HEATHROW'S SLIGHTLY STEEPER APPROACH STAGE 2A OPTIONS DEVELOPMENT

FINAL VERSION 2.0

Heathrow

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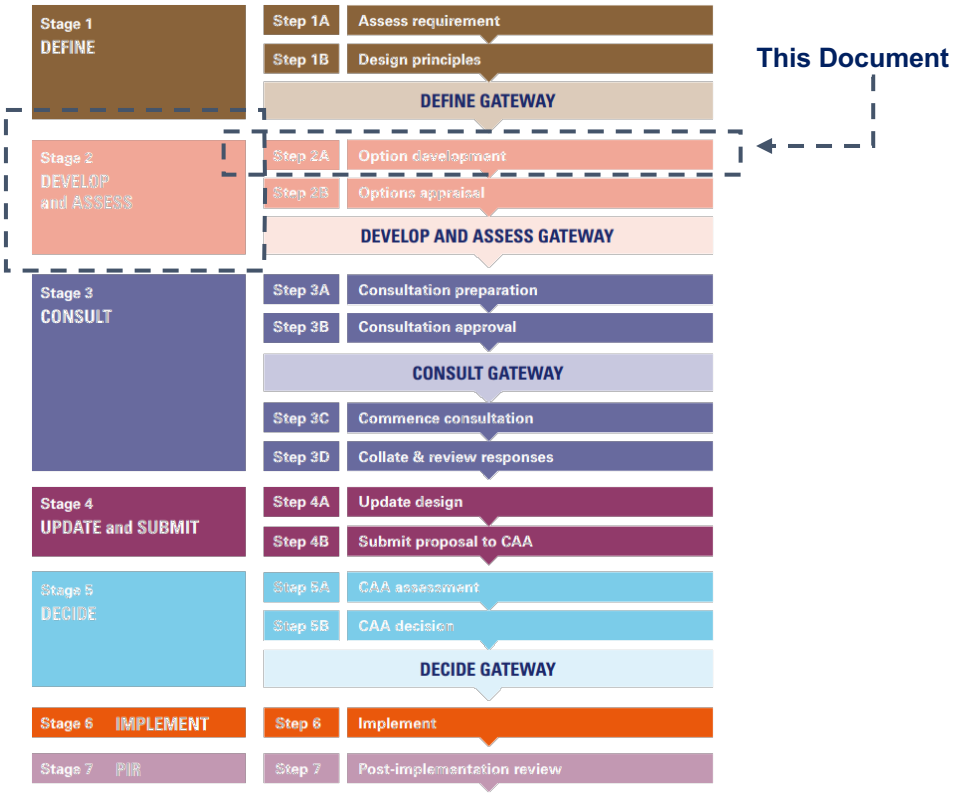
1. PURPOSE OF THIS DOCUMENT

1.1.1 This document sets out the options developed and the evaluation of those options against the design principles as part of the CAP1616 Airspace Change Process for implementation of Slightly Steeper Approaches (SSA) at Heathrow.

1.1.2 CAP1616 is the guidance material provided by the CAA that describes the minimum requirements for the seven-stage airspace change process used for permanent changes to the published airspace design. The figure below displays the full ACP process as defined in CAP1616, illustrating where this document fits into the process.



1.1.3 Slightly Steeper Approaches have been shown to provide noise benefits to communities living close to an airport. As such, Heathrow, working alongside local communities, has aspired to implement this procedure wherever feasible.

1.1.4 Between 2015 and 2017, Heathrow ran two live trials to investigate how Slightly Steeper Approaches for arriving aircraft (3.2° as opposed to the extant 3.0° approaches) would impact Heathrow operationally whilst at the same time attempt to measure the benefit in noise reduction that could be achieved.

1.1.5 For operational reasons, which are explained fully in the trial reports[1], these Slightly Steeper Approaches can only be flown by aircraft using RNAV navigation technology[4]. Of all Heathrow approaches over the trial periods, fewer than 2% flew an RNAV Slightly

[1] First trial report (www.heathrow.com/content/dam/heathrow/web/common/documents/company/local-community/noise/reports-and-statistics/reports/operational-trial-reports/slightly-steeper-approach-trial/Heathrow_Slightly_Steeper_Approach_Trial_Report.pdf) and Second trial report (www.heathrow.com/content/dam/heathrow/web/common/documents/company/local-community/noise/reports-and-statistics/reports/operational-trial-reports/slightly-steeper-approach-trial/Heathrow_Slightly_Steeper_Approach_Trial_2017_Final_Report.pdf)

Steeper Approach. The remainder flew the standard 3.0˚ approach using the Instrument Landing System (ILS).

1.1.6 Local communities supported the trials, which demonstrated that a small noise benefit (an average decrease of 0.5dBA) can be provided whilst causing no negative environmental or operational dis-benefits.

1.1.7 Since the end of the (second) trial period, the Civil Aviation Authority has allowed Heathrow to keep the RNAV Slightly Steeper Approach operational temporarily whilst we prepare to submit an airspace change proposal for permanent adoption.

1.1.8 Heathrow passed through Stage 1 of the Airspace Change Process in August 2019 which established the design principles for this ACP. This document and appendices describe the different options explored for increasing the approach angle for some of Heathrow's arrivals, the evaluation of those options against the design principles and the stakeholder engagement that has taken place during Stage 2A of the process.

1.1.9 This document is written for the CAA and therefore this document is technical in its nature.

2. STAGE 2 DEVELOPMENT OF A COMPREHENSIVE LIST OF OPTIONS

2.1.1 This section sets out the options that were considered for implementing slightly steeper approaches at Heathrow, together with an evaluation of to what extent each option met the design principles.

2.2 Step 2A Options Development

2.2.1 This stage of CAP1616 requires the change sponsor to develop a comprehensive list of options that address the Statement of Need and that align with the design principles from Step 1B. The sponsor is then required to engage the Step 1B stakeholders on all the options that are being considered.

2.2.2 There are two types of approach typically flown at Heathrow: Instrument Landing System (ILS) approaches and Performance-based Navigation (PBN) approaches. The PBN approaches at Heathrow have been historically known as RNAV (Area Navigation) GNSS (Global Navigation Satellite System) approaches although their correct definition is RNP (Required Navigation Performance) Approaches[2]. These ILS and RNAV approaches are quite different in their technical nature although they make no tangible difference to the communities overflown in terms of tracks or altitude over the ground.

2.2.3 To begin, Heathrow needed to determine whether ILS, RNAV or both approaches could be steepened. This decision formed the basis of our first design choice – whether to introduce a slightly steeper approach using ILS or RNAV.

2.3 Instrument Landing System (ILS)

2.3.1 The ILS is a radio navigation system which provides aircraft with horizontal and vertical guidance just before and during landing. This enables a Precision Approach (PA) enabling aircraft to land with a very high degree of accuracy.

2.3.2 The ILS has 2 main components; the localiser and the glideslope. The localiser is the lateral component of the ILS which ensures the aircraft is aligned with the centreline of the landing runway. The localiser aerial which emits the radio signal is situated at the far end of the landing runway. The glideslope provides the vertical guidance allowing the aircraft to descend at a rate which keeps it above obstacles and to reach the runway at the correct touch down point. The glideslope aerial is situated to the side of the landing runway (Figure 1).

[2] This document refers to 'RNAV (GNSS) approaches' as we have used that term throughout the live trials, engagement and reports to-date and we will remain with this term for this process. The new term is now 'RNP Approach'. When we refer to RNAV approaches we are specifically referring to LNAV and LNAV/VNAV. LPV200 approaches have been excluded from this ACP due to very low aircraft equipage within the Heathrow fleet. It is acknowledged that Heathrow are required to implement LPV approaches by 25th Jan 2024 under (EU) 2018/1048 and this will be pursued separately.

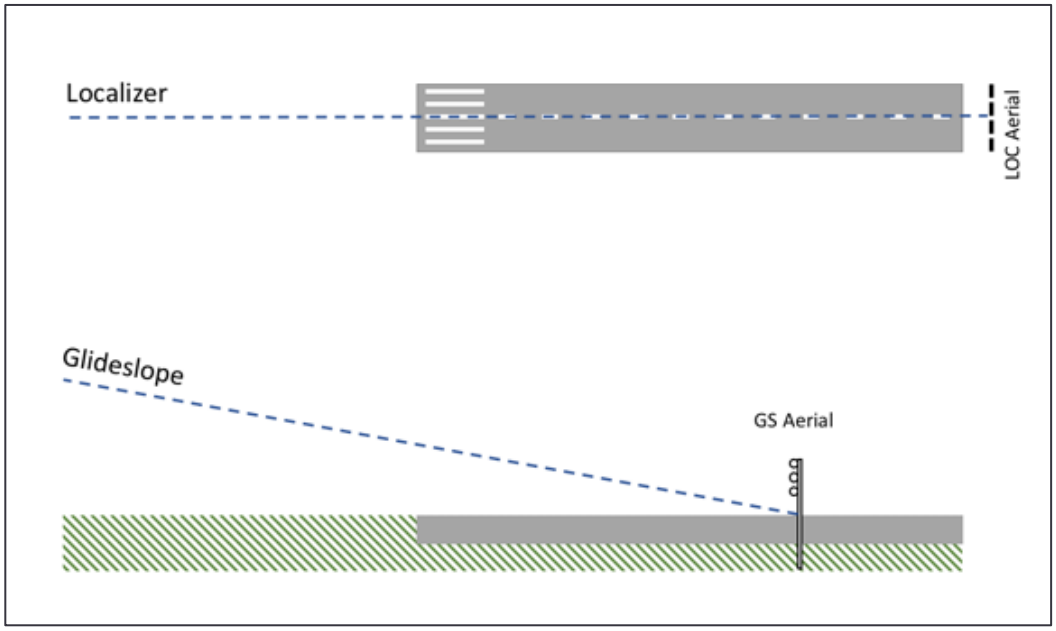


Figure 1: Components of an ILS

2.3.3 The ILS emits radio signals which can be distorted by objects close to the ILS infrastructure. Operations on the airfield in the vicinity of the devices are strictly controlled when the ILS is in use to ensure the signals are not distorted for arriving aircraft, for example, by departing aircraft preparing to use or cross the same runway.

2.3.4 There are three categories of ILS equipment and each is operated with varying amounts of operational integrity. The category of the ILS equipment dictates the tolerances (mainly meteorological) of their use. The category affects various operational limits such as the height by which the pilot must be able to see the runway (known as the 'Decision Height') in order to continue the approach to land, the visible distance along the runway (the Runway Visual Range (RVR)), the lighting system available on the runway and also the restrictions in positioning of aircraft on the airfield whilst the ILS is in use. Every ILS system has an associated Category; CAT I, CAT II or CAT III A/B/C with CAT III C being the highest specification which permits aircraft to continue landing even in extremely poor visibility.

2.3.5 An approach may not normally be continued unless the RVR is above the specified minimum. The pilot follows the ILS guidance until the Decision Height (DH) is reached. At the DH, the approach may only be continued if the specified visual reference is available, otherwise, a go-around must be flown.

- Category I permits a DH of not lower than 200ft and an RVR not less than 550m
- Category II permits a DH of not lower than 100ft and an RVR not less than 300m;
- Category IIIA permits a DH below 100ft and an RVR not below 200m;
- Category IIIB permits a DH below 50ft and an RVR not less than 50m;
- Category IIIC is a full auto-land with roll out guidance along the runway centreline and no DH or RVR limitations apply.

2.4 Suitability of the ILS (Option A) for slightly steeper approaches

2.4.1 International guidelines state that 3.0° is the optimum approach angle for precision approaches and that descent gradients steeper than the optimum should not be used, unless all other means to avoid obstacles have been attempted, since these steeper descent gradients may result in rates of descent which exceed the recommended limits for some aircraft on final approach[3].

2.4.2 Furthermore, internationally agreed standards for procedures (known as 'PANS OPS') state that 3.0° is the maximum angle for CAT II/III precision approaches.

2.4.3 At this stage, if the ILS was to be re-calibrated to an angle steeper than 3.0° it would rule out its use during CATII/III operations as re-calibration is a long term, strategic process rather than something than can be done tactically on the day.

2.4.4 In addition, aircraft approaching via a Category III ILS system that provides the highest capability to land in poor visibility are, in the majority, limited to maximum approach angles of 3.25° with many aircraft constrained to only 3.15° approaches when performing a CAT III autoland[4]. Whilst the aircraft may be certified to ILS angles above 3.0˚, Heathrow's ILS system itself is not certified.

2.4.5 At this time, we have no evidence to demonstrate whether a 3.15˚ ILS approach would have any detrimental effect on the Heathrow operation.

2.4.6 The only short-term, workable solution would be for Heathrow to procure up to four more ILS systems to radiate at an angle of 3.15° in addition to those already radiating at 3.0°. The purchase, installation and maintenance of additional ILS systems for use in CAT I conditions only is not a practical or cost-effective option.

2.5 Suitability of RNAV (Option B) for slightly steeper approaches

2.5.1 Unlike the ILS, Heathrow's RNAV (GNSS) approaches do not rely on ground-based equipment to determine the final approach vertical and lateral path. These are Performance Based Navigation (PBN) procedures that follow the same vertical and lateral profile as the ILS but rely on on-board equipment and satellite navigation as opposed to physical infrastructure on the airport. Therefore, amending the final approach angle, known as the Vertical Path Angle (VPA), is possible without changes to the physical infrastructure on the ground.

2.5.2 However, Heathrow's RNAV approaches are only available when the meteorological conditions allow. RNAV approaches require a greater degree of visibility than ILS approaches do. At Heathrow, an RNAV approach can only be flown when there is a Decision Height of 450ft.

2.5.3 Heathrow determined that increasing the gradient on their RNAV approaches is the only viable option for introducing a slightly steeper approach at this time, owing to the PANS OPS criteria limiting slightly steeper ILS approaches together with the practical cost implications of procuring multiple ILS systems. Figure 2 summarises the assessment of

[3] PANS OPS 8168 Vol II; Part 1; Section 4; Chapter 5; Subsection 5.3 Descent Gradient; 5.3.1

[4] An avionics system that fully automates an aircraft's landing with the flight crew supervising the process

ILS versus RNAV against Heathrow's design principles. The design principle evaluation of these, articulated using the CAP1616 template, is available in Appendix A.

Figure 2: Summary of design principle evaluation of SSA options (ILS or RNAV)

	PRINCIPLE 1	PRINCIPLE 2	PRINCIPLE 3	PRINCIPLE 4	PRINCIPLE 5	PRINCIPLE 6	PRINCIPLE 7	PRINCIPLE 8	CARRIED FORWARD
	Must be safe	*Must achieve the objective of reducing noise compared to a 3.0˚ approach*	*Must not increase the numbers of go-arounds*	*Must not reduce Heathrow's capacity*	*Must not change the lateral tracks of aircraft over the ground*	*Should not reduce the abiliity for arrivals to fly Continuous Descent Approach.*	*Should maximise the number of aircraft able to fly the slightly steeper approach*	*Should not adversely increase pilot or ATC worklaod*	
Option A Steeper ILS									**NO**
Option B Steeper RNAV									**YES**

Doesn't meet design principle
Partially meets design principle
Meets design principle

2.6 RNAV Approach Angle Options

2.6.1 Once slightly steeper ILS approaches were discounted as non-viable for this ACP, the options left for investigation were for different vertical path angles for the RNAV approaches.

2.6.2 As previously explained to our stakeholders during Stage 1B and in the trial reports[5], RNAV approaches are currently flown by fewer than 2% of Heathrow's arrivals. The remainder fly the Instrument Landing System (ILS) approaches.

2.6.3 The main reasons for the lower number of RNAV arrivals compared to ILS arrivals are:

- ILS approaches have been the standard for over 50 years and crews are much more familiar with them than RNAV approaches, which are relatively new on a global level. With Heathrow's large and diverse range of airline customers, many crews operate long-haul[6] flights meaning that they may only fly into Heathrow once every few months. In addition, at the end of a long flight when crews are tired, many will opt for the approach with which they feel most comfortable. 69% of all the 3.2° RNAV approaches flown during the first trial were performed by the A320 family, a short to medium-haul aircraft.

- RNAV approaches are only available in near CAT I conditions or better meaning that during poorer visibility they cannot be used.

- RNAV approaches result in a higher Air Traffic Control (ATC) and pilot workload. Therefore, even if more crews elected to fly RNAV approaches, ATC might not be able to accommodate and could decline pilot requests. This became evident in the first trial of slightly steeper approaches at Heathrow[4].

2.7 RNAV Approach Angles (Vertical Path Angle)

2.7.1 PANS-OPS allows a Vertical Path Angle (VPA) of up to 3.5° for the different types of RNAV approach[7] as a standard[8]:

2.7.2 Final approach angles above 3.5° would require individual regulatory approval for each operator which could greatly reduce the numbers of aircraft willing and able to conduct such approaches, even below the 2% currently performing RNAV approaches at Heathrow.

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[5] First trial report (www.heathrow.com/content/dam/heathrow/web/common/documents/company/local-community/noise/reports-and-statistics/reports/operational-trial-reports/slightly-steeper-approach-trial/Heathrow_Slightly_Steeper_Approach_Trial_Report.pdf) and Second trial report (www.heathrow.com/content/dam/heathrow/web/common/documents/company/local-community/noise/reports-and-statistics/reports/operational-trial-reports/slightly-steeper-approach-trial/Heathrow_Slightly_Steeper_Approach_Trial_2017_Final_Report.pdf)

[6] Flight duration in excess of 6 hours

[7] LNAV, LNAV/VNAV (Baro-VNAV) and LPV. BARO refers to 'Barometric' where the aircraft's height is determined with reference to the barometric air pressure which is sensitive to temperature. VNAV refers to Vertical Navigation. LNAV refers to Lateral Navigation.

[8] PANS OPS 8168 Vol II; Part 3; Section 3; Chapter 4, Subsection 4.2.1.3 A procedure shall not have a promulgated VPA that is less than 2.5°. A procedure with a promulgated VPA that exceeds 3.5° is a non-standard procedure.

2.7.3 In addition, whilst a BaroVNAV final approach angle of 3.5° may seem an obvious target in order to provide greater noise benefit, the issue of the effect of temperature on such approaches was to be considered.

2.7.4 Air temperature has a small effect on the altitude that an aircraft's altimeter[9] says the aircraft is at compared to the height it actually is at. An RNAV Approach's descent angle is based on the angle at the International Standard Atmosphere (ISA) temperature at mean sea level which is 15°C. When the temperature is not exactly 15°C, the barometric approach angle starts to alter slightly. The colder the temperature, the shallower the approach angle. The warmer it gets, the steeper the approach angle. Therefore, a promulgated VPA of 3.5° at Heathrow would not be 'useable' once airfield temperature exceeds 15°C because at above 15°C the actual approach angle would be above the maximum 3.5° permitted. The hottest temperature recorded at Heathrow is 37.4°C so a maximum published VPA of 3.27° would be required to safeguard against this temperature to ensure a VPA of less than 3.5˚ at all times[10].

2.7.5 Conversely, a 3.2˚ BaroVNAV approach performed at 37.4°C would result in an actual VPA of 3.43˚.

2.7.6 In addition, there was uncertainty as to the effect of angles steeper than 3.2˚ on Heathrow's intense operation. Frankfurt Airport has trialled and implemented 3.2° approaches, but Heathrow is not aware of any high intensity airport operations where approach angles are greater than 3.2˚.

2.7.7 In order to generate the evidence required to support a 3.2° slightly steeper approach, live trials took place between 2015 and 2017 to assess the impact of a 3.2° approach on Heathrow's operation. The trial reports are available via the links on page 4.

2.7.8 The trials demonstrated that a published RNAV VPA of 3.2° had no negative impact on Heathrow's operation whilst providing a small but measurable reduction in noise at ground level: 0.5dB SEL[11].

2.7.9 The potential options explored for Area Navigation (RNAV) approaches at Heathrow are listed below:

RNAV Approach Option B1

2.7.10 This option is the status quo and the baseline: Both the ILS and RNAV approaches remain at 3.0˚. This would not achieve a steeper approach than today.

RNAV Approach Option B2

2.7.11 This option would see the Vertical Path Angle (VPA) for all of Heathrow's RNAV approaches increased from 3.0˚ to 3.2˚. The ILS would remain at 3.0˚.

[9] An altimeter is an instrument used to measure the altitude of the aircraft above a fixed level

[10] https://www.eurocontrol.int/sites/default/files/publication/files/guidelines-ctc-by-ats-edition-1-0-signed.pdf

[11] The single event Sound Exposure Level is the sound level in dBA which, if maintained for a period of one second, would cause the same A-weighted sound energy to be received as is actually received from a given sound event.

RNAV Approach Option B3

2.7.12 This option would see the VPA for all of Heathrow's RNAV approaches increased from 3.0˚ to 3.5˚. The ILS would remain at 3.0˚.

2.7.13 When air temperature is above 15˚C, these procedures would be unavailable as the VPA would exceed 3.5˚ (see next section for more detail).

RNAV Approach Option B4

2.7.14 This is a concept whereby an angle greater than 3.5˚ is used further from touchdown (outside the Final Approach Fix) but the angle reduces to 3.5˚ or less, closer to touchdown (inside the Final Approach Fix). For this option, we considered an angle of 4.5˚ reducing to an angle of 3.2˚. The ILS would remain at 3.0˚.

2.7.15 In 2015, British Airways flew a limited number of these segmented approaches into Heathrow under trial conditions on B777 aircraft. Whilst the procedures were flown safely, the spacing on final approach between subsequent aircraft was greatly increased to cater for a potential increase in Vortex Wake encounters. In addition, the pilots selected to fly the procedures were briefed and trained to fly the approaches for the trial period.

2.7.16 Such approaches would require individual crew training and approval and therefore the number of approaches flown would be very low indeed. In addition, the additional spacing required would be detrimental to Heathrow's runway throughput.

2.7.17 There are no existing PBN design criteria for these segmented approaches.

2.7.18 Options B1, B2 and B3 are illustrated in Figure 3 and Option B4 in Figure 4. These figures show the different heights along final approach that could be achieved as a result of the different approach angles.

2.7.19 Options between 3.0˚ and 3.2˚ were not considered because the live trials have demonstrated that 3.2˚ was a safe procedure. Therefore, considering angles less than this was not necessary.

Figure 3: Height differences along final approach owing to different VPAs

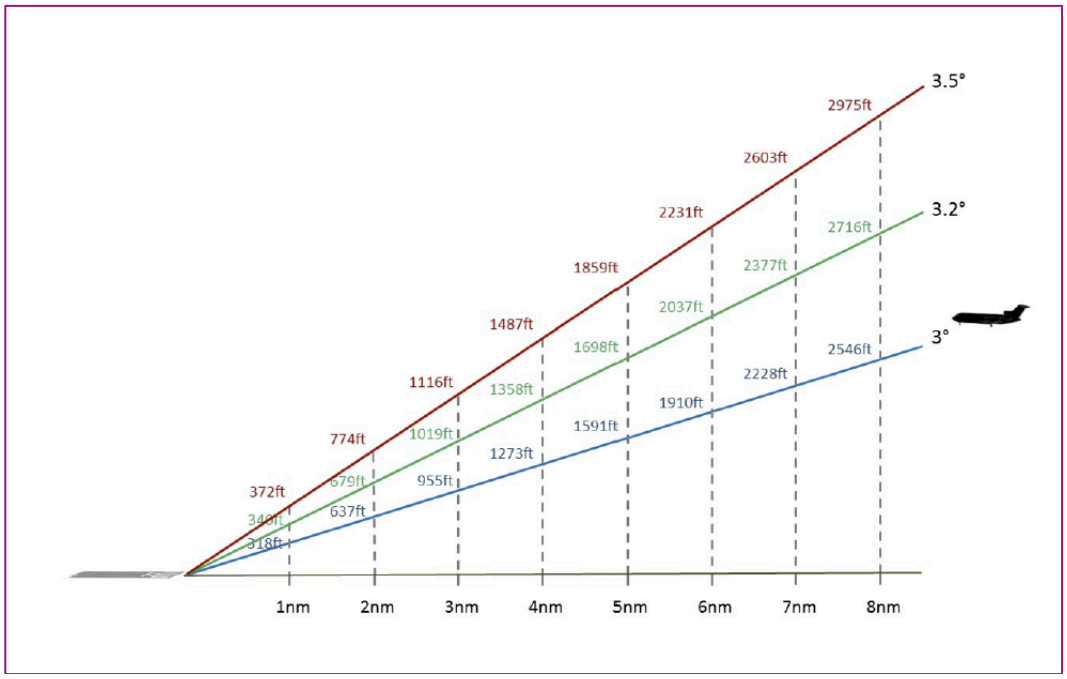
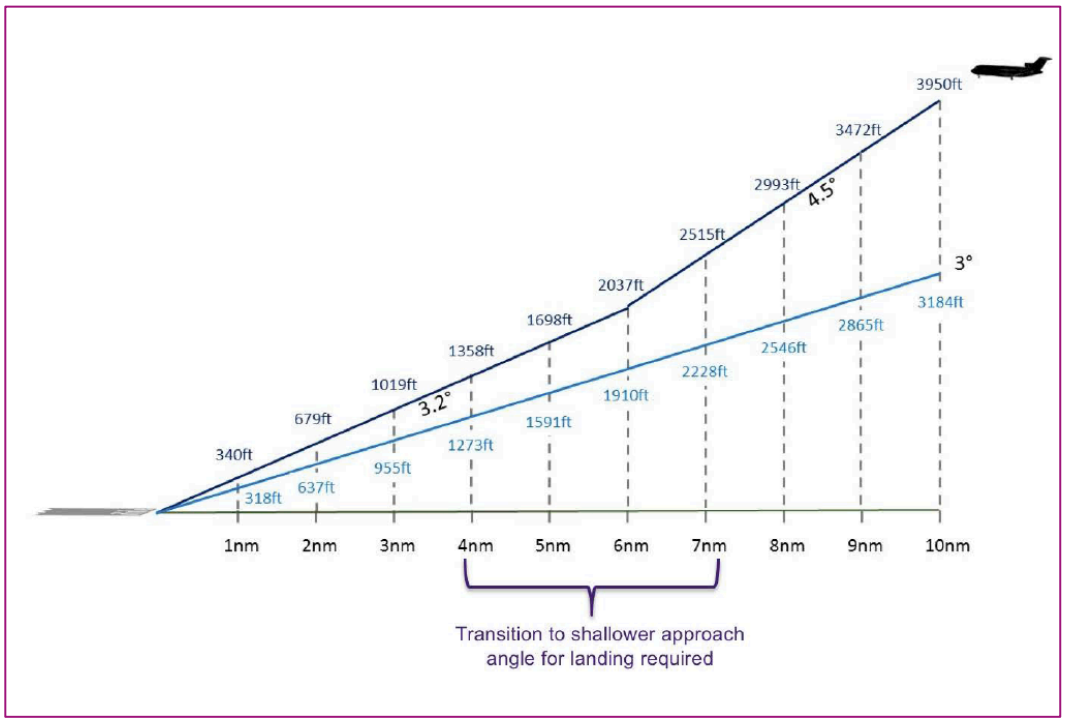


Figure 4: Conceptual height differences along final approach with a segmented approach



3. STAKEHOLDER ENGAGEMENT AND FEEDBACK

3.1 Identified Stakeholders and method of engagement

3.1.1 Our SSA stakeholder representatives were identified at the start of the airspace change process. Heathrow identified the potentially impacted area, based on the extent of the final approaches for Heathrow's runways, extended from the runway threshold out to 10nautical miles (NM), because all of Heathrow's RNAV approaches commence from 10nm from touchdown, see Figure 5.

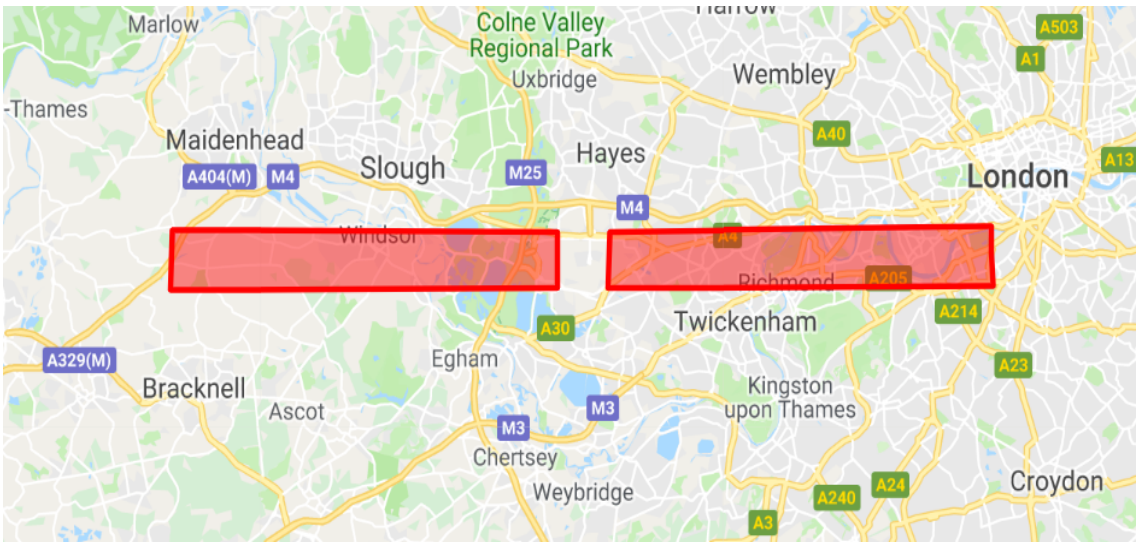


Figure 5: Map of potentially impacted areas

3.1.2 During Stage 1, Heathrow utilised existing forums to carry out the design principle engagement. For the Stage 2A stakeholder engagement, Heathrow engaged with the same forums; the Heathrow Community Noise Forum (HCNF, Table 1), the Heathrow Community Engagement Board (HCEB, Table 2), and the Heathrow Strategic Planning Group (HSPG, Table 3), which represents many of the local authorities surrounding Heathrow.

Borough	Councillor/Officer	Community Representative
Bracknell Forest	[redacted]	[redacted], LAANC
Buckinghamshire CC	[redacted]	[redacted]
Elmbridge	[redacted]	[redacted]
Hillingdon		[redacted], HASRA
Hounslow	[redacted]	
London Borough of Ealing	[redacted]	[redacted], EANAG
Hammersmith & Fulham	[redacted]	
London Borough of Lewisham		[redacted], Forest Hill Society

London Borough of Southwark		[redacted] Plane Hell
Richmond	[redacted]	[redacted], Richmond Heathrow Campaign (RHC) [redacted], RHC [redacted], Teddington Action Group (TAG) [redacted], TAG
Runnymede	[redacted]	[redacted], Englefield Green [redacted], Englefield Green Action Group (EGAG) [redacted] EGAG [redacted] EGAG
South Bucks	[redacted]	[redacted], Richings Park Residents Association
Spelthorne	[redacted]	[redacted], Spelthorne resident
Surrey Heath	[redacted]	[redacted], Aircraft Noise 3 Villages (AN3V) [redacted], AN3V [redacted], AN3V [redacted], The Windlesham Society
Surrey County Council	[redacted]	
Slough	[redacted]	
Windsor & Maidenhead	[redacted]	
Wokingham	[redacted]	
Other		[redacted], HACAN

Industry		
To70 (Independent Advisor)	[redacted]	British Airways
Virgin Atlantic	Civil Aviation Authority	Department for Transport
NATS	Independent Commission on Civil Aviation Noise (ICCAN)	Heathrow

Table 1: List of HCNF Members

List of HCEB Members	
Chair	[redacted]
Director	[redacted]
Director	[redacted]
Non-Exec Board Member	[redacted]
Non-Exec Board Member & Chair of Passenger Services Group	[redacted]
Residents Adviser	[redacted]
Executive Assistant	[redacted]
Head of Communications & Strategy	[redacted]

Table 2: List of HCEB Members

List of HSPG Members	
Buckinghamshire County Council	Runnymede Borough Council
Colne Valley Park Community Interest Company	Slough Borough Council
Elmbridge Borough Council	Surrey County Council
Enterprise M3 Local Enterprise Partnership	South Bucks District Council
London Borough of Ealing	Spelthorne Borough Council
London Borough of Hounslow	Thames Valley Berkshire Local Enterprise Partnership
Royal Borough of Windsor & Maidenhead	Buckinghamshire Thames Valley Local Enterprise Partnership

Table 3: List of HSPG members[12]

3.1.3 For industry groups, Heathrow again engaged with; the National Air Traffic Advisory Committee (NATMAC, Table 4) and the Heathrow Airport Flight Operations Performance and Safety Committee (FLOPSC, Table 5).

List of NATMAC Members	
Airlines UK	Airspace4All
Airport Operators Association (AOA)	Airfield Operators Group (AOG)
Aircraft Owners & Pilots Association (AOPA)	Association of Remotely Piloted Aircraft Systems UK (ARPAS-UK)
British Airways (BA)	Bae Systems

[12] Information taken from http://www.heathrowstrategicplanninggroup.com/about-us

British Airline Pilots Association (BALPA)	British Balloon & Airship Club (BBAC)
British Business & General Aviation Association (BBGA)	British Gliding Association (BGA)
British Helicopter Association (BHA)	British Hang Gliding & Paragliding Association (BHPA)
British Microlight Aircraft Association (BMAA)	British Model Flying Association (BMFA)
British Parachute Association (BPA)	General Aviation Alliance (GAA)
General Aviation Safety Council (GASCo)	Guild of Air Traffic Control Officers (GATCO)
Honourable Company of Air Pilots (HCAP)	Helicopter Club of Great Britain (HCGB)
Heavy Airlines	Isle of Man CC
Light Aircraft Association (LAA)	Low-Fares Airlines
NATS	PPL/IR (Europe)
UK Airprox Board (UKAB)	UK Flight Safety Committee (UKFSC)
Ministry of Defence – Defence Airspace & Air Traffic Management (MoD DAATM)	United States Air Force Europe (USAFE)
Navy Command Headquarters	Military Aviation Authority (MAA)

Table 4: List of NATMAC members

List of FLOPSC Members	
Heathrow	National Air Traffic Services
British Airways	Virgin
Flybe	United
Qatar Airways	Lufthansa (DLH)
KLM	Aer Lingus
American Airlines	Germanwings
Austrian Airlines	Delta
SAS	Qantas
Met Office	Airport Coordination Ltd (ACL)
British Air Line Pilots Association (BALPA)	Civil Aviation Authority
Department for Transport	UK Flight Safety Committee

Table 5: List of FLOPSC members

3.1.4 For the community and local authority stakeholders a presentation was given to the HSPG on the 5th September 2019, to the HCEB on the 17th September 2019 and to the HCNF on the 18th September 2019. A copy of this presentation is at Appendix D, pages 13-20.

3.1.5 For the industry groups, due to the lack of regular meetings, a copy of the presentation was emailed to all the members of NATMAC and FLOPSC, and stakeholders were given two weeks to provide any comments or feedback. Copies of the emails are available at Appendix D.

3.2 How we engaged

3.2.1 Due to the limited nature of this airspace change, as it is a procedure currently in place under a trial (the establishment of which had already included stakeholder engagement, see trial reports for more details[13]), we decided to engage with our community stakeholders via briefings, to make sure they fully understood the situation.

3.2.2 As the material was relatively short, we decided not to hold separate sessions, but instead arranged for time within existing stakeholder engagement meetings.

3.2.3 Heathrow felt that the industry groups being engaged would understand the material without further explanation being required.

3.2.4 A chronological log of the engagement carried out with stakeholders is at Appendix C, with all engagement materials at Appendix D.

3.3 Engagement Material

3.3.1 As per the requirements of CAP1616, we engaged our stakeholders with the comprehensive list of options and explained the process of how we have developed our proposal.

3.3.2 Through a presentation, stakeholders were taken through the current Instrument Landing System (ILS) procedure, an explanation of RNAV Approaches, Heathrow's proposal to introduce slightly steeper approaches using RNAV, the options for different RNAV approach angles and the next steps for this airspace change proposal. A full copy of the presentation is at Appendix D, pages 13-20.

3.3.3 We asked our stakeholders to provide any comments or feedback on the presentation. All stakeholders were given two weeks to provide their feedback.

3.4 Summary of Stakeholder Feedback

3.4.1 We received feedback from Lufthansa, the Ministry of Defence and Austrian Airlines.

3.4.2 The Ministry of Defence responded to our request for feedback but chose to make no comments at this stage.

[13] First trial report (www.heathrow.com/content/dam/heathrow/web/common/documents/company/local-community/noise/reports-and-statistics/reports/operational-trial-reports/slightly-steeper-approach-trial/Heathrow_Slightly_Steeper_Approach_Trial_Report.pdf) and Second trial report (www.heathrow.com/content/dam/heathrow/web/common/documents/company/local-community/noise/reports-and-statistics/reports/operational-trial-reports/slightly-steeper-approach-trial/Heathrow_Slightly_Steeper_Approach_Trial_2017_Final_Report.pdf)

3.4.3 Lufthansa fully agreed with our options and confirmed that a VPA of 3.2° would be the best compromise regarding turbulence, speed reduction and stabilisation on the final approach.

3.4.4 Austrian Airlines stated that the presentation was good and raised the following points for consideration:

- "The vertical guidance [for RNAV Approaches] is based on barometric information only with 3 basic effects: generally, more exposed to errors, generally less accurate guidance of the desired path, and no guidance at all after the minimum; these are safety related issues.
- On the quality issue in regard to noise on steeper approaches you should check the need for earlier extension of configuration (flap, slats and gear), and higher approach configuration (Flap Full instead of Flap3) which results in more aerodynamic noise than on a standard 3 glidepath; both effects are missing in the presentation.
- The mixed mode operation for parallel approaches (ILS with NPA[14]) should be considered at early stages of planning (spacing between runways which are planned to be flown independently)."

3.4.5 We received no feedback from the community groups engaged. During the HCEB meeting some questions were asked and answered during the session. There was questioning from some stakeholders as to the need for an ACP for such a small change with no negative environmental impact. A copy of the meeting notes is available at Appendix D, pages 25-29.

3.4.6 Full copies of all feedback received is available in Appendix E.

3.5 How we responded to the feedback

3.5.1 There was very little feedback to inform options development. With regards Austrian Airlines feedback, these are known issues which were uncovered during the development of the live trials in 2014 and which led to the decision to trial 3.2˚ RNAV approaches. The trials demonstrated that these concerns did not materialise at 3.2˚.

3.5.2 Overall there was minimal interest in this airspace change, as it has been in place as a trial since 2015 and there is limited impact on communities.

[14] Non Precision Approach

4. STEP 2A DESIGN PRINCIPLE EVALUATION

4.1.1 The evidence from the live trials was used to inform Heathrow's design principle evaluation of options 1-4. This is summarised in Figure 5 below. The design principle evaluation of these articulated using the CAP1616 template is available in Appendix B.

4.1.2 The design principle evaluation established that the only viable option for Heathrow at this time is to introduce 3.2˚ RNAV approaches, to be used in conjunction with 3.0˚ ILS approaches. The live trials have provided Heathrow with all the evidence required that the approaches were safe, were not detrimental to the Heathrow operation and that there was a small noise benefit.

4.1.3 Option B1 was discounted because it would not achieve the mandatory design principle of reducing noise compared to a 3.0˚ approach but it remains the baseline against which other options will be assessed. Option B3 was discounted because Heathrow has no evidence that a 3.5˚ approach would not be detrimental to the operation. A 3.5˚ BaroVNAV approach angle would be unavailable whenever air temperature exceeds 15˚C and it is highly likely that there would be an even lower uptake of the steeper approach compared to the 3.2˚ approach on trial today.

Figure 6: Summary of design principle evaluation of SSA options

Option	PRINCIPLE 1 *Must be safe*	PRINCIPLE 2 *Must achieve the objective of reducing noise compared to a 3.0˚ approach*	PRINCIPLE 3 *Must not increase the numbers of go-arounds*	PRINCIPLE 4 *Must not reduce Heathrow's capacity*	PRINCIPLE 5 *Must not change the lateral tracks of aircraft over the ground*	PRINCIPLE 6 *Should not reduce the ability for arrivals to fly Continuous Descent Approach.*	PRINCIPLE 7 *Should maximise the number of aircraft able to fly the slightly steeper approach*	PRINCIPLE 8 *Should not adversely increase pilot or ATC worklaod*	Carried forward into Initial Options Appraisal
B1 RNAV 3.0°									**No - doesn't reduce noise footprint**
B2 RNAV 3.2°									**YES**
B3 RNAV 3.5°									**No - would result in significantly less than 2% of Heathrow's arrivals flying the approach**
B4 Segmented approach 4.5° - 3.2˚									**No - would result in significantly less than 2% of Heathrow's arrivals flying the approach and highly likely to reduce Heathrow capacity. Uncertainty on how to design such a procedure**

Doesn't meet design principle
Partially meets design principle
Meets design principle