

Airports Commission's Senior Delivery Group - Technical Report Number 01

Implementation of Performance-Based Navigation in the UK

Summary

- The UK Future Airspace Strategy (FAS) is a programme designed to modernise our airspace and air transport route network. It is an important part of the Government's transport policy and involves the airlines, airports, air traffic control and many other aviation stakeholders.
- The programme also forms part of the Single European Sky (SES)¹ initiative, which sets out implementing rules, backed by legislation, to drive the reform of airspace and air traffic management across all European States. Similar modernisation initiatives are taking place across the globe, coordinated by the International Civil Aviation Organization (ICAO).
- Much of the air navigation technology that supports air transport needs upgrading. Doing nothing is not an option. The introduction of new technology, like Performance Based Navigation (PBN), will strengthen the resilience of our major airports to react effectively to disruption, improve the environmental performance of aircraft arrival and departure routes and further enhance air safety.
- The measures included in FAS are a pre-requisite for accommodating future growth in demand for aviation, regardless of whether there is a decision to build new runway capacity. This is important for the whole country because the aviation sector is a key driver for the economy, international trade and employment.
- The Government and aviation industry are committed to ensuring that local communities have a say in how the modernisation programme is delivered. Effective engagement with those that may be impacted by the changes is critical to the development of a modern, sustainable air transport route network.
- Measures needed to upgrade the route network can alter the distribution of aircraft noise over the ground and some local communities may be affected differently.

¹ The SES legislative framework consists of four Basic Regulations (Numbers 549/2004, 550/2004, 551/2004 and 552/2004) covering the provision of air navigation services (ANS), the organisation and use of airspace and the interoperability of the European Air Traffic Management Network (EATMN). The four Regulations adopted in 2004 (the SES I Package) were revised and extended in 2009 with Regulation 1070/2009 with the intention of increasing the overall performance of the air traffic management system across Europe (the SES II Package).

The SES Framework also includes more than 20 Implementing Rules and Community Specifications ("technical standards") adopted by the European Commission starting from 2005, and these are designed to ensure the interoperability of new technologies and systems used for air traffic management.

- Aircraft follow PBN routes more accurately because they are satellite based, which leads to a greater concentration of traffic around the route centreline.
- Removing the link to ground based navigational aids means that airspace routes can be designed flexibly around densely populated areas, but the areas that are overflown may experience disturbance more regularly.
- The accuracy of PBN routes creates the potential to introduce alternative flight paths that can be switched on and off to provide areas which are disturbed by aircraft noise with some respite from overflights.
- The distance that multiple flight paths should be separated in order to create effective noise respite is currently unknown, will vary by airport, and may require some routes outside the existing Noise Preferential Route (NPR) structure.
- Airports and air traffic control are exploring the use of respite routes that do not lead to a significant number of new people being affected by noise, but there are operational constraints on the number of such possible routes.

Airports Commission's Senior Delivery Group (SDG), February 2015.

Introduction

This information paper provides a high level explanation of Performance Based Navigation (PBN) routes and the effect they are expected to have as part of a wider programme to modernise the UK's airspace and air transport route network. The paper is a starting point for those unfamiliar with PBN. It describes some of the challenges of upgrading our existing routes to a PBN standard and in particular the impact of aircraft noise on local communities. Further work will be required to study the different ways of mitigating the environmental impact of aircraft noise.

The paper is published on behalf of the Airports Commission's Senior Delivery Group (SDG) - a group of board level representatives from the Department for Transport, Civil Aviation Authority (CAA), Ministry of Defence, NATS, Heathrow, Gatwick, British Airways and easyJet. The SDG was formed in March 2014 to take forward the Commission's recommendations to improve the use of existing runways and airspace in south-east England. As part of its work, the SDG has been looking at the measures included in the UK's FAS, which sets out a cross-industry programme of initiatives to modernise the airspace and route network for resilience, capacity, safety and environmental efficiency benefits.

Background

The UK's airspace and route network is in the early stages of a significant modernisation programme, coordinated by the FAS, which will be delivered over the next five to ten years. FAS forms part of the SES initiative – an ambitious package of legislation aimed at improving airspace performance on a European rather than local level. SES includes plans to restructure European airspace, add capacity, improve safety and increase the overall efficiency of the European air transport network.

The biggest changes in the UK are likely to be in the south east of England where London's five big airports and many smaller aerodromes create some of the world's busiest and most complex skies. The airspace in the south east was designed over 40 years ago at a time when commercial aircraft were fewer in number and less capable than today². In that time, the number of flights has increased substantially; a trend that is expected to continue.

The Government and other SDG members believe that the airspace modernisation programme is an important foundation to improve resilience and accommodate traffic growth in an environmentally sustainable way. If the changes are not delivered the inefficiency and complexity that exists today is likely to intensify, increasing passenger delays and limiting the wider economic benefits of aviation – a mode of transport that generates over £20bn per year in economic output and which directly employs 220,000 people.

Regardless of new runway capacity in the south east, the airspace and route network is not sufficiently resilient or sustainable to fully meet the country's future transport needs. Inbound and outbound routes are not optimised for each individual airport. The frequent

² For example, modern aircraft are able to climb much more quickly, which reduces the noise footprint on the ground but they can only do this if the route structure enables this.

interactions between routes prevents aircraft from climbing and descending efficiently, thereby creating additional aircraft noise, fuel burn and CO₂ emissions over London and also reducing the spare capacity available to deal with disruption when it occurs.

Alongside the benefits and national/European strategic importance of modernising our airspace and route network, there is one main area of potential dis-benefit – the impact of redistributing aircraft noise. The modernisation programme is underpinned by the transition to satellite-based PBN routes that are more precise and flexible than conventional routes. Although PBN routes are designed with the intention of avoiding population centres as far as practicable, changes in the distribution of aircraft noise can have a significant impact on the communities that are affected.

Recent projects to trial PBN routes have highlighted the challenge of making even relatively small changes to airspace routes or procedures which can either move aircraft into areas that were not previously overflown or which are more intensively overflown. In addition, the greater accuracy of track keeping has also been identified as an important factor in additional noise disturbance for some communities.

The Government and aviation industry are committed to ensuring that local communities have a say in the use of PBN routes. The arrangements for community engagement are important to ensure that those who may be affected understand the proposed changes and are able to contribute their ideas and experiences. The purpose, scope and timescales for each engagement will be made clear in advance. Further work is needed to identify the mix of people and organisations who have an interest in the engagement and to build the knowledge and confidence of all those potentially affected.

The PBN Concept

The objective of PBN is to improve the precision of aircraft navigation through the introduction of a globally recognised set of standards defined by the International Civil Aviation Organization (ICAO).

Historically the air transport route network was designed with reference to ground-based radio navigation aids. Pilots navigated from point to point along a set of fixed routes based on the location of the aids. The development of area navigation (RNAV) in aircraft Flight Management Systems (FMS) removed the dependency on ground based aids.

RNAV has since been further enhanced by the development of Global Navigation Satellite Systems (GNSS) that enable much more accurate aircraft positioning. There are different specifications of PBN which vary depending on the level of accuracy, consistency and functionality that the aircrafts' navigation systems have to meet (see opposite).

Introduction of PBN in the UK

The introduction of PBN routes is an essential component of the modernisation programme. There is a worldwide drive to upgrade the routes that aircraft fly to maximise the potential benefits of new technology. In 2009, ICAO adopted a resolution requiring states to develop a PBN Implementation Plan. The CAA responded in November 2011 with the publication of the Policy for the Application of PBN in UK and Irish Airspace.

In alignment with ongoing European regulatory developments, the CAA has announced a mandate for the adoption of a RNAV 1 PBN standards by all aircraft that use routes to/from key London airports from November 2017, and the implementation of the routes themselves by winter 2019. The mandate is expected to set a minimum standard for the London airspace with some airports adopting a more advanced version of PBN on some routes to achieve greater benefits.

The Impact of PBN routes

The introduction of PBN routes has the potential to bring benefits not only to the aviation industry and the travelling public, but also the economy and environment. The benefits include reductions in fuel costs and CO₂ emissions through reduced miles flown (some of today's routes have long segments of level flight at lower altitudes) and optimum climb and

RNAV specifications describe the basic level of performance. The UK en-route network is based on RNAV 5 where '5' denotes a performance requirement of +/- 5 Nautical Miles for 95% of the flight time. The RNAV 1 specification (+/- 1 Nautical Mile) is considered the minimum standard for introducing new arrival and departure routes in busy terminal airspace like London. In practice the track keeping accuracy achieved by aircraft is much more accurate than the 5 or 1 miles implied by 'RNAV 5' and 'RNAV 1'.

RNP (Required Navigation Performance) is a similar specification to RNAV, but requires that aircraft have systems to monitor navigation performance and alert the flight crew if the required levels are not being achieved. RNP applications are also more precise and include advanced capabilities like curved paths.

descent profiles, as well as improved safety from stabilised approaches³ and increased capacity through reduced route spacing. In addition, PBN removes the dependency on ground-based navigation aids, allowing for the rationalisation of expensive infrastructure.

The increased navigational accuracy generated by the use of PBN means that while fewer people overall might be affected by aircraft noise, those who are will potentially experience more disturbance. This understandably causes concern and some opposition to the introduction of PBN routes, as demonstrated by the reaction from communities affected by PBN trials or the implementation of permanent PBN routes in 2014. The challenge will be to introduce measures (as part of PBN) which will offset the impact from more concentrated paths over a reduced number of people.

UK Government Policy

For many years the Government's policy has been that, in most circumstances, it is desirable to concentrate aircraft along the fewest possible number of specified routes in the vicinity of airports at low levels⁴ and that these routes should avoid densely populated areas as far as possible. At the noise-designated airports (Heathrow, Gatwick and Stansted) where the Government sets noise controls, this policy has practical application in the mandating of Noise Preferential Routes (NPRs), many of which were designed over 40 years ago.

The degree to which air traffic should be concentrated has been considered by the Government as part of various aviation policy updates over the last few years, including the Aviation Policy Framework⁵ and in Chapter 7 of the Air Navigation Guidance to the CAA published in January 2014⁶. The established policy is to concentrate air traffic and this is consistent with the Government's overarching policy to limit and, where possible, reduce the number of people in the UK significantly affected by aircraft noise. The introduction of PBN means that the concentration of traffic can be achieved much more effectively than in the past.

Both the Aviation Policy Framework and the Air Navigation Guidance suggest that in some circumstances (such as where there is intensive use of certain routes) it may be appropriate to explore options for respite with local communities by designing multiple routes that can be used alternately although there is the caveat that this should not lead to significant numbers of people newly affected by noise.

³ Where an aircraft is in the correct configuration for landing and at the optimum speed. Unstable approaches are a causal factor in runway excursions, where an aircraft departs the runway on landing, or go-arounds, where a landing is aborted.

⁴ Generally below 4000 feet above mean sea level.

⁵ UK Aviation Policy Framework, March 2013, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/153776/aviation-policy-framework.pdf

⁶ Guidance to the Civil Aviation Authority on Environmental Objectives Relating to the Exercise of its Air Navigation Functions, January 2014, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/269527/air-navigation-guidance.pdf

Respite Options

PBN increases the ability to introduce multiple routes that can be used alternately in order to provide some respite for communities. Airspace change sponsors are encouraged to examine such route options when developing their proposals. However, there are some constraints which need to be considered when developing respite routes.

There is no single definition of what is meant by respite from aircraft noise. It could mean hours, days or weeks and consequently the concept is likely to mean different things to different people. While this might enable the concept to be shaped to fit local circumstances, it is essential that when specific proposals are made to introduce respite the type of respite is clearly defined within the proposal.

To get any perceptible noise benefit for those on the ground, respite routes need to be adequately spaced apart which is likely to mean aircraft noise is spread over a larger area as aircraft, depending on their altitude, may still be clearly audible several kilometres from the actual flight path.

Effective provision of respite from aircraft noise may require these new routes to be outside the existing 3km swathes associated with current NPRs. Such a situation could result in more people being affected by aircraft noise and may offset some of the benefits for local communities to be derived from respite.

Respite options will vary considerably depending on the airport location, runway direction and direction of the routes in use. There are also limitations on the number of respite routes which could be introduced for arrival and departures. In practice, there are potentially only 2 to 3 route options for an individual runway arrival/departure profile. The limitations are created by aircraft flight management computer database capacity, flight crew workload, and the ability of air traffic control to manage the transition from a normal flight path routing to a respite option(s) and vice versa. There is also a limit to the level of complexity which air traffic control can manage safely whilst ensuring the continuance of the overriding need to maintain the same or improved level of safety if respite options were implemented.

Airspace trials can prove to be a valuable way of obtaining evidence on both the benefits and the impact of an airspace change proposal. As well as collecting data on the operational benefits, they can also be used to trial possible respite options or the use of new operational procedures which could limit noise disturbance. Usually, such trials are temporary in nature and are for a maximum of six months unless the CAA allows an extension whilst an airspace change application is being progressed. When considering undertaking a trial, it is recognised that the sponsor may not have to undertake a full public consultation. Before an airspace trial commences, there should always be a consideration of what level of consultation is appropriate and proportionate to the objectives of the trial and in view of its likely impact.

Current status of PBN Implementation in the UK

En-route

All of the en-route network to which airport arrival and departures connect, is already PBN (RNAV 5) compliant.

Airport Arrival and Departure Routes

London Area

PBN arrival and departure routes are being implemented across the London airports in conjunction with a programme to fundamentally redesign of the airspace structure. This programme is intended to change the airspace around London in order to simplify its control and operation, to create additional capacity, and to reduce environmental impact.

Gatwick Airport - The departure flight paths at the airport were updated in November 2013 to RNAV 1 standards after trialling routes since 2007. RNAV1 was mandated on all departures from May 2014. Plans for the introduction of new PBN departure and arrival routes are not expected until after 2020.

Heathrow Airport - PBN departure trials on specific southbound routes began as part of the wider NATS Departure Enhancement Project (DEP) in December 2013. Having gathered sufficient evidence the trials were concluded in November 2014. Heathrow is planning PBN departure and arrival routes for implementation in 2019.

London City Airport - The airport is proposing to switch to PBN arrival and departure routes below 4,000ft from winter 2015, and it is seeking to replicate 10 existing departure routes and two existing arrival routes to a PBN standard.

Stansted Airport - Two RNP 1 departure routes including advanced curved path radius turns have been trialled since April 2013 with plans to propose that the procedures become permanent in late 2015.

Luton Airport - Two RNAV 1 departure routes are currently part way through the CAA oversight process and, if approved, implementation is planned before summer 2015.

Farnborough - An airspace change proposal is anticipated for the introduction of PBN arrival and departure routes.

Southend - An airspace change proposal is anticipated for the introduction of PBN arrival and departure routes.

Rest of the UK

Bristol - The airport introduced RNAV 1 arrival routes in 2014.

Birmingham Airport - The airport has already introduced a number of RNAV 1 departures and continues to trial options for others.

Scottish Development and Deployment Group - Prestwick, Glasgow and Edinburgh airports have developed plans for the modernisation of the Scottish airspace, including the introduction of PBN routes. Edinburgh plans to trial an RNAV 1 departure procedure in 2015.

Northern Development and Deployment Group - Manchester, Liverpool John Lennon, Birmingham, East Midlands, Leeds Bradford, Hawarden and Newcastle airports have recently established this Group to coordinate the implementation of PBN routes in the Manchester Terminal Control Area. Newcastle already has a small number of RNAV 1 departures published with arrival routes under consideration.

Next Steps

The members of the SDG have committed to further consider the implications of the introduction of PBN routes, including possible respite options for those most affected by the new routes. This consideration includes taking forward work to clarify the technical limitations of multiple respite routes as well as encouraging airports to further engage with local communities to ensure that their views are considered when it comes to designing future routes and respite options. The SDG is also actively considering the implementation of increased vertical profiles, steeper approaches, and continuous climbs and descent operations which rely on the greater use of PBN in order to achieve the full potential of these initiatives. The CAA is developing guidance material to support aviation stakeholders considering the implementation of PBN routes. The first edition of the guidance is due to be released in Spring 2015.

The SDG is also aware that the Government's Aircraft Noise Management Advisory Committee (ANMAC) has also started to consider some of the issues associated with the widespread introduction of PBN routes at the designated airports (Heathrow, Gatwick and Stansted).

The SDG will provide an update on these activities in its next report.