such as the level of visibility, weather conditions, aircraft avionics fitment, crew training, airline operating procedures and civil aviation regulations, which can have different requirements for domestic and international flights. Some airline operating procedures have links to insurance requiring their pilots to use the highest form of navigation technology available regardless of circumstances.

Decisions on which landing technology and flight path an aircraft will use are made by pilots and air traffic control around 30 minutes before landing. This assists air traffic controllers with sequencing aircraft for landing with other aircraft taking off from an airport. The decision may change as the aircraft gets closer to landing due to a range of influences.

For all pilots, civil aviation regulations require the runway to be clearly visible at a specified altitude and distance from the runway prior to landing. This requirement is known as the 'minima'. At the minima, should a pilot not be able to see the runway, then the approach will be aborted and reattempted. The altitude and minimum distance of the minima varies between airports and within the same flight path corridor depending on the precision of the navigation technology.

PERFORMANCE BASED NAVIGATION

In recognition of the need to manage the projected global growth in air transport capacity, the International Civil Aviation Organisation (ICAO) has established a series of objectives to increase the capacity and efficiency of air navigation. While interdependent with safety, this objective is focussed primarily on transitioning to Performance-Based Navigation (PBN) systems.

PBN describes the broad range of navigation technologies that uses satellite. Each type of PBN technology has prescribed performance requirements to guide an aircraft flying with its autopilot on within a set tolerance of lateral and vertical accuracy.

HORIZONTAL AND VERTICAL GUIDANCE

All forms of landing navigation technology are used by pilots for horizontal and vertical guidance to the runway. Ground-based systems have a lower level of precision and are unable to be used in automated landings and also have higher minimas. Satellite-based navigation systems have much greater precision and are able to be automated and have much lower minimas.

SATELLITE-BASED NAVIGATION

CASA has determined that all methods of satellite-based navigation would be formally known in Australia as being a form of Required Navigation Performance, with each technology having its own prescribed performance requirements and specification.

There have been two broad forms of satellite-based navigation used by aircraft for landing: Required Navigation (RNAV), which provides horizontal guidance only, Required Navigation Performance - Authorisation Required (RNP-AR), known in Australia as ‘Smart Tracking’, which provides both horizontal and vertical guidance.

A new navigation system called Barometric Vertical Navigation (BARO VNAV) has recently been developed to assist pilots when landing. BARO VNAV uses satellite signals to position an aircraft horizontally and barometric pressure to control the vertical descent to the runway.

According to recent ICAO and CASA requirements, the last few nautical miles of all final approaches to runways, including satellite-based approaches, must be in a straight line with the runway to ensure the highest level of safety is achieved. ICAO data shows that straight-in approaches to airports are 25 times safer than a circling approach, and that adding vertical guidance is a further eight times safer than an approach without.

In some instances, this will cause a change to the flight path corridor where current RNAV and ground-based approaches, that need to be replaced, are offset and not aligned with the runway. Exceptions can be made where terrain or other obstacles need to be avoided, however CASA have specifically ruled out continuing to use an existing or establishing a new approach flight path that is offset as a noise abatement measure.

At present, the only navigation technology that is not required to have a long runway aligned final approach is Smart Tracking. Unlike other technologies, satellite signals are continuously received by the equipment in the cockpit which enables aircraft to fly a curved flight path on autopilot with high precision in close proximity to the runway.

MORE INFORMATION

More information is available at www.airservicesaustralia.com/projects/aircraft-navigation-modernisation-program or by contacting the Noise Complaints and Information Service on 1800 802 584 (freecall).

NAVIGATION TECHNOLOGY COMPARISON

Ground-based

Without vertical guidance

Non-Directional Beacon (NDB)

- Low frequency radio signal transmission.
- Provides limited situational awareness information.
- Used enroute between airports and to mark the location of an airport.
- High minima altitude.

VHF Omnidirectional Range (VOR)

- Very high frequency radio signal transmission.
- Includes distance and weather information.
- Improved situational awareness than NDB for pilots.
- Used enroute between airports and to mark the location of an airport.
- High minima altitude but lower than NDB.

With vertical guidance

Instrument Landing System (ILS)

- Two antennas transmit signals to receivers in the aircraft cockpit, one for horizontal guidance and the other for vertical guidance.
- Must be runway aligned for 10 nautical miles.
- Low minima altitude – similar to Smart Tracking.

Satellite-based

Without vertical guidance

RNAV

- A basic form of satellite-based navigation in which equipment on board the aircraft calculates and follows a direct navigation path between two points.
- No reliance on ground-based navigation aids.
- No vertical guidance is provided.
- Medium minima altitude – lower than VOR.

With vertical guidance

BARO VNAV

- Satellite signals to position the aircraft laterally and changing barometric pressure to control descent to the runway.
- Not as accurate to the runway as ILS.
- Medium minima altitude – lower than RNAV.

Smart Tracking

- The most advanced form of satellite-assisted navigation. Aircraft track with high accuracy and are able to follow curved flight paths when close to landing - important when designing routes in congested airspace, around noise-sensitive areas or through geographically challenging terrain.
- Low minima altitude – similar to ILS.