



## Heathrow Expansion

ACP Technical Note 01 A high level description of the approach for options development and appraisal to meet CAP1616 requirements for IPA and Expansion

### ACP Technical Note 01:

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**REVIEW HISTORY**

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## CONTENTS

1.	INTRODUCTION .....	1
1.1.	Overview and purpose .....	1
1.2.	Scope .....	2
2.	HEATHROW APPROACH TO OPTIONS DEVELOPMENT AND REFINEMENT .....	2
2.1.	CAP1616 context for options appraisal .....	2
2.2.	Design scope: focusing on 'groups of operationally dependent routes' at initial appraisal .....	3
2.3.	Our interpretation of the requirement for a 'comprehensive list of options' .....	4
2.4.	Adaptation of options and development of new options through the design process .....	5
2.5.	Focussing options development on the most significant components .....	6
3.	CONCLUSION .....	8

# 1. INTRODUCTION

## 1.1. Overview and purpose

1.1.1. CAP1616 defines high level requirements of the airspace change process and it is the responsibility of the Change Sponsor to develop a detailed plan for meeting those requirements. This document describes some key elements of the Heathrow Airport Limited (Heathrow) approach to meeting CAP1616 requirements for options development and appraisal (Stage 2).

1.1.2. The elements of the Heathrow approach covered in this document are those which Heathrow seek clarity from the CAA on the requirements of CAP1616. This document is not intended to be a full process description and does not rehearse all of the steps already undertaken. Detailed plans for the execution of the options appraisal will be built up in a stepwise approach with levels of detail being added to the framework as the methodology is developed.

1.1.3. The elements of the Heathrow approach described in this document will underpin the detailed planning for Stage 2 of the expansion ACP. For example, the development of criteria for refining the options (as described in Para E18 of CAP1616) cannot be completed until we have established what level of design detail will be available at each appraisal stage.

1.1.4. This document is designed to be shared with the CAA, with a view to gaining assurance that the elements of the Heathrow approach described in this document are in line with their expectations for CAP1616, and so that Heathrow can plan for Stage 2 in line with those expectations. The specific questions being asked in this document are:

- a. Is our design scope for initial appraisal, which focusses on 'groups of operationally dependent routes, in line with CAA expectations for CAP1616 compliance?
- b. Is our interpretation of the requirement for a 'comprehensive list of options' in line with CAA expectations for CAP1616 compliance?
- c. Is our approach to the adaptation of options and development of new options through the design process in line with CAA expectations for CAP1616 compliance?
- d. Is our approach to options development, which is focussed on the most significant design components, in line with CAA expectations for CAP1616 compliance?

## 1.2. Scope

- 1.2.1. This document is produced for an audience who is familiar with airspace design and CAP1616. Technical terms and common abbreviations are used throughout.
- 1.2.2. The document is produced with reference to Expansion and Independent Parallel Approaches (IPA) Airspace Change Proposals (ACPs). It does not set a precedent for future Heathrow ACPs. The detail for each ACP should be considered on a case by case basis depending on the scope/scale.
- 1.2.3. Stakeholder engagement and consultation is a key focus within the CAP1616 process and more specifically, plays a pivotal role within Stage 2A; providing input and feedback into the options development phase; however, it is not the focus of this document. Each ACP has a separate engagement and consultation strategy document.

## 2. HEATHROW APPROACH TO OPTIONS DEVELOPMENT AND REFINEMENT

### 2.1. CAP1616 context for options appraisal

- 2.1.1. CAP1616 defines a process where a comprehensive set of options is developed (Stage 2A) which “is then whittled down through a shortlist to the optimal option for delivery” (CAP1616 P155) by Stage 4. This is achieved through a Design Principles Evaluation in stage 2 and then three appraisal exercises in stages 2,3 and 4 (Initial, Full and Final) each of which successively refine the longlist of options until the best available option has been identified.
- 2.1.2. Para E10 states that this approach “builds the evidence base as the proposal matures, so for example the Final options appraisal contains the Initial and Full appraisals. It is therefore a proportionate approach because it avoids the need for expensive detail on every potential design option. It is also more informative, by ensuring that the detail matures in line with the proposal, and that a reasonable evidence base is made available to all stakeholders early on and increasingly throughout the process.”
- 2.1.3. Figure 1 characterises this approach showing the relationship between options and the design detail (represented by the granularity – ie the scale and level of detail - of the analysis at each stage). This figure has been produced by Heathrow and is a model for how Heathrow is approaching the sequential appraisal activities

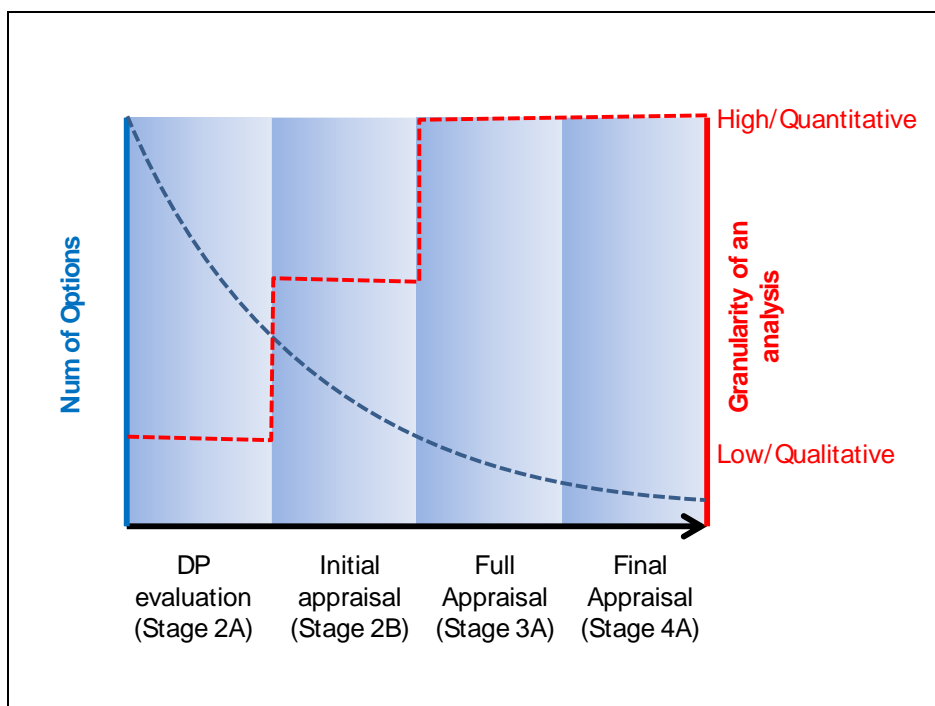


Figure 1: Heathrow's illustration of options vs granularity of analysis through the ACP process.

2.1.4. Airspace changes involve finding the right balance of benefits and impacts to identify the “optimal option for delivery” (CAP1616 Page 154).

Heathrow recognises that to demonstrate this optimally, evidence is required to show that all reasonable alternatives were considered and to demonstrate why they were discarded in favour of the preferred design. Heathrow therefore fully embraces the CAP1616 process regarding options development and are seeking to apply CAP1616 in such a way as to maximise the number of possible options that will be considered, with a view to strengthen the final proposal.

## 2.2. Design scope: focusing on ‘groups of operationally dependent routes’ at initial appraisal

**2.2.1.** This section provides the context for the question: **Is our design scope for initial appraisal, which focusses on ‘groups of operationally dependent routes, in line with CAA expectations for CAP1616 compliance?’**

2.2.2. Para E10 of CAP1616 recognises that the process for refining the options to a shortlist and ultimately the preferred design needs to be proportionate, balancing the stage of design (and therefore the number of options) against the scope/granularity of analysis. This section describes how the Heathrow approach to Stage 2/3 of CAP1616 aims to find an appropriate balance. This approach is summarised in Table 1 and described in more detail in the remainder of this section.

### Sets of operationally dependent routes

2.2.3. The first row in Table 1 describes the design scope at each stage. A design will consist of a number of component parts, some of which are dependent on one another and others that are not. The design scope row in Table 1 refers to the nature of the components being addressed at each stage. For Stage 2A and Stage 2B, Heathrow will focus on refining options for 'groups of operationally dependent routes' for initial appraisal. The refined options for initial appraisal will then feed into full appraisal of the 'full system of routes' in Stage 3. The relationship between groups of operationally dependent routes and the full system of routes is illustrated in Figure 2, and the rationale for this approach laid out detail in the remaining text in this section.

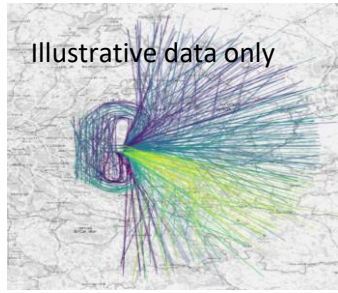
	Stage 2A: Options Development	Stage 2A: Design principle evaluation	Stage 2B Initial Appraisal	Stage 3: Full Appraisal
<b>Design scope</b>	The Heathrow approach to this stage is to develop a comprehensive set of options for <b>groups of operationally dependent routes</b>	The Heathrow approach to this stage is to assess the impact of options for <b>groups of operationally dependent routes</b> (see Figure 2)	The Heathrow approach to this stage is to assess the impact of options for <b>groups of operationally dependent routes</b> (see Figure 2)	The Heathrow approach to this stage is to assess the impact of options for the <b>full system of routes</b> (see Figure 2)
<b>Data scope</b>	Options will be drawn using data from a wide range of alignments for individual routes covering the whole design envelope (see Figure 2). These will not be “airspace change options” in terms of CAP1616 because they will not necessarily be operationally feasible (ie no consideration of separations). However, they will ensure that the development of options for the groups of operationally dependent routes is based on a thorough process considering a range of possibilities.	The Heathrow approach to this will be a qualitative assessment also referring to qualitative data relating to areas and populations overflown or potential affected by noise using information such as overflight data and noise event footprints.	<p>CAP1616 requirements (E12)</p> <p><i>“The Initial appraisal is based around a qualitative assessment.”</i></p> <p>Including</p> <p><i>“– an indicator of the likely noise impacts</i></p> <p><i>– a high-level assessment of other costs”</i></p> <p>The Heathrow approach to this will be qualitative assessment, also referring to the following quantitative data sources:</p> <ul style="list-style-type: none"> <li>- statistics relating to areas and populations overflown or potential affected by noise using information such as overflight data and relative noise exposure data for comparison of the groups of operationally dependent routes.</li> <li>- WebTAG is not a requirement of Stage 2B, however, Heathrow may choose to refer to webTAG modules where possible, given the level of analysis that is practical, and given the number of options (see paragraphs 2.2.8 onwards for discussion on the number of options and how this impacts the scope of analysis). The specific modules to be used will be identified when the criteria for each stage of appraisal is established (CAP1616 Para E18)</li> </ul>	<p>CAP1616 requirement (E23)</p> <p><i>“For the Full appraisal, we expect the Initial appraisal to be developed into a more detailed quantitative assessment, moving from qualitatively defined shortlist options to the selection of the preferred option.”</i></p> <p>Including</p> <p><i>“– all reasonable costs and benefits quantified</i></p> <p><i>– all other costs and benefits described qualitatively”</i></p> <p>The Heathrow approach to this will be to use:</p> <ul style="list-style-type: none"> <li>-all relevant existing WebTAG modules</li> <li>-extra quantified data including overflight and SEL stats from initial appraisal</li> <li>-qualitative analysis only where issues are not fully captured in WebTAG</li> </ul>

*Table 1: Heathrow’s approach to design and data scope for evaluation and appraisal*



### Preparation for Stage 2

We cover each Design envelope in 'lines' that could represent possible routes.



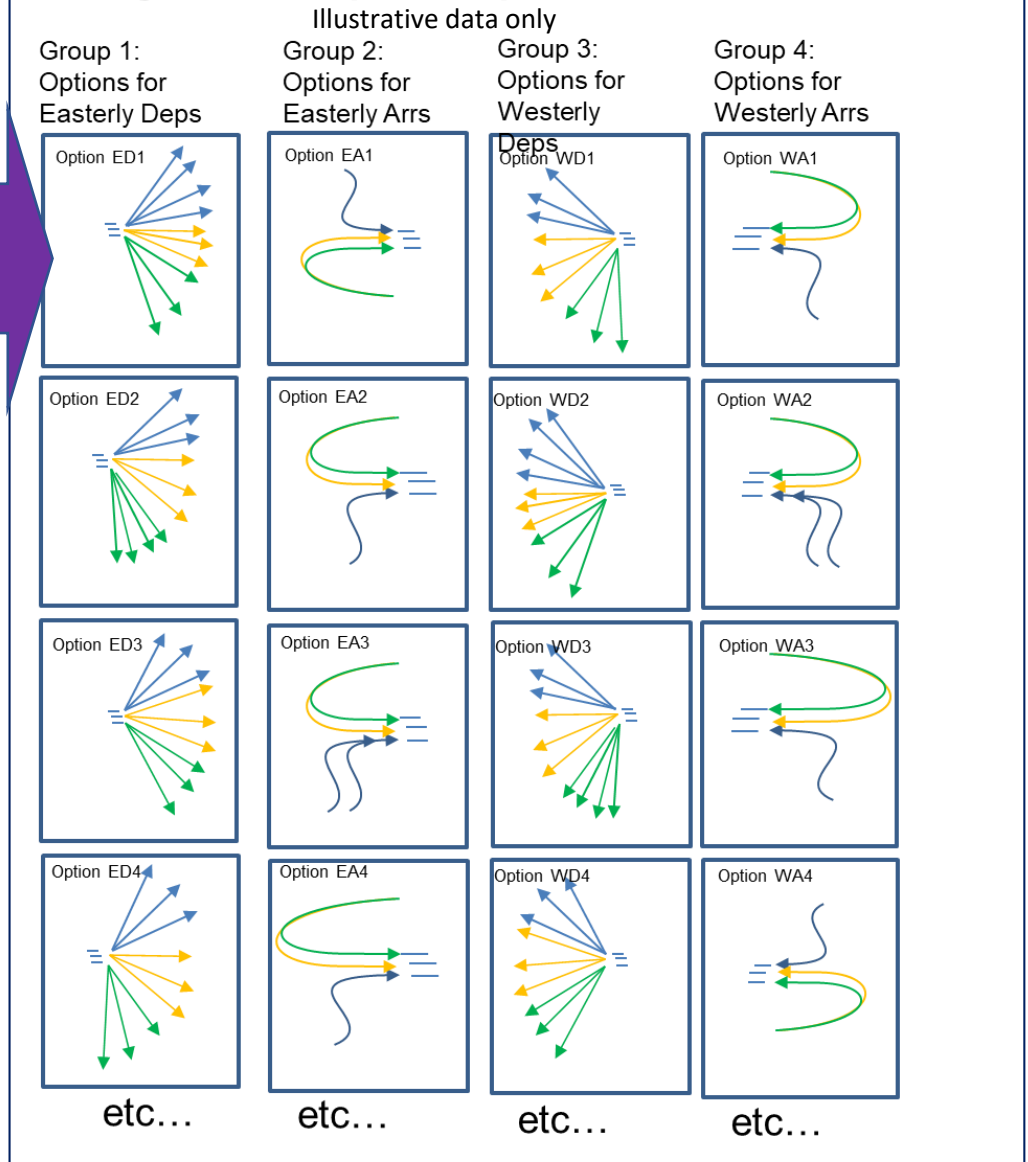
Stats are generated so we understand the nature of the areas underneath them (eg in terms of population, industrial areas, parks etc..).

This information is fed into the generation of options in Stage 2 and will be part of the stage 2 submission.

These are illustrations of design options to demonstrate the process. They are **not** actual design options.

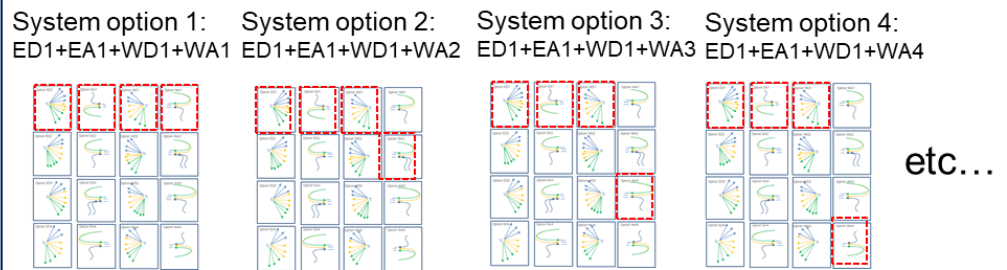
Actual design options would be detailed lines over the ground developed to address the design principles and drawn with reference to IFP and operational criteria.

## Stage 2 – Groups of dependent routes



Options for each group refined through initial appraisal and fed into Stage 3

## Stage 3 – Complete route systems



With 4 options for each group of dependent route there would be  $4*4*4*4=256$  options for the complete route system – each of which would have a different set of LAeq contours to feed into webTAG monetisation at full appraisal

Figure 2: Illustration of the evolution from options for 'groups of operationally dependent routes' to options for the 'full system of routes'

- 2.2.4. CAP1616 states that the “change sponsor must bear in mind that the option that is eventually chosen must be compliant with the relevant technical criteria” (Para 122).
- 2.2.5. Individual routes that have an operational dependency on one another (for example a separation requirement) cannot therefore be considered in isolation from one another because the position of one could dictate the potential positioning of the other. For example, the westerly departure routes for expansion must be designed to be separated from one another in line with operational standards for route separation - this means that options for the position of each route will be dependent on those in around it.
- 2.2.6. However, the group of westerly departure routes will never be in operation at the same time as the group of easterly departure routes. This means that options for the group of westerly departures can be considered in isolation from easterly departures and vice versa. This is illustrated in Figure 2 which shows arrivals can also be grouped<sup>1</sup>.
- 2.2.7. Note that the routes for IPA can likewise be grouped according to which are dependent on one another in terms of runway in operations.

#### Maximising options

- 2.2.8. Developing and considering options for groups of operationally dependent routes in isolation from one another is good from the perspective of maximising the number of options considered, but has consequences for the granularity of the analysis possible at each stage. The trade-off between number of options and analysis granularity, and the Heathrow approach to managing it such that options are not limited as a consequence is described below.
- 2.2.9. The approach is illustrated in Figure 2. For expansion we will have at least<sup>2</sup> four groups of operationally dependent routes, relating to easterly departures, easterly arrivals, westerly departure and westerly arrival. Following Design Principle Evaluation (stage 2A), we will identify options for each group to feed into the initial appraisal; in this example we assume 10 options for each group.

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<sup>1</sup> Arrivals and departures can interact, however the Heathrow ‘macro’ concept is to keep arrival and departure operations completely segregated below 7000ft, eg on westerlies, all departure routes will be to the west of the airport while all arrivals will be to the east. This segregation means that the options for individual arrival and departure routes never interact below 7000ft and so can be considered in isolation from another. Options for separating arrival and departure streams above 7000ft are beyond the scope of the expansion ACP as they are part of the LAMP network ACP.

<sup>2</sup> It may be necessary to further subdivide the arrival routes into further groups based on mode of operation. This will be determined at the options development stage.

Considering the options for each group in isolation from the options in the other groups results in 40 separate options being fed into the initial appraisal.

- 2.2.10. However when considered in combination, these 40 separate options would become  $10 \times 10 \times 10 \times 10 = 10000$  separate combinations for the full system. Each of these would be a separate option for appraisal because they would result in a different set of impacts, in particular they would each have a different set of LAeq contours (which are required for webTAG monetisation)<sup>3</sup>.
- 2.2.11. This is clearly an impractical number of system options to analyse at full webTAG granularity, and therefore Heathrow are proposing an approach that keeps the initial design scope for initial appraisal at ‘groups of operationally dependent routes’. This approach is specially designed to maximise the number and range of options considered at the Initial Appraisal. The Initial Appraisal is then used to refining the options for each group to a shortlist for each group. The refined options for each group are then combined with those from other groups to generate a more manageable number options for the full system of routes to be fed into the full appraisal<sup>4</sup>
- 2.2.12. Para E12 of CAP1616 states that “*Initial appraisal is based around a qualitative assessment*” but that “*the change sponsor is encouraged to develop its shortlist options using as much analysis as reasonably possible*”. The approach described above and in Table 1 meets this requirement because it involves initial appraisal that will qualitative referring to quantitative data including statistics on overflight and relative noise exposure data for each option. The rationale laid out in this section describes why it is reasonable to stop short of full system LAeq and associated webTAG monetarisation at this stage. Full webTAG monetisation will be undertaken at full appraisal in Stage 3 on the shortlist of options following refinement at Stage 2B.
- 2.2.13. Stage 3 will also include the formal consultation. Detailed analysis will be presented for the options taken into consultation. This will include full system analyses such as Leaq contours and analysis of individual tracks such Lmax and SEL footprints.

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<sup>3</sup> Note that Table 1 shows that Heathrow will develop *relative* noise exposure contours at Stage 2B for comparative purposes. These noise exposure contours would only take account of the particular set of dependent routes and so would not be a true representation of overall noise exposure. Therefore they cannot feed into a webTAG analysis of the absolute level of impact, but would allow for a comparative analysis between options for the sets of dependent routes.

<sup>4</sup> Note that we still expect there to be c.30 full system options fed into the IPA full appraisal and hundreds of options for full appraisal for expansion

## 2.3. Our interpretation of the requirement for a ‘comprehensive list of options’

- 2.3.1. This section provides the context for the question: **Is our interpretation of the requirement for a ‘comprehensive list of options’ line with CAA expectations for CAP1616 compliance?**
- 2.3.2. CAP 1616 para 120 states: “In Step 2A, the change sponsor develops a comprehensive list of options that address the Statement of Need and that align with the Design Principles from Stage 1.
- 2.3.3. Para 124 states that their assessment will consider whether the sponsor has, in CAA’s view “identified all the possible options”
- 2.3.4. We interpret the definition of comprehensive as used in CAP1616 to mean “including all, or nearly all elements of aspects of something” and “of large content or scope” ([link](#)). This is different from “all possibilities”, which if taken literally, in relation to the complete airspace redesign is an impossible/infinite task – this is because all route lines can theoretically be tweaked by increasingly small margins to create a new line.
- 2.3.5. We therefore base our process on the requirement for a comprehensive list, that has been created based on consultation, stakeholder engagement, our Statement of Need and our Design Principles.
- 2.3.6. In practical terms this means we will demonstrate our options align with the Design Principles by developing options that are focussed on each specific Design Principle in turn. This means that there will be an option (or number of options) that are optimised, as far as is possible given the early stage of the design process, for each Design Principle.
- 2.3.7. This approach has been developed to ensure that we identify, as far as practically possible (see para 2.31-2.34) the “full range of interventions available” (CAP1616 Para E16). This requires a design process that encourages innovation.
- 2.3.8. This is achieved by approaching the problem from different angles rather than just looking at the design principles in turn according to their prioritisation. Innovation can be encouraged by seeding the design process in differing ways. In our approach the initial seed is the design principle that we initially choose to optimise to, which will change each time we start a new design exercise<sup>5</sup>.

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<sup>5</sup> If you always start the design process with the highest priority principle and then adapt that according to each of the other design principles in order of the prioritisation, you likely to end up with the same or similar results each time you go through a design iteration and will not necessarily identify a comprehensive range of possible options. Note that this does not mean that the prioritisation of design principles is being ignored as the prioritised list will be used to help assess the relative merits of each option at the evaluation and appraisal stages.

2.3.9. Each resultant option will then be reviewed against the ‘seed’ design principle, and also all the other design principles. They will then be fed through a further round of design looking for opportunities for combining elements of the individual options to better address a range of Design Principles.

2.3.10. Note that this initial review against the Design Principles would be part of the Stage 2, Step 2A “Sponsor develops a range of airspace change options” in the flow diagram on Page 44 of CAP1616. As such it would be covered in the Stage 2A engagement activity. The Design Principle Evaluation as required by CAP1616 will not happen until after stakeholder engagement (shown in the flow diagram on CAP 1616 Page 44).

#### 2.4. Adaptation of options and development of new options through the design process

2.4.1. This section provides the context for the question: **Is our approach to the Adaptation of options and development of new options through the design process in line with CAA expectations for CAP1616 compliance?**

2.4.2. CAP1616 infers a process in which each stage of evaluation/appraisal refines the original longlist until the preferred design option (which bests meet all the criteria) is identified. This infers that that the final chosen design will exist from the outset as one of the original comprehensive list.

2.4.3. Our experience of airspace design has demonstrated that new, unforeseen information can sometimes affect the airspace design, or that new ideas may be generated as a consequence of learning derived from the evaluation, appraisal and ongoing engagement.

2.4.4. A prime example relates to safety. We have a safety Design Principle included from the outset, but we will not be able to undertake much of the detailed safety assurance such as hazard analysis until much later when full design details are available and the design has been subject to detailed real time simulation. Such work will generate new information which (given the experience of previous airspace changes) is likely to identify the need to adapt an option (which would effectively become a new option, with the previous version a discarded option) or opportunities to generate completely new options that better meet the design principles.

Para 193 recognises that this may occur in step 4A but we consider that good design should leave open the possibility for adapting existing options, or generating new options, at any point in stage 2A, 2B or 3A, should the opportunity arise to improve on existing options. Any new or adapted option would be assessed against design principles and appraisal criteria so that each

has a full record of assessment so that they may be compared to the other options.

## 2.5. Focussing options development on the most significant components

2.5.1. This section provides the context for the question: **Is our approach to options development, which is focussed on the most significant design components in line with CAA expectations for CAP1616 compliance?**

2.5.2. The final ACP submitted in stage 4 of the airspace change proposal must provide a complete description of the airspace and operational procedures such that the CAA can be assured that it would be safe to implement. This will include detailed route definitions, complete with evidence that they meet all the requirements such as PANS OPS criteria, obstacle clearance, and CAA policies. This detail will also include ATC operational procedures for normal and unusual circumstances (eg MATS II entries) and evidence of full safety assurance.

2.5.3. This kind of detail takes a significant amount of time to generate and so it is not practical to develop it for all options from the outset. This is recognised in CAP1616 Para E10 which describes *“a proportionate approach because it avoids the need for expensive detail on every potential design option.”*

2.5.4. Figure 2 is a Heathrow representation of what this means for the relationship between the number of options and the level of detail for each option.

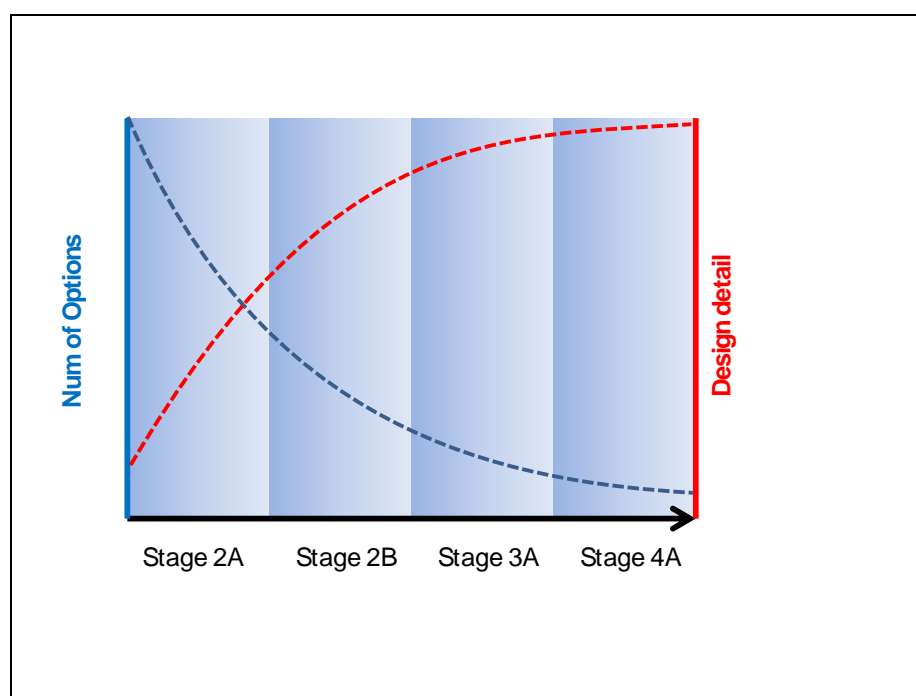


Figure 3: Heathrow's illustration of options vs design detail through the ACP process.

2.5.5. CAP1616 Para E10 states that the process should be “informative, by ensuring that the detail matures in line with the proposal, and that a reasonable evidence base is made available to all stakeholders early on and increasingly throughout the process.”

2.5.6. To meet this requirement Heathrow broadly categorise design information into two categories:

- e. Primary design characteristics which will dictate how well each option meets the design principle evaluation and appraisal criteria. This captures characteristics such as the alignments and vertical profiles for the routes that will carry most of the traffic. These primary characteristics will in turn dictate the effects that are key to most stakeholders such as operational efficiency/capacity, noise impacts, fuel/CO2 efficiency and the volume of controlled/segregated airspace required.
- f. Secondary design characteristics which are necessary parts of the final design, but which will have a relatively small or negligible impact on the evaluation and appraisal criteria. This would include:
  - i) contingency procedures such as missed approaches that are relatively rarely used and can be shown to have a negligible impact on the design principles/appraisal criteria
  - ii) operational practices for unusual circumstances such as recovery scenarios which are relatively rarely used and can be shown to have a negligible impact on the design principles/appraisal criteria
  - iii) peripheral routes that are not changing much, and/or which can be shown to have a negligible impact on the design principles/appraisal criteria

2.5.7. A proportional approach focussing on developing a reasonable evidence base for effective engagement with stakeholders (as described in CAP1616 Para E10) means that the options development process should focus on the first category, as it is the primary design characteristics that will dictate the key impacts that are of interests to the stakeholder. Heathrow’s initial option development is therefore focussed on primary design characteristics.

2.5.8. The secondary characteristics are also considered from the outset, but to a lesser degree. For example, Heathrow will be seeking to ensure that design options primary characteristics can accommodate secondary criteria such as missed approaches but would only be seeking to do this at a generic level, proving that missed approach procedures could be developed rather than developing detailed missed approach procedures themselves. This avoids wasted time/resource developing design details for secondary design characteristics for options that end up being discontinued on the basis of the

primary characteristics. Secondary characteristics would be fully developed for the full appraisal at Stage 3A, when the options have been refined to a relatively small number. Consultation at Stage 3B will include details of all elements of the design (primary and secondary) for the proposed options.

### 3. CONCLUSION

- 3.1.1. This document sets out the Heathrow approach to parts of the process for options development and refinement through Stage 2 of the ACP. This approach has been developed to meet CAP1616 requirements such that:
  - a. a broad range of options are developed and
  - b. each is passed through an appropriate level of evaluation and/or appraisal to ensure that there is a robust evidence trail to support the identification of the final design for the ACP.
- 3.1.2. We seek CAA confirmation that the approach laid out in this document is in line with CAA expectations for CAP1616 compliance, in particular focusing on the questions laid out in paragraph 1.1.4.