



RESPITE WORKING GROUP REPORT

A REVIEW ON THE STATE OF THE ART ON RESPITE

PREPARED FOR HEATHROW AIRPORT LTD

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RESPITE WORKING GROUP REPORT: A REVIEW ON THE STATE OF THE ART ON RESPITE

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The Respite Working Group (RWG) was set up by Heathrow’s Noise Forum (HNF) in October 2014 and was tasked to produce a paper on current state of the art on respite from aircraft noise.

Heathrow Airport appointed Anderson Acoustics to chair and act as secretariat to the RWG. As part of this process Anderson Acoustics also conducted a desk study and took on the responsibility for reflecting the findings and discussion of the Group into this Report. We would like to thank Heathrow Airport Ltd, the Heathrow Noise Forum and the RWG members for their support with the work reported here. We are grateful to the RWG members for contributing their time and expert opinions. They have approved the content of this paper which Anderson Acoustics have prepared on their behalf.

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EXECUTIVE SUMMARY

INTRODUCTION

The concept of providing respite has been moving up the agenda in recent years, as a useful and effective strategy for providing a break from aviation noise. However, there are no specific guidelines to explain what *respite from aircraft noise* means and how it should be implemented.

The Respite Working Group (RWG) was set up in October 2014 to provide advice to the Heathrow Noise Forum on the management and assessment of respite from aircraft noise. This report presents the findings of the RWG in looking at the current understanding and definitions of respite and how it might be successfully adopted by Heathrow Airport.

This report also provides an analysis of the current *state of the art* in relation to implementing respite from aircraft noise as part of a noise management strategy, and provides a proposal for areas of future research.

CONTEXT: THE NEED TO BETTER UNDERSTAND THE CONCEPT OF RESPITE

There are three main drivers in the push for a better understanding of what respite from aircraft noise means and how to deliver it:

- 1 Community demand for respite:** There is a consistent call from residents living under flightpaths for a break from aircraft noise. This has intensified due to the negative reaction towards recent trials of revised airspace design. It is important to understand what the communities themselves (both those currently overflowed and those not) consider effective respite to be and how that could be achieved in reality.
- 2 The Airspace Modernisation Programme:** The implementation of Performance Based Navigation (PBN) as part of the Airspace Modernisation Programme will result in much greater consistency and accuracy of aircraft flight paths. This will result in a concentration of noise along flight paths. This improved accuracy generates an opportunity for the pattern of flightpaths to deliver *shared concentration*¹ but raises a question as to whether respite can be provided through safe rotation of flightpaths.
- 3 The UK policy context:** The UK Aviation Policy Framework cites the principle of respite as a measure for reducing the impact of aircraft noise. However, there is currently no guidance on its definition, implementation or delivery. The member states of ICAO's have adopted a "Balanced Approach" to noise management and while not explicitly mentioned in the Balanced Approach, respite is one of the operational measures which should be considered in that context.

APPROACH

The Respite Working Group (RWG) was set up in October 2014 to provide advice to the Heathrow Noise Forum on the management and assessment of respite from aircraft noise. Heathrow Airport appointed Anderson Acoustics to chair and act as secretariat to the RWG. The group met regularly

¹ *Shared concentration* is a term that has been used to describe the use of multiple PBN Standard Instrument Departure routes (SIDs) within a Noise Preferential Route (NPR swathe) – or indeed beyond. This could result in the concentration of noise along several different PBN SIDS which can be alternated so that noise is shared. In theory this concept may also be applied to arrivals.

between October 2014 and May 2015. Anderson Acoustics led the review of evidence on the state of art on respite, providing the evidence to be considered by the RWG at each meeting. The following approach was taken to the work:

- Collation of information on research and airport case studies
- Review of definitions
- Review of respite implementation at selected case study airports.
- Review of relevant scientific research.
- Agreement of key issues and challenges.
- Presentations to Heathrow Noise Forum.
- Drafting of scoping report, recommendations and agreement of main messages with the RWG.

REVIEW OF EVIDENCE ON “CURRENT STATE OF THE ART OF RESPITE” CONSIDERED BY RESPITE WORKING GROUP

DEFINITIONS OF RESPITE

It was established that there are no universal definitions of respite. For the purposes of this project, the Group developed the following *working definitions* for internal use for this work;

Box 1: Working Definitions used by the RWG for the purposes of this work

Relief can be defined as a break from or a reduction in aircraft noise.

Respite can be defined as a scheduled relief from aircraft noise for a period of time.

REVIEW OF OTHER AIRPORTS

This part of the review looked at how seventeen case study airports from across Europe, the United States and Australia have implemented respite or relief into their operations and how they have approached PBN implementation. It was found that whilst respite has been used as a method for mitigation, there is no consensus on what constitutes respite:

- Different airports measure and quantify the provision of respite in different ways with no unique and consistent approach either spatially, temporally or operationally.
- A common way to provide respite is to spatially alternate flightpaths with some airports combining route and runway rotation. This provides more modes of operation and more opportunities for relief from noise.
- PBN implementation has generally introduced an increased concentration of noise along route centre lines with greater consistency and accuracy of tracks flown. Airports have not generally used PBN to improve respite. In some countries PBN routes are implemented by the “Aviation Authority” (e.g. the FAA in the USA) rather than the airport. The more successful implementations have proactively engaged and consulted with local communities.
- There is a general lack of proactive feedback being sought to understand the views of the local community. When there is proactive communication, for example when asked whether they’ve noticed and understand that there is a schedule of relief etc., respite seems to be positively received.

REVIEW OF SCIENTIFIC RESEARCH ON RESPITE

The review included the latest research on respite in relation to:

- the effects of aircraft noise changes on community perception
- the potential health benefits from the provision of noise breaks, and
- the economic valuation of respite and tranquillity.

CONCLUSIONS OF THE RESPITE WORKING GROUP

Overall, the following key conclusions were drawn by the RWG based on the review evidence:

- **There is currently no clear, consistent or universally accepted definition of respite.**

The RWG agreed on the working definitions above for the purposes of this project. There are many factors affecting the perception of respite and additional work is required to further define 'a period of time', 'break' and 'reduction' in terms of community perception.

- **What the community values as respite is not fully understood.**

Despite a number of related studies and implementation examples, there is at present no clear understanding of what the community values as effective respite². Effective provision of respite depends not only on operational features but also specifically on how the community perceives and values respite. Community-level understanding is therefore a priority in developing an effective respite strategy for Heathrow Airport.

- **There is no universal formula for the successful implementation of an effective respite strategy and operational design for respite needs to consider operational conditions at an airport.**

The effective provision of respite depends on the relative position of the local community to the different flight paths that might be used, and how often each flight path is actually used. The operational conditions at an airport will determine which options may be feasible in terms of delivering respite. These could include factors such as safety, efficiency, aircraft and avionic capabilities and controllers' workload, amongst others.

- **There is currently no single acoustic metric that can adequately describe respite.**

Our review work has shown that only a few metrics have been used to objectively describe respite. Since it is not clear what the community deems as effective respite, and therefore which parameters are useful in describing its key elements, it is not possible to choose a suitable metric that is fit for purpose at this time. Instead, the Group has suggested a list of guiding principles and a candidate list of metrics to describe the noise environment in terms of offering respite.

- **Further work is needed to develop a clearer understanding of which parameters are useful in describing respite, in a way that is valued by the community.**

Using this information we can then test the suitability of our candidate measures. We also need to understand the relative importance of acoustic and non-acoustic metrics in evaluating respite, so that we can put the usefulness and limitations of any acoustic metric in context.

- **A strong and effective communication strategy and good community engagement is essential for the successful implementation of respite.**

From the cases analysed, two conclusions were drawn: multi-stakeholder engagement is fundamental and more efforts in communication are needed. It is key to engage *all* stakeholders during *all* phases of respite design and implementation. Communication should ensure that those involved understand the likely implications and associated trade-offs of respite implementation.

² Although the term community refers to the population of overflown residents, it is worth noting that the opinions may not be entirely unanimous and that residents may have differing opinions on effective respite.

Once we have a clearer understanding of how the community values respite, research can then focus on the selection of the most suitable engagement method for cross-sector involvement, how to identify the key information to share, how best to describe and present that information and the most effective combinations of media to use to disseminate the information.

- **There is currently insufficient information on the benefits of respite to health and on the economic value of the effects of respite.**

There is clearly no one-size-fits-all solution, every end solution will vary - there is a need for further research.

RESEARCH PRIORITIES RECOMMENDED BY THE RESPITE WORKING GROUP

In addition to the key lessons learned listed above, the Group identified three priority areas where greater understanding is required in order to implement effective respite from aircraft noise, these should be prioritised in the next phases of research:

- What does the community value as effective respite?
- How can respite be delivered by an airport that is both operationally feasible, cost effective as well as valued by the local community?
- What are the objective measures to describe respite in a way that reflects community perception?

NEXT STEPS: RESEARCH PROPOSAL

The Group agreed that priority must be given to gaining a better understanding of how the community values respite, before considering operational feasibility, cost-effectiveness and the development of metrics. The following key objective has been identified for Heathrow: *To better understand the key characteristics of an effective respite strategy for Heathrow Airport and its local communities, consistent with efficient operations.*

Two research phases have been proposed:

- **Phase 1:** To develop a set of principles for providing effective respite from aviation noise at Heathrow. Two key questions have emerged. The first is what spatial variation in routes is required to make a perceived difference and benefit, in terms of height and position for both arrivals and departures; the second, what are the optimum temporal separations or patterns required in order for the community to value it as effective respite?
- **Phase 2:** Test practical implications for airspace design of the emerging principles from Phase 1 above. This would involve community subjective response research and operational testing of options.

1 INTRODUCTION

The concept of providing respite from aircraft noise to affected communities has become increasingly important in recent years. As well as increasingly demanded from those individuals affected at the community level, respite is already referred to in government policy and within the context of the airspace modernisation programme.

However, what is our understanding of respite? How is it valued by communities and how should it be delivered? Are all communities supportive of it? There are few, if any, specific guidelines on what respite means and how it should be implemented.

Heathrow Airport has acknowledged the importance of understanding these issues in the context of developing its noise management strategy. In October 2014, the Respite Working Group (RWG) was set up to review current state of the art on respite from aircraft noise and provide advice to the Heathrow Noise Forum.

This report brings together the findings of that review, as well as a proposal for future research. In particular:

Section 2 sets the context and looks at why we need to gain a better understanding of respite and its implications.

Section 3 outlines the approach taken by the Respite Working Group during this project.

Section 4 presents a summary of review evidence on the *state of the art* on respite considered by the RWG.

Section 5 outlines the conclusions of the Respite Working Group.

Section 6 outlines the priorities for research recommended by the Respite Working Group.

Section 7 recommends next steps and a proposal for future research.

2 CONTEXT: THE NEED TO BETTER UNDERSTAND THE CONCEPT OF RESPITE

There are three main drivers in the push for a better understanding of what respite from aircraft noise means and how to deliver it:

1. Community Demand
2. Airspace modernisation programme
3. UK Policy Context

2.1 Community Demand

There is a consistent call from residents living under flight paths for a break from aircraft noise. This has intensified due to the negative reaction towards recent changes in airspace design. It is important to understand what communities themselves consider effective respite to be and how that could be achieved in reality.³

2.1.1 Community engagement

Whilst a significant reduction in area and population within noise contours has been achieved, it is commonly reported that adverse community reaction⁴ towards airport operations and expansion has increased over time but this general trend may not as robust as previously thought and further research is in progress (Gjestland et al 2014). Providing periods of respite or a break from aircraft noise has become a crucial issue in making airport operations more tolerable, in particular for the population directly under the flight paths.

With the advent of social media, local residents within communities are making their feelings known in real-time and community engagement directly with airports on these issues continues to grow. An example of a co-ordinated community movement on the subject of respite is the Heathrow Association for the Control of Aircraft Noise (HACAN). HACAN campaigns against Heathrow expansion and has more recently focused its work on the concentration and constant numbers of overflights to and from the airport, and the persistent disruption it causes to people's quality of life. The increases in concentration over some areas has led to calls for more official periods of respite for those affected and has raised the critical importance of the runway alternation system and its impact on communities in West London (Stewart., 2013).

2.1.2 Reaction to PBN

The interest in providing respite has gathered pace due to the significant negative reaction towards recent changes in airspace design. The latest PBN implementation trials at Heathrow and elsewhere resulted in an unprecedented increase in the number of people complaining, most of them due to the concentration of noise over some areas which were previously overflown much less frequently. Residents raised concerns around fairness and the distribution of aircraft overflights. (HACAN, 2015)

³ It is worth also noting that some communities may have a real or perceived disbenefit from a respite solution due to changing noise patterns.

⁴ Although the term community refers to the population of overflown residents, it is worth noting that the opinions may not be entirely unanimous and that residents may have differing opinions on effective respite.

HACAN surveys have shown that people favour sharing the noise around so that no community suffers constant noise, as long as it is done in a fair and transparent way. A broader community reaction has not been widely explored.

Typical comments reported on local community websites include:

“Went to bed early to try and beat the early morning wake up from too loud, too low flying planes at unearthly hours, only to still have planes flying over my house at 11.30.pm. It's ridiculous. They should vary the path so more residents are affected less often.”

“Seemingly constant noise from aircraft over Clapham Junction. It started at 4.30 this morning (and every morning). I can usually still hear planes until 11.30 at night. It massively effects the quality of our sleep. Why can't the flight path be altered occasionally to give residents some respite?”

“Why can't they alternate the flight paths like they do in other countries like Sydney?”

People report a perceived benefit from a predicted break from overflights. Some studies have shown that runway alternation could reduce annoyance, although there is no robust quantification of the extent of such a reduction (Brooker, 2010) (Gelderblom, Gjestland, Gramdoin, & Taraldsen, 2014) (I. Flindell, 2014).

2.2 Airspace modernisation programme

The implementation of Performance Based Navigation (PBN) as part of the Airspace Modernisation Programme results in much greater consistency and accuracy of aircraft flight paths. This leads to a concentration of noise along flight paths. This improved accuracy generates an opportunity for the pattern of flightpaths to deliver *shared concentration*⁵ but raises a question as to whether respite can be provided through rotation of flightpaths.

2.2.1 Background

The European Commission launched the Single European Sky (SES) initiative to reform the architecture of European air traffic management. Through a proposed package of legislation it aims to meet future capacity, improve safety and increase the overall efficiency of European airspace (European Commission, 2014).

Under the framework of the SES, the UK Government established the Future Airspace Strategy (FAS), a programme aimed at modernising the airspace and air transport route network.

The modernisation of UK airspace aims to strengthen the resilience of airports in reacting effectively to disruption and accommodating traffic growth in a more sustainable way. It is hoped that the implementation of FAS will help to achieve time, fuel and CO₂ savings by adopting more direct routings and increasing efficiency, as well as achieving noise reductions as a result of fewer aircraft being held at low altitudes (CAA, 2011).

⁵ *Shared concentration* is a term that has been used to describe the use of multiple PBN routes within a specific Standard Instrument Departure (SID). This could result in the concentration of noise along several different PBN routes within that SID, which can be alternated so that noise is shared.

The modernisation programme is supported by the transition to satellite-based performance navigation (PBN) routes, which are more flexible and precise than conventional routes using ground based navigation aids. Although PBN allows the UK's complex airspace to be re-designed in this way, this can lead to greater concentrations of traffic along new and existing route centre lines. While fewer people may be exposed to aircraft noise, some of those who are currently exposed might experience an increase in disturbance due to a greater concentration of flights. Responses to recent PBN implementations have highlighted this point in the media and on social networking sites, referring to 'noise ghettos' and with quotes such as "It's not about the many but what you do to the few".

2.2.2 PBN and respite

If PBN is to be used to enable respite, a major question for policy makers is whether to concentrate flights over specific areas and/or use multiple routes to provide respite. A policy that will result in greater noise concentration may need to be presented hand-in-hand with a respite policy that provides breaks from noise and overflights to the affected community. However, this could be at odds with current UK policy of limiting and where possible reducing the number of people significantly affected by aircraft noise.

Within the context of airspace re-design, it is important to note that any changes to airspace design needs to take into account many complex issues, and any development of an effective respite strategy needs to give priority to these factors from the outset for any practical respite options to be implemented. The issues to consider include:

- Safety
- Airspace design limits
- Efficiency and resilience requirements
- Aircraft capabilities and avionics
- Consideration of track miles, fuel burn and associated cost
- Aircraft traffic control and controllers workload
- Pilot's workload
- Trade off with other environmental factors

The recent paper of the Airport Commission's Senior Delivery Group on PBN implementation has reflected many of the points raised in this section (SDG, Technical Report No1, 2015). It confirms that the accuracy of PBN routes creates the potential to introduce alternative flight paths that can be switched on and off to provide areas that are disturbed by aircraft noise with some respite from overflights. The paper confirms that 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.

2.3 The UK Policy Context

The UK Aviation Policy Framework cites the principle of respite as a measure for reducing the impact of aircraft noise. However, there is currently no guidance on its definition, implementation or delivery.

2.3.1 Current government guidance

The UK Government's overarching policy is "to limit and where possible reduce the number of people in the UK significantly affected by aircraft noise" (DfT, 2013).

This has meant, in practical terms, that aircraft are increasingly concentrated along the fewest possible number of specified routes, avoiding densely populated areas as far as possible. As a result, and owing in part to improvements in aircraft technology and using tailored operational procedures, annual Lden and summer average $L_{Aeq,16hr}$ ⁶ noise contour areas have reduced over time. (CAA, 2014)

Providing options for delivering any form of respite from aircraft noise has become a key issue in the noise policy agenda.

The member states of ICAO's have adopted a "Balanced Approach" to noise management through the exploration of four principal elements, namely reduction at source (quieter aircraft), land-use planning and management, noise abatement operational procedures and operating restrictions, with the goal of addressing the noise problem in the most cost-effective manner. While not explicitly mentioned in the Balanced Approach, respite is one of the operational measures which should be considered in that context. The EU has also adopted the Balanced Approach and has required the use⁷ of PBN to secure the emission efficient and safe use of airspace.

2.3.2 Noise policy in the UK

The Aviation Policy Framework (APF) includes respite as a measure to reduce and mitigate noise in communities already exposed. It recommends exploring "options for respite which share noise between communities on an equitable basis, provided this does not lead to significant numbers of people newly affected by noise". It does not define *new* or *significantly*. It also highlights the importance of ensuring predictability to local communities in airspace planning (DfT, 2013, p. 62).

The Civil Aviation Authority (CAA) includes respite as one of four key areas for improving aircraft operations in order to better manage aviation noise, in particular in the context of expanding capacity (CAA, 2014).

The Air Navigation Guidance, produced by the Department for Transport and CAA, suggests exploring options for respite with local communities by designing different routes that can be used alternately. However, it includes a caveat that this should be achieved without significantly increasing the number of people newly exposed to noise (DfT, 2014, pp. 28,29).

The Airports Commission in the UK also considers respite as a key strategy to mitigate noise impacts on the population. Its Appraisal Framework evaluates the noise implications of applying different respite strategies to each of the three shortlisted options for increasing long-term capacity in the UK (Airports Commission, 2014 and 2015).

⁶ LAeq = Equivalent Continuous Noise Level. This is generally described as the average noise level over a specified period of time.

⁷ The European Commission adopted on 27 June 2014 the Regulation (EU) 716/2014, making binding the implementation of certain standardised navigation functions, entitled Extended Arrival Management and Performance Based Navigation in high density airspace, across Europe. This is expected to improve the precision of the approach trajectory to major airports and facilitate traffic sequencing at an earlier stage, thus reducing fuel consumption and environmental impact in descent/arrival phases of flight;

None of the above references offer specific guidance on what respite means, nor how it should be implemented or delivered. This is in line with Government and International policy guidance which promotes local solutions for local problems,

3 APPROACH

3.1 Purpose and Objectives

The Respite Working Group (RWG) was set up in October 2014 to provide advice to the Heathrow Noise Forum on the management and assessment of respite from aircraft noise.

The terms of reference and membership of the RWG are set out in Appendix 1. The group comprises cross-sector representatives with an interest in the provision of respite, including government, the aviation regulator, air traffic control, airlines, the local authority, the local community, Heathrow airport, independent researchers and industry experts.

The purpose of the group was set out: “To provide advice to Heathrow Airport on the management and assessment of respite from aircraft noise”.

The main objectives addressed in this initial review were to:

- Understand and agree formal definition(s) of respite;
- Investigate current practice in the management of respite;
- Identify indicators for the management of respite including measures of success;
- Identify any gaps in knowledge for the management of respite;
- Establish a common level of understanding between different stakeholders of the scope and opportunities to implement respite as part of noise management programmes at Heathrow.
- Propose actions to Heathrow Noise Forum.

3.2 Review Methodology

Heathrow Airport appointed Anderson Acoustics to chair and act as secretariat to the RWG. The group met regularly between October 2014 and May 2015, with agreed themes at each meeting:

Figure 1: Respite Working Group Meeting Plan (2014-2015)



The following approach was adopted:

- **Collation of information on research and airport case studies:** members of the Group supplied details of current respite implementation examples, useful airport contacts, relevant scientific papers, other relevant publications and website links.
- **Review of definitions:** A list of different definitions was compiled and examined, based upon insights from Group members, as well as findings from online searches across government, regulatory, industry and community groups' websites.
- **Review of respite implementation at selected case study airports:** A review of current practices for the implementation of respite was undertaken by Anderson Acoustics across seventeen different airports in Europe, the United States and Australia and the findings presented to the RWG. The selection of the airports was based upon the knowledge of and recommendations from members of the Group. Appendix 2 presents a list of the airports studied and the main sources of information used in the analysis.

The following standard information was gathered for each of the case study airports:

Airport / Case Name	
1. Definition	8. How it was measured?
2. Why respite was implemented?	9. Measures of success
3. Parties involved	10. Communication strategy
4. Legal status	11. Perception from the community
5. Level of implementation	12. Summary key findings
6. Operational information	13. Sources of information
7. New communities exposed	

- **Review of relevant scientific research:** The evidence based review work by Andersons and presented to the RWG also included a review of the latest studies in relation to the effects of aircraft noise changes on community perception, the potential health benefits from the provision of noise breaks and the economic valuation of respite and tranquility. An overview of respite from non-aviation sources was also included. The main purpose of this review was to build a better understanding of the concepts of noise respite and how it has been addressed in sectors other than aviation. It did not aim to form a comprehensive review or provide definitive conclusions.
- **Agreement of key issues and challenges:** The Group agreed on the need to analyse the lessons learnt, key challenges and gaps in knowledge in relation to respite from aircraft noise.
 Identification of priorities: The Group identified the key research needs for the future and agreed a suggested way ahead for Heathrow Airport to consider in developing a strategic plan for respite implementation. The Group compiled a scope of research work to be considered by the Heathrow Noise Forum (HNF).
- **Presentations to Heathrow Noise Forum:** Progress of the work from the RWG was presented to the Heathrow Noise Forum (HNF) on a bi-monthly basis.
- **Drafting of scoping report, recommendations and agreement of main messages with the RWG:** All the findings and recommendations have been collated and organised into this report by Anderson Acoustics, on behalf of the RWG. The main messages were agreed by the RWG and subsequently presented to the HNF. Before publication, this report was circulated to RWG members for comments and revised as required.

4 REVIEW OF EVIDENCE ON “CURRENT STATE OF THE ART OF RESPITE” CONSIDERED BY RESPITE WORKING GROUP

This section presents a summary of the collated findings from all of the review work prepared by Anderson Acoustics and presented to the RWG. For each topic reviewed, a summary of key findings is given and illustrated with pertinent examples where appropriate. In summary the following was investigated:

- 1 Definitions of respite used and determined a working definition
- 2 How other airports consider respite including how it is implemented, how it is described, community perception and engagement;
- 3 Review of scientific research including other industries (construction), health benefits and valuation.

4.1 Definitions of respite

The RWG considered the comprehensive review of definitions of respite used by many different stakeholders, including local communities, government, regulators, academics, airports and the aviation industry⁸. Appendix 3 gives more detail about the definitions identified during this review.

4.1.1 Existing definitions

From the UK Government and UK regulatory perspective, respite is generally understood as a key measure to mitigate the impact of aircraft noise over communities significantly exposed to aircraft noise. However, there is no specific definition to help measure, quantify or implement respite.

Noise Quest⁹ provides specific guidance on what respite means and how to define it. They explicitly suggest that respite is related to the relief from aircraft noise events over a period of time. However, they note that respite should be locally defined to fit the needs of any community or study area (Federal Aviation Administration (FAA) , 2015).

From the community and residents’ perspective, respite is highlighted as a crucial factor to consider when planning flightpaths. According to John Stewart, Chair of HACAN, respite is related to the provision of predictable periods of relief from the noise of the planes landing and taking off at Heathrow. In his own words, these are periods where there should be no planes overhead. Some of the people complaining about aircraft noise at Heathrow Airport highlight the importance of sharing and fairness¹⁰ in the distribution of the noise and the need for respite periods (Stewart, 2015).

⁸ In some cases, a definition of respite was inferred based on the context of information provided.

⁹ Noise Quest is an online initiative sponsored by the Federal Aviation Administration (FAA), National Aeronautics and Space Administration (NASA), and Transport in Canada.

¹⁰ Note: There may be a lack of definition of what constitutes fairness and sharing; it may be sharing noise across communities that already have some overflight or may be across the whole community including those that do not have overflights

4.1.2 Definitions used by airports

A summary of the definitions of respite identified from the airport case studies is provided in Box 2:

Box 2: Summary of findings on definitions of respite from case study airports

- There is no consensus among the airports studied on what constitutes respite.
- Respite is sometimes used as a method for mitigation.
- The majority of the airports analysed make no reference to respite as a concept (e.g. Brussels and Denver), but for some an implied definition was identified (e.g. Brisbane).
- Some airports suggest a definition through design and operation of their airspace, such as alternation of routes and runways (e.g. Schiphol or Frankfurt).
- Sydney airport defines respite as a continued period of time (clock hours) when there are no movements on a particular flight path.
- The proposal submitted by Heathrow Airport to the Airports Commission for a new runway presents a definition of respite.

4.1.3 Theoretical definition

Following the review process, the RWG established that there are no universal definitions of respite. For the purposes of this project the Group developed the following *working definitions*:

Box 3: Working Definitions

- **Relief** can be defined as a break from or a reduction in aircraft noise.
- **Respite** can be defined as a scheduled relief from aircraft noise for a period of time.

4.2 Review of other airports

The review considered how seventeen case study airports from across Europe, the United States and Australia have implemented respite into their operations and how they have approached PBN implementation. See Appendix 2 for further detail about the sources used.

4.2.1 Implementation

This section includes analysis of how respite was implemented at the case study airports in operational terms.

Box 4: Summary of findings of operational information from case study airports

- A common way to provide relief is to spatially alternate flightpaths.
- Some airports combine route and runway rotation, giving more modes in which the airport can continue to operate whilst providing a period of respite to local communities.
- Time of day restrictions can limit the flexibility and capacity of airports.
- PBN implementation has generally introduced increased concentration of noise around route centre lines with greater consistency and accuracy of tracks flown.
- Airports have not generally used PBN to improve respite.

Frankfurt and Brisbane combine both route and runway rotation, giving many more modes in which these airports can operate and provide a scheduled relief to their communities. Other EU airports have also considered the introduction of regulations for runway use or restrictions to operations, such as at Vienna, Schiphol and Heathrow, particularly at sensitive times, for example at night. It is acknowledged that providing a break from noise can limit the flexibility and capacity of airports.

Alternating routes is the most common way to provide a break from aircraft noise amongst the cases analysed. This has been used to distribute noise away from densely populated areas during periods of the day, and so reducing the effect on some populated areas by sharing impact with neighbouring populated areas.

The cases analysed for Gatwick and Heathrow related to recent trials to test different ways for providing respite. Gatwick tested the provision of respite at night by alternating flight paths, while Heathrow's DOKEN¹¹ trial tested the use of PBN to deliver scheduled respite to communities sited beneath different departure routes.

All of the US airports studied use PBN as part of the NextGen modernisation programme, led by the Federal Aviation Administration (FAA) rather than the airports themselves. The main driver of this programme relies on improving the safety and efficiency of the US airspace. The review suggests that although respite was not initially intended, it is possible to infer that relief was delivered in some cases, due to how the flightpaths were designed.

Brisbane, Perth and Sydney airports provide respite or relief as part of their current operations, based on a noise sharing approach. The three cases are somewhat different. For Brisbane, respite has been part of their daily operations and it has been used in principle for the design of their new runway. In the Perth case, respite was implemented following recommendation from the Noise Ombudsman to reduce flights over an area and share the noise. For Sydney, changes have been implemented due to a significant adverse reaction to the opening of Sydney's third runway in 1994, which led to the airport adopting a new noise sharing approach designed to remove concentration of noise over the suburbs to the north of the airport. This noise-sharing plan is based upon ten operational modes that are alternated throughout the day.

Appendix 4 provides detailed operational information on respite implementation for each case study airport.

4.2.2 Describing respite: metrics and measures

Box 5: Summary of findings of respite metrics and measures from case study airports

- Different airports measure and quantify the provision of respite in different ways with no unique and consistent approach either spatially, temporally or operationally.
- This is one of the key gaps in terms of respite management. Only five of the seventeen case study airports have specific metrics on respite.
- Those metrics identified are related to periods of time (e.g. days, clock hours) in which a break in noise is provided through using an alternative flight path and an absence of overflights.
- There is no clear or universal definition of what constitutes an overflight nor the separation distances required.

¹¹ http://www.heathrow.com/file_source/HeathrowNoise/Static/DOKEN_report_FINAL.pdf

The review of airports identified a number of ways to describe information on breaks from noise. It is worth noting that no one has ‘verified’ these metrics as providing respite or relief, they are simply measures that monitor how a management tool has been implemented i.e. % runway alternation etc. These metrics are described below:

Metrics	Example ¹²	Comments
Dedicated Runway Operations (DROps)	At Frankfurt the provision of respite is monitored with the daily use of DROps via radar plots and reports from noise monitoring stations.	The DROps established guidelines on how, when and where to provide noise breaks. The airport provides periods of relief through their dedicated runways operations process, currently for departures in the early morning whereby runways and routes vary between odd and even days.
Numbers of days within the period of time when the flight path is likely to experience no flights	Brisbane Airport reports on the percentage of days with no scheduled flights for each flight path, which is referred to as respite. The information is presented by time of day, day of week and season, in conjunction with N70 ¹³ contours.	Some criticism has arisen that calculating respite on individual flight paths does not give an accurate picture of where the noise is actually audible. That is, respite under one flight path is disturbed by movements on another flight path, particularly the case in areas close to a number of different paths.
% clock hours when there are no overflights	Sydney has developed this metric to quantify respite. Sensitive clock hours have been defined, following extensive trialling and community engagement. These are 6-7am and 8-11pm on weekdays and 6am-11pm at weekends.	The metric has a limitation in that it only accounts for respite in whole hours and thus tends to understate respite e.g. if an area receives no flights between 13:05 and 14:55, no respite will be recorded even though the area in question received nearly 2 hours of respite. There is also an audible issue as well as described above.
Number above (NA) differences by postcode	The DOKEN trial at Heathrow provided useful insights on how to measure the noise environment in order to understand respite using N65 and presenting data at postcode level.	For this trial, N65(8hr)>25 and N65(16hr)>50 ¹⁴ appear to provide more significant and clearer differences in exposure than Leq differences as they combine an element of noise level and an element related to the degree of overflight and therefore could be used potentially to identify areas that may be afforded some respite.
% of time an area is overflown	<p>The runway alternation system at Heathrow Airport is monitored by the percentage of arrivals and departures using their preferential runway (in alternation) for day and night rotation periods. In addition, the number of days an area is “overflown” can be derived.</p> <p>The proposal for a third runway at Heathrow predicted respite using a simple procedure based on whether or not an area was overflown (one flight would be considered overflown), taking into account the different modes of runway operations and route use.</p>	Calculating respite on individual flight paths does not give an accurate picture of where the noise is actually audible. That is, respite under one flight path is disturbed by movements on another flight path, particularly the case in areas close to a number of different paths

¹² Appendix 5 provides graphical representations of some of these metrics

¹³ Number Above is the number of noise events that reach or exceed a certain dB(A) Lmax threshold within a given time period. In the above example, an Lmax value of 70 dB(A) is adopted.

¹⁴ When reviewing changes resulting from the rotation pattern a time period, T, of 8 hours was selected to reflect the period in which each runway/route combination occurred as well as the 16 hour day. In particular the N65(hour)>25 contours were used and N65(16 hour)>50.

Metrics	Example ¹²	Comments
Changes in flight track density or height of overflights	Gatwick used radar track data to review the effects of their trial period in terms of density/height of overflights and how effectively these overflights were eliminated from the areas identified and redistributed, relative to any populated areas (not just those identified for respite).	In their trials proposal document, it was suggested that qualitative feedback should be sought from those in the “respite areas” and also from any areas which might have had an increase in the flight track density or a change in heights of overflights, and also to review any registered complaints received during the trial period.
Median Quiet Interval (MQI)	The FAA through its website Noise Quest, provides examples on how respite can be measured. For instance, they suggest using the “Median Quiet Interval (MQI)” to measure respite from “intrusive” noise events. The MQI indicates the average time between aircraft events that exceed a selected threshold.	It is calculated using the Time Above (TA) and Number Above (NA) metrics. For example, if TA ₆₅ = 30 and NA ₆₅ = 100, then MQI = 14.1 minutes, meaning that there would be one event above 65dB occurring every 14.1 minutes (Federal Aviation Administration (FAA), 2015) ¹⁵ .
Time Above (TA)	See above.	

Section 5 builds upon these findings and suggests a range of principles for objectively measuring respite.

4.2.3 Community Perception of Respite

A key issue when analysing the case study airports, was to understand whether communities are aware of respite and how they perceive and value the benefits.

Box 6: Summary of findings of community perception from case study airports

- There are a lack of proactive strategies to seek feedback or ask the community for their views about the respite implementation near them.
- There is a lack of knowledge about the value of respite to affected communities, compared, for example, with other mitigation measures.
- The more successful implementations have proactively engaged and consulted with local communities.
- Only the Heathrow DOKEN Trial did a systematic evaluation of community perception. Results from this evaluation indicated that a noise break, provided by alternation of PBN routes, is significantly valued by the community¹⁶.

Based on the cases analysed, the Group can conclude that there is no proactive strategy for understanding how communities perceive and value the initiatives that aim to provide a break from aircraft noise.

¹⁵ Based on the calculation; (24 hours total time - 0.5 hours above 65 dB) / (100 events above L_{max} of 65 dB) = 0.235 hours or 14.1 minutes. It is important to understand that this example assumes that 100 aircraft events (that exceed the 65 dB threshold for 30 minutes of a full 24-hour day) are equally spaced out in time over 24 hours.

¹⁶ Since the drafting of this report, a noise respite project commenced around Frankfurt Airport and includes a survey of residents perception, results are due to be published around mid 2016.

From the cases analysed, only the Heathrow DOKEN Trial carried out a systematic evaluation of the community perception and valuation of respite. This involved the commissioning of an independent research project to seek the community's attitudes to different types of noise relief (I. Flindell, 2014)¹⁷.

Results from Flindell's research suggests that noise relief, is significantly valued by the community. According to this study, residents have expressed a preference for flightpath dispersion, as opposed to the use of one singular flightpath. Although there is no evidence that scheduled respite provides any additional perceived benefit, it is suggested that it can contribute to positive attitudes towards the airport.

4.2.4 Communication and engagement strategies

The review examined the most common strategies that airports have adopted for communicating and engaging with communities with respect to respite and/or the implementation of airspace changes.

Box 7. Summary of findings: communication & engagement strategies at case study airports

- Good communication and transparent engagement is one of the most important issues for successful implementation of respite.
- In some cases, respite has been implemented with the involvement of the local community in the design process.
- At some airports there may be inadequate representation of local residents within the engagement processes.

Community demand-driven engagement

Looking at the airport case studies, in some cases implementation of respite was led by demand from the local community, which meant that the community were included in the respite design process.

In Frankfurt, there is a voluntary Expert Noise Abatement Group that monitors current performance, reviews new proposals and makes recommendations for implementation. Representatives from the industry, the Government and the local community participate in the group.

In Schiphol the engagement process included the establishment of an independent body to provide guidance, participate in the decision making process and build trust with the local community. This group, the Alders Table¹⁸, has been involved in the design of respite procedures, providing direct engagement and communication with communities.

Regulations to provide periods of relief to communities near Vienna Airport were the result of a mediation process at the time of designing the third runway. Different representatives participated in the mediation, including a citizen's initiative against the third runway, mayors of the most affected municipalities, environmental advocates of Vienna provinces, researchers and the airport itself.

¹⁷ See footnote above

¹⁸ The Alders Table is a consultation body that provides advice to government on how to achieve a balance between the growth of Schiphol, noise annoyance mitigation measures and the quality of the environment, for the period up to 2020.

A respite trial at Gatwick was implemented in response to requests from communities and individuals living in the areas around the airport for a predictable form of respite from aircraft noise. The Gatwick Airport Consultative Committee¹⁹ and the Noise and Track Monitor Group²⁰ shared views on the design of the trial.

Heathrow's DOKEN trial was developed with the Heathrow Noise Forum's input on the communication strategy and to investigate if community members were aware of the trial. Although the airport provided information to the community, particularly through social media and web pages, it was found that although 55% of respondents claimed to have been aware of changes to flight tracks, qualitative research revealed that no residents were aware of the exact details, and almost nobody was aware of PBN as a concept (I. Flindell, 2014).

Benefits of proactive community outreach

Among the US airports studied, the Denver case stands out due to its extensive outreach efforts, which included scoping meetings, individual meetings with local authorities, planning and noise officers, and public conferences in the neighbourhood. According to the analysis of different PBN implementation cases by consultancy firm HMMH, Denver's unique success is largely attributed to three factors: (HMMH, 2014)

- People and commitment: The collaborative efforts of the Working Group and its multiple stakeholders. They put their own agendas aside to solve a problem.
- Strong, comprehensive / interdisciplinary knowledge base within the group about technical issues of airports operations and airspaces issues, planning developments and regulation and on impacts (and needs) of the community and environment.
- Financial incentive for success, from noise fines (due to constraining noise limits at 101 points, an exceedance of which carries a costly/significant penalty of \$500K per annual occurrence).

Section 5.5 takes into account the lessons learned here to recommend some general principles for successful communication and engagement strategies.

4.3 Review of scientific research on respite

The review included the latest research on respite in relation to:

- the effects of aircraft noise changes on community perception
- the potential health benefits from the provision of noise breaks, and
- the economic valuation of respite and tranquility.

It also gives an overview of how respite from noise is managed and presented in non-aviation industries, in particular in relation to construction noise.

¹⁹ The Gatwick Airport Consultative Committee (GATCOM) advises Gatwick Airport's Managing Director about issues that concern the local communities, travellers and other users of the airport.

²⁰ The noise and track monitoring advisory group (NATMAG) brings together representatives from DfT, NATS, airlines, Gatwick Airport and local authorities. The group discusses a wide range of noise and track-keeping issues and monitors track-keeping performance, night engine testing and ground noise complaints.

4.3.1 Aviation noise and respite research

Box 8. Summary of findings on aviation noise and respite research

- Differences between sound levels can result from aircraft at different heights and distance from receiver.
- At a given lateral distance from an aircraft, aircraft at lower altitudes may be quieter than those at higher altitudes.
- Overall annoyance can be a consequence of the maximum level and the number of noise events.
- The extent of adverse response is not determined by average noise levels alone.
- There are multiple non-acoustic factors, such as perceived fairness and the capacity that people have to cope and control the noise, that determine annoyance and adverse reaction to aircraft and airport noise.
- The number of noise events is very significant; an increase in number can have a significant effect on annoyance even if the overall average noise level is similar.
- The effect of improving sound quality is as yet not clear.

A recent study examined the effect of altitude on the lateral dispersion of aircraft noise (Rhodes, 2015). It was noted that for a given aircraft, the noise level on the ground is determined by the distance from the aircraft to the receiver, ground absorption and shielding, scattering and refraction effects.

When the angle between the ground and the aircraft is less than 60 degrees, shielding from the aircraft engines, atmospheric refraction and scattering effect can reduce noise by up to 6dB more than that caused by an increase in propagation alone. Further reductions occur when the angle is less than 15 degrees. This result means that above a certain lateral distance, aircraft at lower altitudes may be quieter than those at higher altitudes. For example, beyond 2,000m to the side of the flight path, an aircraft at 6,000ft is noisier than one at 1,000ft. This suggests that altitude and lateral dispersion should be taken into account when designing new flight routes.

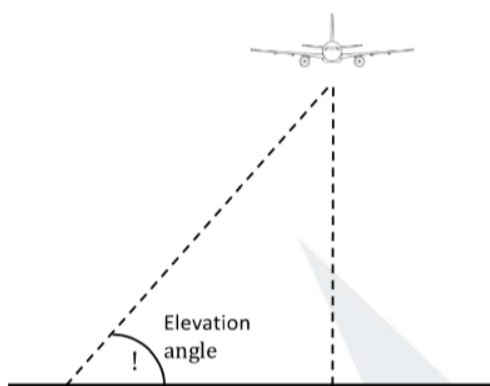


Figure 2: Elevation angle (Source: Rhodes, 2015)

Another recent lab study regarding the effects of aircraft noise changes on human perception, annoyance, disturbance and performance investigated two change scenarios (J. Lambert, 2015):

- by reducing the number of aircraft (by half) compared to a typical fleet mix.
- by improving the sound quality of individual aircraft.

Both scenarios were designed to ensure that the passenger numbers and LAeq were constant and were tested in home-like environments, created in three laboratories in France and Hungary. The study concluded that a reduction in aircraft has a significant change in annoyance despite a similar LAeq and higher LMax. No clear effect was identified following changes in sound quality.

Furthermore, the study showed that neither reducing the number of movements, nor improving the sound quality of aircraft has an effect on performance (using a memory test). This suggests that an event-based index may be a more appropriate descriptor for aircraft annoyance than an energy-based index. However, the author adds a caveat to say that the fleet mix used might include aircraft deemed to be more annoying than others that were not included.

4.3.2 Respite management in the construction industry

Box 9. Summary of findings on construction noise research

- Respite from construction noise is offered through the ceasing of all activities. This is not possible for aviation unless a curfew is implemented.
- The noise control on construction sites in Australia and the UK includes the provision of respite periods through controlled working hours.
- These controls are based on type of area, sensitive periods and when noise levels exceed a certain threshold.
- The total duration of a construction project can be extended in exchange for providing periods of respite. This is usually negotiated directly with the community.

The noise control and management on construction sites includes regulation and code of practices that provides guidance on working hours and respite periods, based on sensitive times and the type of area. In general, respite from construction noise is usually offered through the ceasing of all activities, or at least those that are audible at the site boundary. This is not possible for aviation unless a curfew is implemented.

An example is the Interim Construction Noise Guidelines in Australia. These set out parameters for when and how to provide periods of respite from construction noise for residential areas. When noise levels exceed 75dB during standard hours (Monday to Friday, between 0700-1800) the site is required to provide respite periods, through restricting the hours during which these noisy activities can occur. In addition, the guidelines highlight that any restriction imposed should take into account the preference of the community with regard to sensitive periods (time of day or day of week) and the acceptance of the likely increase in total duration of the whole construction project in exchange for the agreed period of respite (Department of Environment and Climate Change NSW, 2009).

In the UK, the British Standard code of practice for noise control on construction and open sites (BS 5228) provides examples on how regulations are influenced by the type of area where the construction is taking place, as well as sensitive time-periods. For instance, while the noise control of

the City of London requires a noise break of two hours, twice a day (1000-1200; 1400-1600) during weekdays, controls at residential areas aim to protect people from noise at night and weekends. This takes into account that the noise would cause speech interference in an office during the day but would cause no problem in the same office at night (BSI, 2014).

The Westminster Noise Strategy suggests that noise control regulations should take into account that some periods of the day will be more sensitive than others. It suggests that noise control for evening and overnight should be stricter than for daytime, and that the consideration of offering noise breaks is important (City of Westminster, 2010).

4.3.3 The health impacts of respite

Box 10. Summary of findings on respite and health research

- Little research exists on the positive health effects of respite from noise.
- However, there are studies into the benefits of tranquil areas on quality of life, which can help to inform future research and management of respite.
- Studies suggest that access to quiet areas that offer a break from man-made noise can have positive effects on health and wellbeing.
- Scheduled relief from a noise source appears to be valued by the community.
- Benefits are not only related to lower noise levels, but also to the provision of an alternative environment, away from the noise.
- Non-acoustic factors such as visual aspects can have a major effect on community perception.

Most of the research on noise and health is focused on the potential negative effects from continued exposure to environmental noise on health and quality of life. There has been little research directly carried out on the positive effects of respite from noise (from any source). There are, however, a number of studies from which the findings may help inform future research on respite.

The main areas of research include investigations into the benefits of tranquil areas on quality of life. Research in this field has generally concentrated on the importance of respite provided by quiet areas in urban environments. In this context, the concept of respite takes into account other characteristics of the space including aesthetics. This section attempts to review these studies alongside other case studies of respite and highlight the key relevant findings. We also include the research into response to changes in aviation noise and specific social survey work around Heathrow airport during recent trials.

Quiet areas

Findings from the RANCH project (Road traffic noise and Aircraft Noise exposure and children's Cognition and Health), highlight the role of quiet areas for psychological restoration and health benefits in children exposed to aircraft noise. The study suggests that offering access to quiet areas or quiet periods to children exposed to high noise levels might serve as a protective factor for reducing annoyance at school and sleep disturbance symptoms as a result of continued exposure to aircraft noise (S. Stansfeld, 2010) (C. Clark, 2007).

Research has also suggested that access to quiet areas that offer a break from man made sound can have a positive effect on health and wellbeing. Some studies have shown that access to quietness is a key factor for modifying residents' noise responses. The health benefits of quiet spaces can be linked mainly to stress releases and physiological and psychological well-being²¹.

“Quiet sides”

In particular, the benefits of quiet façades or quiet sides of buildings which facilitate the possibility of respite from road traffic noise have been analysed (Gidlöf-Gunnarsson, 2010). This has indicated that those with access to a quiet side of their dwelling experienced a benefit of between 30% to 50% for different disturbance types whilst improving sleep and physiological and psychological wellbeing. It is suggested that in areas where the exposure level is high ($L_{Aeq,24hr} > 65\text{dB}$), a quiet side could help to reduce the adverse effects of noise, whereas in new developments or in areas where the road traffic noise does not exceed 60dB the concept could be used to create better sounding environments. It can be inferred that access to a quiet area provides a break from noise and increases the perceived control of the noise exposure, which has been shown to have a modifying effect in annoyance responses.

The role of non-acoustic factors

It is important to highlight that the response to noise (in terms of annoyance judgments) is influenced by many non-acoustic factors, which might be very relevant for respite. For example, people have reported a high level of annoyance when they can visualise the noise source. This feeds into the debate that perceived respite might not be totally linked to the noise level, but also to the fact that an overflying aircraft is there at all (even if it is sometimes a long distance away).

Visual factors

The “visual” factors have been well studied. For example, the annoyance judgments due to road traffic noise were influenced by the visual judgments of the attractiveness of quiet courtyard (when analysing the effect of quiet sides on wellbeing and restoration on people exposed to road traffic noise). The visual judgments were also affected by what people heard²².

Respite in healthcare settings

The benefit of quiet periods has also been investigated within healthcare environments. It was found that by introducing two-hour periods of quiet time in intensive care units during the day, patients were more likely to be found asleep⁴ (Dennis et al., 2010). Sleep is essential for energy restoration and physical recuperation which is crucial for the healing process. During each period, telephone volumes were reduced, staff were asked to converse quietly, radios and televisions were turned off and where possible, tests, procedures and consults were conducted outside the quiet hours. The probability of patients being asleep during these quiet times were four times higher than during the half hour before the period starting.

A similar investigation was conducted but rather than focusing on critical care units, periods of scheduled quiet were introduced in acute care settings where similar outcomes were established (Gardner et al., 2009). Results suggest that scheduled quiet time would be a positively perceived intervention with therapeutic benefit. Interestingly, Dennis et al. also noted that the nurses valued the

²¹ Studies referenced: (A. Gidlöf-Gunnarsson E. Ö., 2010), (A. Gidlöf-Gunnarssona, 2007), (E. Ohrström, 2006), (T. Kihlman, 2001), (Schulte-Fortkamp, 2002)

²² Studies referenced: (A. Gidlöf-Gunnarsson E. Ö., 2010) (A. Fyhri, 1999) (A. Gidlöf-Gunnarsson E. Ö., 2007)

quiet time, commenting these periods provided respite from a hectic pace, offering an opportunity to ‘refocus and re-prioritise’.

Quiet periods

The Quiet City Project is a report prepared by the City of London Department of Environmental Services to investigate how noise affects residents and workers in the City of London and to determine whether there is a need to protect quiet and tranquil areas. Among other questions, residents and workers were asked what steps could be taken to reduce the noise. Unprompted, about 25% of workers suggested the enforcement of quiet hours, the introduction of quiet zones or other restriction of construction works (The City of London, 2010). This suggests that the idea of respite might be welcomed by the workers in the city.

The benefits of quiet periods – a significant reduction in noise for an allotted amount of time - appear to go above and beyond the benefits derived from a general reduction of high noise levels, providing an opportunity for improving physiological and psychological well-being. Although noise levels are central to the concept of a quiet area, there are a number of other factors including its visual aesthetics which may help to determine whether an area is deemed quiet or tranquil.

4.3.4 The economic value of respite

Box 11. Summary of findings on respite and its economic value

- There are few studies that provide some indication of the economic valuation of respite and these are airport specific.
- These studies have developed a methodology for valuing respite.
- Evidence suggests that respite can make some contribution to positive attitudes towards the airport.
- Further work is needed and should be airport specific.

There has been limited monetary valuation of the effects of delivering respite through the use of hypothetical questioning only. No attempts have been made to monetise the value of a “happy” community, positive community relations, or indeed the cost to the operators of implementing a respite strategy.

The economic value of tranquillity

While adverse effects of noise have been extensively studied, the beneficial effects of tranquil areas and provision of respite are less understood.

A report commissioned for the Department for Environment, Food and Rural Affairs (Defra) in the UK attempted to place a value on the benefit of quiet areas (URS / Scott Wilson, 2011). The study set out three goals: to define what constitutes a quiet area, to understand the benefits of quiet areas and ultimately, to estimate the economic value derived from a visit to a quiet area.

It concluded that although there is no single definition, a number of criteria may be used to judge to whether a space is considered quiet. These include: natural sounds being audible and not masked by

man-made sounds, the area being less noisy than its surroundings, having a maximum L_{day} value of 55dB and being publicly accessible.

Based on a review of 80 studies, the report indicates that the benefits of quiet can be classified into four categories:

- Health effects: psychological and physiological wellbeing, restoration and recovery
- Amenity: reduced annoyance, relaxation, and recreation
- Productivity: creativity, problem solving, cognitive development
- Environmental: better habitat for biodiversity and air quality

That work suggests that the benefits of quiet go beyond those from a reduction in high noise levels. These benefits may be derived from the amenity of the space and the improved quality of life, the possibility of relaxation and escape from the ‘hustle and bustle’ of noisier surrounding areas and reduced annoyance. These positive benefits have important economic implications, providing savings on health costs, increased work productivity, an impact on property prices and cost savings from the prevention of ecosystems decline.

Although highly caveated, the study places a value between £1.18 and £7.40 per visit to a green space which was extrapolated to a total value between £19.02 million and £1.4 billion per year for all visits to quiet areas in England. However, the study does stress that there is no unique or absolute price of quiet, and that any attempt to put a price on it undermines the very richness of the characteristics of a place.

While the study concludes that more effort is required to ensure that acoustic factors are accounted for when considering public spaces, it may be worth highlighting the converse; when considering respite from aviation noise, non-acoustic factors such as the amenity or visual aesthetic of the areas affected by aircraft noise should be taken into account to improve community response.

The economic value of respite

As part of the DOKEN trial, Heathrow Airport commissioned independent research projects to understand the community’s attitudes to different types of noise relief (I. Flindell, 2014). The research team conducted a qualitative study of residents on completion of the six-month trial in areas to the east and west of the airport that had been expected to be most affected by the temporary change in operations.

The study suggests that noise relief, however it is delivered, is significantly valued by the community and whether it is scheduled or not makes little difference. The study also stresses the relevance of effective communication to residents regarding this type of initiative. It is key that residents understand that a way to provide scheduled respite exists and can be of benefit to them.

The study presented relative monetary values for specific options between dispersed flights, alternating routes or implementation of one single route to respondents. The authors added a caveat on the use of these monetary estimates because of the relatively small sample size used.

Although it would be feasible for policy makers to make use of these values within evaluations of different operational policies at a specific airport, it is key to bear in mind that every situation is unique. No single approach will provide a complete solution to the problem.

5 CONCLUSIONS OF THE RESPITE WORKING GROUP

The Group agreed on the following lessons learned review work presented in the previous section:

5.1 There is currently no clear, consistent or universally accepted definition of respite.

Defining respite is a challenging task involving complex concepts and multiple factors, as illustrated below.

Figure 3: Illustration of concepts to consider in relation to respite from aircraft noise



The need to develop a common working definition was agreed from the outset. The following priorities were identified as a guide for defining respite:

- The need to include concepts of scheduled or predictable periods of relief.
- Ability to extend any definition to include sharing, events, overflights, noise and the community/its people.
- Ability to differentiate between respite and relief, since some stakeholders use both terms interchangeably. This suggests a need for two separate definitions.
- Definitions should not be over-prescriptive at the outset.
- It is important to build a common understanding of what “overflight” means.
- Any definition should be easy to understand by the community.

Based on these priorities and for the purpose of this project, the Group agreed the following **working definitions**, outlined in Section 4.1:

“Relief can be defined as a break from or a reduction in aircraft noise.”

“Respite can be defined as a scheduled relief from aircraft noise for a period of time.”

For practical use, supplementary statements could be included to take into account local circumstances and put these working definitions into context, but that is beyond the scope of this project. Additional work is needed to further define “a period of time”, “break” and “reduction” in terms of community perception.

5.2 What the community values as respite is not fully understood.

Despite a number of related studies and implementation examples, there is at present no clear understanding of what the community values as respite. There is no one-size-fits-all approach and the value of respite depends on local circumstances and is airport dependent. There has been no specific targeted research into this and as such, information can only be inferred from the various related studies or activities.

The Group has identified some issues that might affect or are related to the perception of respite from aircraft noise.

- Subjective valuation of benefits or drawbacks
- Predictability
- Temporal variations in exposure
- Whether aircraft are arriving or departing
- New versus existing community overflight
- Airports with static or growing capacity
- Monetary value of respite
- Role of non-acoustic factors
- Trust and tolerance towards airports authorities and operators
- Role of tranquil areas
- Importance of local issues in determining extent of response to aircraft noise
- Relevance of number of movements vs. averaged noise levels
- Communication and engagement.

Effective provision of respite depends not only on operational features but also specifically on how the community perceives and values respite. The value of respite depends on, but is not limited to, key non-acoustic factors including trust, time of day etc., such that the importance of the acoustic characterisation of the noise itself is often not paramount. Active engagement with all interested community groups and consideration of all community interests are therefore priorities in developing an effective respite strategy for Heathrow airport.

Successful community engagement can help to modify some of the non-acoustic factors driving any adverse response to noise, and that engagement is also necessary for any airport’s ongoing social licence to operate and, where applicable, grow.

5.3 There is no universal formula for the successful implementation of an effective respite strategy and operational design for respite needs to consider operational conditions at an airport.

Relative position of the community

The effectual provision of respite depends on the relative position of the local community to the different flight paths that might be used, and how often each flight path is actually used.

For people living in different areas around an airport, the actual amount of noise relief achieved depends on the relative distances to the different flight tracks that might be used and how often and when each flight track is actually used. The potential benefits of scheduled noise respite depend on the magnitudes of the differences in the physical acoustic characteristics of the noise and numbers of overflights between two respite scenarios. The Group acknowledges that the delivery of respite for one community may result in an increase in noise for others.

For residential areas where alternated flight tracks are relatively close together, the differences in sound levels might be small or even negligible, and therefore there might be no benefit from offering scheduled alternation to provide noise respite. However, for residential areas where the distances between alternated flight tracks are considerable, the differences in sound levels could also be considerable and providing scheduled respite could then be very worthwhile.

Operational design

The main operational challenges identified are related to the provision of respite within the context of PBN implementation. The use of PBN has led to the greater concentration of flight tracks over narrower paths and an increased negative community reaction. PBN will be implemented worldwide and this work has confirmed the need to consider supplementary strategies to provide a break from these more concentrated overflights (and hence increased noise exposure), and to consider fairness as a concept.

This work has also raised the issue of how to disperse routes while flight tracks are more concentrated on individual paths and has identified a risk of overlapping “respite areas” as one of the main obstacles for delivering effective respite. UK Government Policy now needs to consider its implied position on *shared concentration* for arrivals and departures, as this could impact how respite is implemented, through either rotating a small number of routes or spreading aircraft out over a larger number of routes.

It is worth noting that Sydney’s approach with ten operational modes is a model Heathrow is unlikely to emulate. Their complex system relies on the fact Sydney has no interactions with any other major airport.

Any strategic plan should also, at an early stage, take into account the following issues:

- Safety
- Airspace design and limits

- Efficiency and resilience requirements
- Aircraft capabilities and avionics
- Consideration of track miles, fuel burn and associated cost
- Aircraft traffic control and controllers' workloads
- Pilots' workloads
- Trade-offs with other environmental factors

In addition, the following principles have been identified as the likely elements of a successful respite strategy. Any strategy for achieving respite will:

- be contextualised to the specific airport(s) to which it refers,
- be valued by the community,
- include planning and operational principles,
- include non-acoustic factors,
- take into account that alternating routes can be a suitable compromise between benefits of efficiency, safety and fairness,
- ensure the role of the regulator / airport authority is open and engaged,
- involve different stakeholders throughout the whole process (planning, design and implementation), with the community and local residents being well represented,
- strike a fair balance between concentration and dispersal of noise amongst the population exposed, including any new population affected as a result of respite implementation, and
- be developed in a transparent way, building on others' experience to avoid "reinventing the wheel".

Route design

Implementation examples have shown that respite has been offered through either route or runway rotation, or both. Route designs can be optimised by considering overflying the least populated areas, and potentially adopting different procedures such as curved approaches.

5.4 There is currently no single acoustic metric that can adequately describe respite.

The review work has shown that only a few metrics have been used to objectively describe respite. Frankfurt, Brisbane and Sydney airports currently have specific indicators for quantifying and assessing respite. Simple indicators such as the percentage of runway use, the percentage of time in which a flight path is expected to be out of use or the clock hours approach from Sydney, can be used as examples. These appear to be sensible as they relate to the specific local operations and definitions described by the individual airports in relation to providing respite. They provide a clear measure that is transparent to the community.

However, although we have measures that essentially monitor how a management tool has been implemented, and could be assumed to indicate respite, there is no validation of the link between these measures and perceived respite and how effective the management intervention is in providing respite.

Since it is not clear what the community deems as effective respite, and therefore which parameters are useful in describing its key elements, it is not possible to choose a suitable metric that is fit for purpose at this time. It is important to consider some fundamental issues first.

General considerations

For what purpose are objective measures used? In relation to respite, the purpose of a metric is: “to provide a clear, transparent and meaningful physical description of the environment, to show the actual difference between respite options and how they affect different locations on the ground”.

This work has seen metrics presented in tabular form, as contours on maps, as grid values or by postcode points. Communities who are interested in very local data may find that information at the postcode level may be of greatest use. However, in considering options around an entire airport, it is likely that strategic decisions will require a combination of different metrics.

Metrics can either be general descriptions (e.g. the number of overflights per hour etc.) or acoustically based (related to a measure of acoustic energy). Acoustic metrics can only ever describe a noise environment and not the response to it, since community response to noise is complicated and depends on many variables other than the physical sound characteristics.

Individual, economic and social factors are often more important than sound level for determining “acceptability”. Given the weak statistical correlation between acoustic metrics and community response that exists for a general case, there will always be limitations to how much any metric can determine a level of response. The overall aim of an acoustic metric for respite is not to measure the overall amount of noise but simply to improve or simplify the description of the actual change in operations (due to implementing a respite strategy) as it affects different locations on the ground. The use of any metric must therefore be ring-fenced and its limitations clearly explained so that it is not used out of context.

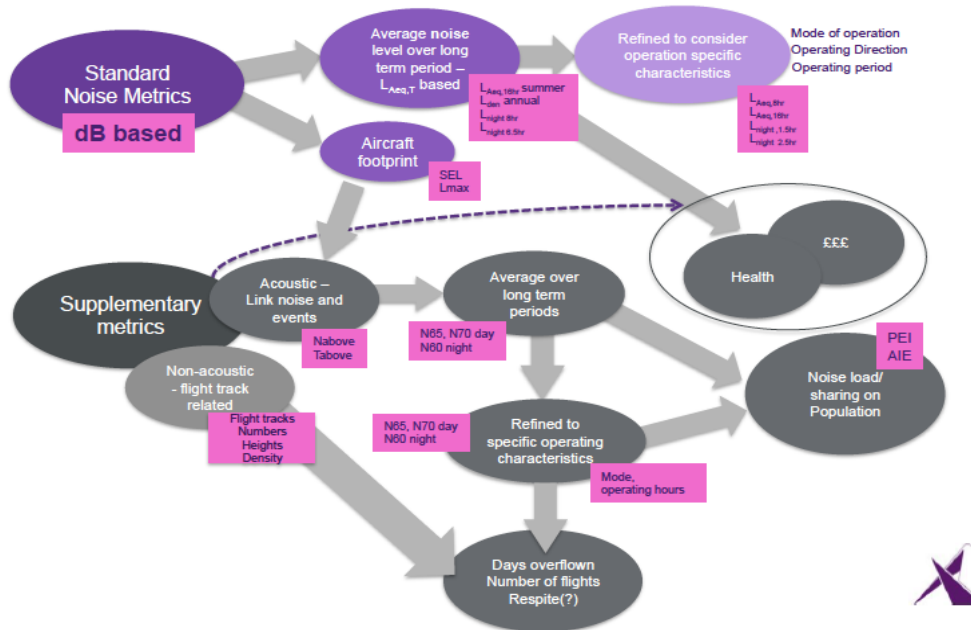
From previous work on metrics (N. Porter, 2014) metrics have been classified as standard and supplementary, as shown in Figure 4 below. Metrics used to inform on respite are unlikely to be based on standard types such as average energy values; they are more likely to be a supplementary type, event based and by mode of operation.

Guiding principles

Based on the experience and understanding thus far, the Group proposes a number of guiding principles for defining metrics to measure respite from aircraft noise. Any metric should:

- be fit for purpose,
- reflect what is noticed or valued,
- be meaningful to communities,
- be clear and transparent,
- facilitate policy making/strategic decision-making, and
- reflect change.

Figure 4: Metrics



Candidate list of metrics

The Group suggests the following candidate list of objective measures to describe the noise environment in terms of offering respite. This list could be supplemented by any of the measures shown in Figure 4:

- DROps.
- Numbers of days within the period of time on when the flight path is likely to experience no flights.
- Percentage of clock hours when there were no overflights.
- Number above (NA) differences by postcode.
- Percentage of time an area is overflown.
- Changes in flight track density or height of overflights.
- Median Quiet Interval (MQI).
- Time Above (TA).

5.5 Further work is needed to develop a clearer understanding of which parameters are useful in describing respite in a way that is valued by the community.

Using the collated metric information, the suitability of the list of candidate measures can be tested. We also need to understand the relative importance of acoustic and non-acoustic metrics in evaluating respite, so that we can put the usefulness and limitations of any acoustic metric into context.

5.6 A strong and effective communication strategy and good community engagement is essential for the successful implementation of respite.

From the cases analysed two conclusions were drawn: multi stakeholder engagement is fundamental, and more efforts in communication are needed. It is key to engage with *all* stakeholders throughout *all* phases of the respite design and implementation.

The Group discussed that communication should go beyond the provision of information. It should build on people's understanding of the likely implications and associated trade-offs resulting from respite implementation. The Group noted that community reaction to a changing flight path would likely be different than for the opening of a new runway, and therefore different approaches in communication and engagement should be undertaken, tailored according to the respite implementation being considered.

A range of principles can be drawn from the experience and lessons learnt from the case study airports analysed, specifically in relation to communication and engagement with local communities:

- It is key to involve different stakeholders in the respite design process in a transparent and open way, including community, industry, regulators and local authorities. When one single party determines changes, trust from the other parties may be lost. Community involvement has been shown to be successful as it ensures changes are not solely motivated by efficiency.
- Communication strategies should account for different contexts and the relative position of affected communities.
- A direct approach and the use of simple and understandable language is critical in establishing common ground between parties and for enabling meaningful dialogue.
- Effective communication and engagement is needed before, during and after a change happens.
- It is important to present and explain the context of any changes.

Once there is a clearer understanding of how the community values respite, research can then focus on the selection of the most suitable engagement method for cross-sector involvement, how to identify the key information to share, how best to describe and present that information and the most effective combinations of media to use to disseminate the information.

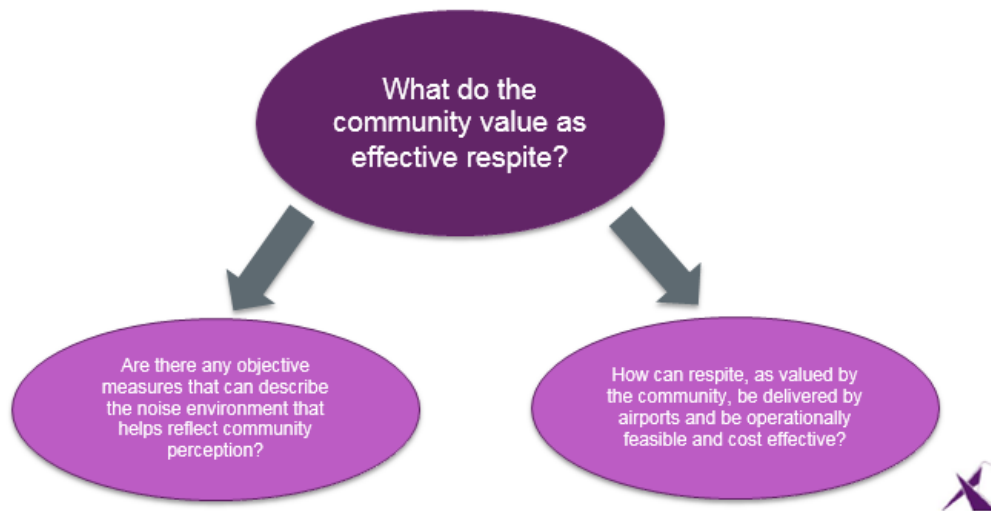
5.7 There is currently insufficient information on the benefits of respite to health and on the economic value of the effects of respite.

The work has shown that benefits of respite to health and on the economic value of the effects of respite is not clear. There is clearly no one-size-fits-all solution – there is a need for further research.

6 RESEARCH PRIORITIES RECOMMENDED BY THE RESPITE WORKING GROUP

Drawing on the lessons learned in Section 5, the Group identified three priority areas where greater understanding is required in order to implement effective respite from aircraft noise at Heathrow. These are summarised in Figure 5 below.

Figure 5: Summary research priorities: Key areas to understand to implement effective respite



Priority 1: What does Heathrow’s local community value as effective respite?

Central to developing any implementation strategy on delivering effective respite is to focus on what the community values as effective respite.

Priority 2: How can respite be delivered by Heathrow that is operationally feasible, cost effective as well as valued by the local community?

A set of emerging principles is required, based on how the community value effective respite. These need to take into account the spatial separation of respite routes and the temporal variations that need to be offered to be effective, whilst considering the operational constraints and costs.

Priority 3: Are there any objective measures that can describe the noise environment that helps reflect community perception?

Research will consider the guiding principles and the candidate list of metrics agreed by the Group and described above in section 5.4.

7 RESEARCH PROPOSAL

Based on the research priorities identified above, the RWG has developed a list of actions in order to address the priorities and move forward with research:

1. Understand what the community values as effective respite as a priority, before any other work is undertaken.
2. Clarify the definitions for: 'a period of time', 'break', 'reduction' in terms of community perception.
3. Determine how far routes need to be changed to make a perceived difference and be of potential benefit in terms of height and position, for arrivals and departures.
4. Understand more clearly which parameters are useful to describe respite in a way that is valued by the community.
5. Test the list of candidate measures after further research is completed.
6. Identify the relative importance of acoustic metrics and non-acoustic metrics.
7. With a clearer understanding of how the community values respite, conduct further research, focussing on:
 - Selecting the most suitable engagement process with all stakeholders (community, industry, regulator, etc.)
 - Identifying the key information to share
 - Describing and presenting that information in the most suitable way for all parties
 - Identifying the most effective combinations of media to use
 - Selecting the optimum temporal separations or patterns required

The Group agreed that priority must be given to gaining a better understanding of how the community values respite, before considering operational feasibility, cost-effectiveness and the development of metrics. The following key objective for research was identified:

KEY RESEARCH OBJECTIVE

To better understand the key characteristics of an effective respite strategy for Heathrow Airport and its local communities, consistent with efficient operations.

Two phases of research were identified in relation to this key objective:

Phase 1: To develop a set of principles for providing effective respite from aviation noise.

Phase 2: To test out practical implications for airspace design of emerging principles from (1).

These phases are summarised below.

7.1 Phase 1: To develop a set of principles for providing effective respite from aviation noise at Heathrow

This objective can be broken down into two key questions that need to be explored:

Question 1: What spatial variation is required to routes to make a perceived difference and be of potential benefit in terms of height and position for both arrivals and departures?

The first key question could be investigated through laboratory experiments to explore the discernible differences (as perceived on the ground) between the noise characteristics of flight operations reflecting a range of height and lateral distances from the receiver, and to explore the perceived benefit or importance of these differences when providing effective respite options. It is envisaged that the laboratory tests would require a sound simulation presentation system using range of stimuli to take into account differences in acoustic features at different heights, distances and angles from listener to aircraft position.

Question 2: What are the optimum temporal separations or patterns required in order for the community to value it as effective respite?

This could be investigated through qualitative fieldwork to explore the preferences for temporal distribution of overflights for offering respite from aviation noise, to better understand attitudinal sensitivities to these different temporal distributions, and to provide preliminary monetary valuation of different possible options. Since no actual respite options are to be implemented at Heathrow in the near future, this work would have to be based on hypothetical changes, building on methods developed in previous research to better understand attitudinal sensitivities through qualitative work using focus groups, in depth interviewing techniques, and Stated Preference (SP) techniques.

7.2 Phase 2: Test practical implications for airspace design of the emerging principles from Phase 1.

Once an emerging set of principles has been developed, they can be tested to establish their practical implications for existing operations or future airspace design. The experimental design of this stage will evolve and could include community subjective response research, more fieldwork using either responses to hypothetical changes and operational testing of options through trials.

The flow of the proposed research is summarised in Figure 6 below.

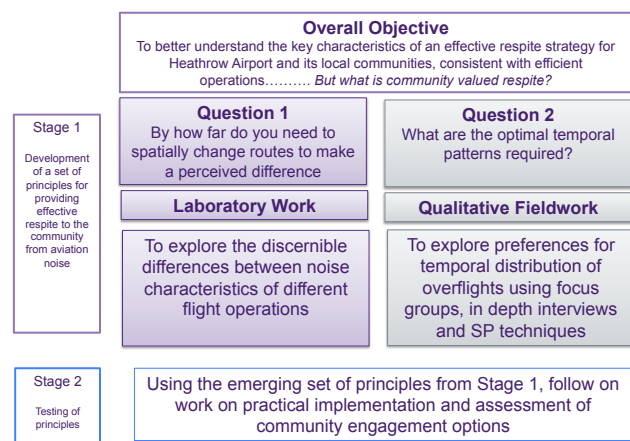


Figure 6: Overall research flow summary

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APPENDIX 1: HEATHROW RESPITE WORKING GROUP TERMS OF REFERENCE

Purpose

To provide advice to Heathrow Noise Forum on the management of aircraft noise respite.

Objectives

The Heathrow Respite Working Group will:

- Understand and agree formal definition/s of respite;
- Investigate current practice in the management of respite;
- Identify indicators for the management of respite including measures of success;
- Identify any gaps/ knowledge for the management of respite;
- Consider how to differentiate respite from noise sharing;
- Understand predictability issues;
- Review the findings of the community attitudinal surveys and complaints database accompanying the current departure trials at Heathrow in order to better understand variations in community expectations to respite.
- Establish a common level of understanding between different stakeholders of the scope and opportunities to implement respite as part of noise management programmes at Heathrow.
- Propose actions to Heathrow Noise Forum.

Principles

Members are expected to abide by the principles of the Heathrow Noise Forum.

Membership

Member of RWG	Organisation
Nicole Porter (Chair)	Anderson Acoustics
Diana Sanchez (Secretariat)	Anderson Acoustics
Cpt Dean Plumb	British Airways
Dr Darren Rhodes	Civil Aviation Authority, UK
Tim May	Department for Transport
John Stewart	HACAN
Brendan Creavin	Heathrow Airport
Rick Norman	Heathrow Airport
Rachel Thomas	Heathrow Airport
Rob Gibson	Hounslow Borough Council

Member of RWG	Organisation
Dr Ian Flindell	Ian Flindell Associates
Gerry O' Connell	IATA
Carrie Harris	NATS Environment

The members will be invited by Heathrow Airport Ltd, in discussion with the Heathrow Noise Forum as a whole. The maximum number of members will not exceed 15. The Working Group will operate for a period of up to six months from the date of the first meeting, whereupon its ongoing work programme will be reviewed by the Heathrow Noise Forum. Anderson Acoustics are to provide Chair and Secretariat.

Meetings

Meetings will be held six times and members are expected to attend all of the meetings. Where a member does not attend two consecutive meetings, Heathrow reserves the right to invite an alternative member to represent the interests of the relevant stakeholder group.

The Working Group will be quorate with 10 members, one of whom shall be the Chair or his/her nominee.

Meetings will generally be held at Heathrow Airport Limited's offices, though may on occasion be held in other locations where relevant to the Group's work.

Any papers will be circulated at least three working days before the meeting.

Outputs

The Working Group will agree a work plan and regularly review progress against this. After each meeting of the Working Group, an update will be provided by the Chair to Heathrow Noise Forum. A formal report of progress against the work plan will be provided on a quarterly basis.

All materials published will be freely available with the exception of any specific material clearly identified as confidential during a meeting or in any correspondence.

Interaction with Other Groups

The Heathrow Respite Working Group will interact with other groups where requested to do so by the Heathrow Noise Forum.

Amendments to the Terms of Reference

The Terms of Reference may be amended after consultation and agreement by members of the Working Group.

APPENDIX 2: LIST OF AIRPORTS AND SOURCES OF INFORMATION FOR REVIEW WORK

Airport	Main source of information
Europe	
Brussels	Direct contact with airport and with community groups
Frankfurt	Direct contact with airport
Gatwick Night time trials	Night Noise Arrivals Respite Trials Report (Gatwick Airport, 2013)
Heathrow a. DOKEN Trial b. Runway Alternation c. Proposal for 3rd Runway to Airports Commission.	<ul style="list-style-type: none"> – Heathrow DOKEN Trials Final Report (Heathrow Airport, 2014) – SYSTRA DOKEN Trials Report. (P. Le Masurier, 2014) – Heathrow Web page and direct contact with the Airport – Evidence submitted to Airports Commission
Schiphol	Direct contact with airport
Stockholm Arlanda	Direct contact with Swedavia
Stockholm Bromma	Direct contact with Swedavia
Gothenburg City	Direct contact with Swedavia
Vienna	Direct contact with airport
US	
Boston Logan Int.	Case studies of PBN implementation in the US (HMMH, 2014).
Chicago O’Hare	Online search: FAA, Chicago O’Hare and media: (Forest Glen Community Club, 2013) (Chicago Department of Aviation, 2015) (Airport Watch, 2015)
Denver Int.	Case studies of PBN implementation in the US (HMMH, 2014).
Phoenix Sky Harbour Int.	Online search at Phoenix Airport and media. (CNN, 2105) (Phoenix International Airport, 2015) (Airport Watch, 2015)
Seattle-Tacoma Int.	Case studies of PBN implementation in the US (HMMH, 2014).
Australia	
Brisbane	Brisbane Airport Noise Booklet. (Brisbane Airport , 2014) Air Services Australia (Airservices Australia, 2014)
Perth	Air services Australia. (Airservices Australia, 2015) (Peter Law, 2015)
Sydney	Direct contact with airport

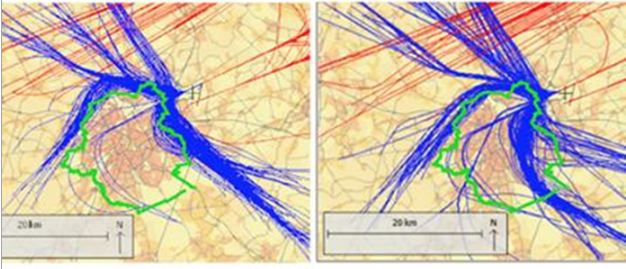
APPENDIX 3: TABLE OF DEFINITIONS OF RESPITE USED BY DIFFERENT STAKEHOLDERS

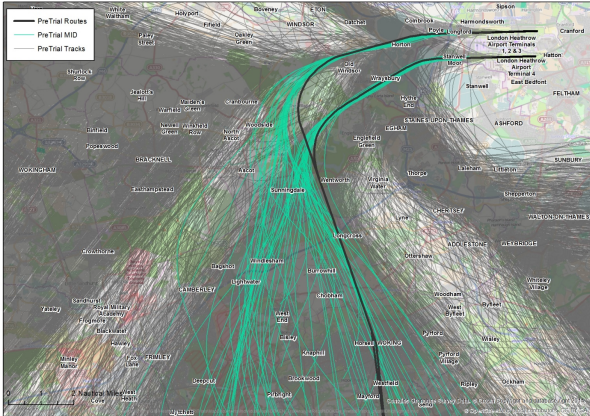
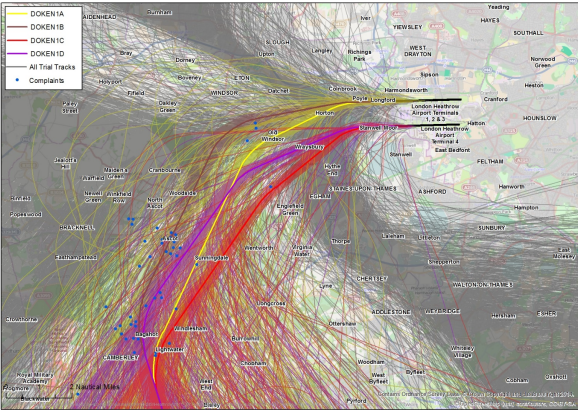
Stakeholder	Organisation	Definition used or inferred
Regulator and government perspective	UK Department for Transport (DfT)	<p>The DfT recognise respite as a key mitigation measure to share noise, which has been valued by the communities.</p> <p>The Booklet Against Aircraft Noise published in 1979 makes reference to runway alternation as a system that provides a fair sharing of periods of relative quiet among the communities affected by aircraft noise. The same booklet highlights that the system has been regarded as the most effective of current noise abatement measures of the airport (DfT, 1979).</p> <p>In the recently published Guidance to the CAA on environmental objectives relating to air navigation, the DfT supports the use of respite as an innovative technique to mitigate aircraft noise among communities already significantly affected by aircraft noise. DfT gave special attention to those populations where the frequency of movements has increased over time. The provision of respite is of major importance in the context of airspace changes (DfT, 2014)</p>
	UK Aviation Policy Framework (APF)	<p>The APF considers respite as a means of mitigating the impact of aircraft noise. It reinforces the importance of exploring options for respite which allows noise to be shared between communities on an equitable basis, provided this does not lead to significant numbers of people newly affected by noise. Thus it does not define what new or significantly means. Also, it highlights that regardless of the preferred option for delivering respite; those responsible for planning how airspace is used should ensure that predictability is afforded to local communities, to the extent that this is within their control (DfT, 2013).</p>
	Civil Aviation Authority, UK (CAA)	<p>Respite is considered as a one of the objectives that guides one of the four types of the operational measures to limit noise (based on ICAO Balanced Approach) (CAA, 2014).</p>
	Federal Aviation Administration and Transport Canada	<p>Respite in general depends on the nature and frequency of the aircraft operations. Respite is referred to as relief from aircraft events for a period of time. However, they warn that it should be locally defined to fit the needs of any community or study area. Examples of possible definitions are “the total relief from any aircraft event for an hour, a morning, or an early evening” or “the relief from aircraft events that would otherwise interfere with outdoor activities” (Federal Aviation Administration, 2015).</p>
Community perspective	HACAN	<p>According to John Stewart, chair of HACAN, respite or relief is related with the provision predictable periods of relief or breaks from the noise of the planes at Heathrow. These are periods during the day or week when there will be no planes overhead. (Stewart, 2015)</p> <p>According to Virginia Godfrey, another HACAN representative, respite is related with predictable periods of relief allowing the burden of aircraft noise to be shared among population exposed. She goes a step further and proposes a way of quantifying respite; in her own view, alternation is a means to provide respite and should be described as Half Day Noise Relief. (Godfrey, 1997)</p>

Stakeholder	Organisation	Definition used or inferred
	Messages from people complaining at Heathrow due to aircraft noise	Some of the complaints submitted to Heathrow Airport mentioned respite and the importance of a fair distribution of noise as key issue. For example, <ul style="list-style-type: none"> “Expect aircraft noise, but constant noise without respite is not acceptable or reasonable” “New trials are unfair. Others should share the burden” “The noise level is unchanged, but the frequency has increased with no let up”
Airports perspective	Brussels	No established definition
	Frankfurt	The noise management at Frankfurt includes the provision of respite periods through the use of runways and routes options, which vary between odd and even days. In this sense, respite is described as scheduled and predictable noise breaks for heavily populated areas on specific days.
	Gatwick	Implied definition: approach suggests that respite is considered as scheduled and with predictable noise breaks.
	Heathrow	For current operations, including runway alternation and DOKEN trials there was no objective definition. For the Airports Commission respite was defined by overflight, using a corridor 1 Km wide centred on the SID centre line, up to 20 miles from the Airport. Respite was defined by percentage of time overflown taking into account the different modes of runway operations.
	Schiphol	No definition used or implied.
	Arlanda, Bromma & Gothenburg)	Do not directly refer to respite, however have operational measures aimed to provide a kind of relief for some communities
	Vienna	Implied definition: predictable and specific periods of relief for populated areas from night-time aircraft noise and movements.
	Boston International*	No established definition
	Chicago O’Hare*	No established definition
	Denver International*	No established definition
	Phoenix*	No established definition
	Seattle – Tacoma*	No established definition
Brisbane	No firm definition provided, their closest stated principle is “Principle 3: Noise exposure should be fairly shared where possible”. A government report about future operations at the airport states respite as a key noise concern, particularly at night and weekends.	

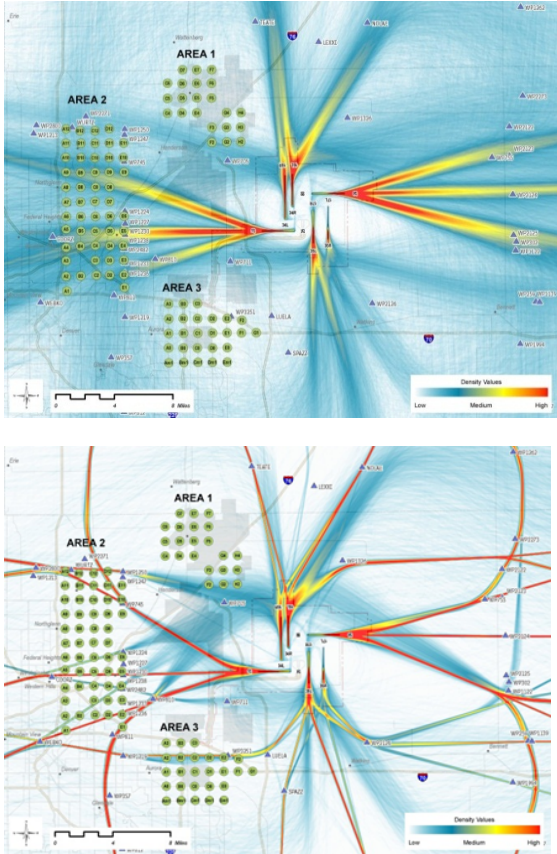
Stakeholder	Organisation	Definition used or inferred
	Perth	No actual definition given, it is implied that it is a reduction in flights over an area by providing alternate routes for aircraft. Noise level seems to be the measure, not a singularly time based measure like Sydney.
	Sydney	Respite can be defined as a continued continuous period of time (clock hours) when there are no movements on a particular flight path. For example if there were no movements on a particular flight path during 50 clock hours in a 100 clock hour period then it would be reported as 'Respite Hours 50%'.
Academics perspective	Independent researcher (Ian Flindell)	"...Residents receive relief from aircraft noise when aircraft are not flying overhead. When noise relief occurs according to a pre-arranged schedule, this is defined as noise respite.". (Flindell, Noise Respite: What does it mean? , 2015)

APPENDIX 4: SUMMARY OF OPERATIONAL INFORMATION ACROSS AIRPORTS

Airport	Operational information	Alternation of		New communities
		Route	Runway	
Brussels	<p>Since, there is no agreement on a long-term aviation planning policy, which determines consistent flight paths and routes, it is not currently possible to plan and provide predictable respite to communities. The issue of flight paths at Brussels has moved up and down the Belgian political agenda over the past couple of decades. Flight paths are constantly changing. Most recently in early 2014, there was a re-routing of flight paths over the city to ease pressure on the Flanders communities.</p> <p>Insert 1: Brussels flight path changes</p> <p>L'heure de vérité : les tracés radar</p> <p>Avant le plan Wathelet (24/2/2013) Avec le plan Wathelet (24/2/2014)</p> 	✓		✓
Frankfurt	<p>The airport provides periods of relief to heavily populated areas through the “Dedicated Runways Operations” process. This is currently used for departures routes in the early mornings. Runways and routes vary between odd and even days. This has allowed for a scheduled design for noise respite. For the future, it is expected that curved approaches to create noise relief at peak times for densely populated areas will be introduced.</p>	✓	✓	
Gatwick (Night time respite trial)	<p>A trial to test the provision of respite from night -time arrival noise was conducted during summer 2013. Flight paths were rotated to remove overflights from arrivals (below 6,000 feet) from pre-agreed noise impacted areas (most densely populated), on a pre-determined date/time basis.</p>	✓		✓

Airport	Operational information	Alternation of		New communities
		Route	Runway	
<p>Heathrow DOKEN Trial</p> <p>A trial to test the use of PBN to provide predictable respite to communities sited beneath Westerly departures flights was undertaken during 2014. Flight patterns were changed resulting in moving from a sharing of noise with general dispersion above 4,000 feet pre-trial to a pattern of shared concentration of noise along the new routes. Two rotation patterns were consistently applied through the trial. As a result, respite was provided principally through runway alternation.</p> <p>Insert 2: Tracks of all departing aircraft from 27L and 27R before the trial with those flying the conventional Midhurst route shown in green.</p>  <p>Insert 3: Tracks of departing aircraft from 27L and 27R during the trial with those flying on DOK1A 1B 1C and 1D shown in different colours.</p> 		✓	✓	

Airport	Operational information	Alternation of		New communities
		Route	Runway	
Heathrow Runway alternation	<p>Heathrow has established a runway alternation mechanism to share the noise burden and to give communities periods of relief from aircraft noise when the airport is on westerly operations. This runs in a two-week cycle giving residents living under flight paths predictable relief from the noise for half the day. An annual scheduled is published on Heathrow's webpage.</p> <ul style="list-style-type: none"> • Day- time runway alternation: follows a daily cycle and fortnightly cycle. In the mornings one runway is used for take offs and the other for landings. At 15:00 they swap over. This pattern is continued for the rest of the week, and switch completely in the following one. • Night -time runway rotation: since there are very few movements at night, there are four options to operate alternation on a four weekly cycle. 		✓	
Schiphol Amsterdam	<p>A new departure flight path was implemented in order to distribute noise away from more densely populated areas. Respite is provided by alternating use of runway according to pre-determined noise limits set at 35 locations around the airport.</p>		✓	
Sweden Airports Arlanda, Bromma & Gothenburg	<p>Although there is no specific respite programme or initiative, the three Swedish airports have in place operational measures that potentially can provide a kind of relief to some of their communities, following conditions stated in the Environmental Permit. For instance, Arlanda has implemented curved approaches to reduce noise over the population south of the airport. Bromma in Stockholm is closed at night and there are suggestions for using flight alternation at Gothenburg Airport.</p>	✓		
Vienna	<p>The Airport has specific regulations for alternating and using runways for night- time periods. These regulations are aimed at providing relief over the area south of Vienna. It includes a single runway use, preferential runway use and a movement cap (between 2330-0530).</p>		✓	
Boston Logan Int.*	<p>Eight Areas Navigation (RNAV) procedures were implemented to avoid lower overflights from departures above populated areas, by deviating aircraft over the sea. Also, three additional Standard Arrivals Route (STARs) were implemented, concentrating arrivals routes over one corridor. It can be inferred that PBN provided a change in pattern of exposure, leading to a change in noise exposure for some specific communities. However, it is not clear if any type of respite or relief was provided. Due to runway configuration, there was a risk of overlapping exposure areas which may limit the areas receiving potential relief.</p>	✓		

Airport	Operational information	Alternation of		New communities
		Route	Runway	
Chicago O'Hare *	Flight paths were changed to improve safety and reduce risk of collisions. PBN was used to implement new flight paths, which concentrated noise over one corridor at night. This generated more and constant noise for suburbs immediately west and southwest of the airport, leading to a significant increase in the number of complaints. Communities were opposed to these new flight paths, due to the lack of relief from aircraft noise.	✓		
Denver Int. *	<p>New RNAV STAR (17) and RNAV Standard Instrument Departure Route (SIDs) (16) were introduced to improve the efficiency of Denver's airspace. The routes were designed to minimise noise impacts and noise-related penalties. An iteration of the proposed RNAV SIDs, suggested that a kind of relief might be provided to communities overflowed by departing aircraft.</p> <p>The implementation process involved a wider group of stakeholders following a four-year (2010-2014) design, analysis, and environmental assessment period. This has been recognised as an exemplary implementation of NextGen procedures.</p> <p>Insert 4: Comparison of flight track densities on departures after adoption of PBN</p> 	✓		

Airport	Operational information	Alternation of		New communities
		Route	Runway	
Phoenix Sky Harbour Int.*	On Sep 2014 PBN was implemented in order to increase efficiency and safety on routes. Flight paths to and from the Airport were changed, concentrating movements over a corridor above historic residential neighbourhoods. Aircraft began their northbound turns at a closer point to the airport than under the old flight path. Due to the huge amount of complaints, FAA is expected to release an update on the changes.	✓		
Seattle-Tacoma Int.*	New RNAV procedures were defined for arrivals, maximising flights over a less dense populated area north of the airport while avoiding changes to the east where population densities and the likelihood of controversy were much higher. Two new STARs were approved, including 21 new RNP and RNP-to-ILS procedures that provided precision curved approach paths. Optimized Profile Descents (OPDs) were also implemented, allowing aircraft to start idle-descents at 38,000ft. However, the risk of overlapping routes (while alternating flight paths) reduces the probability of delivering respite to communities overflown, in particular for those under the final approach.	✓		
Brisbane	Respite is provided under current operations by runway and flight path alternation system. There are 6 operational modes, including reciprocal runway, which provides the highest rate of respite but is dependent on weather conditions. A smart tracking system is being proposed to increase the options for respite, allowing the use of flight paths and noise-sharing procedures that would normally only be possible in high-visibility, daytime conditions.	✓	✓	
Perth	A trial was implemented to reduce flights over a densely residential area (Roleystone) by alternating routes. It was anticipated that this measure would provide relief for 4,000 people by reducing the ground noise level to well below 50dBA, but would increase noise for 250 people.	✓		
Sydney	A noise sharing approach was designed to remove concentration of noise over the suburbs to the north of the airport. This plan was based upon 10 operational modes that are alternated throughout the day. Noise sharing targets have been put in place i.e. the amount of aircraft movements to the north, south, east and west of the airport.	✓		✓

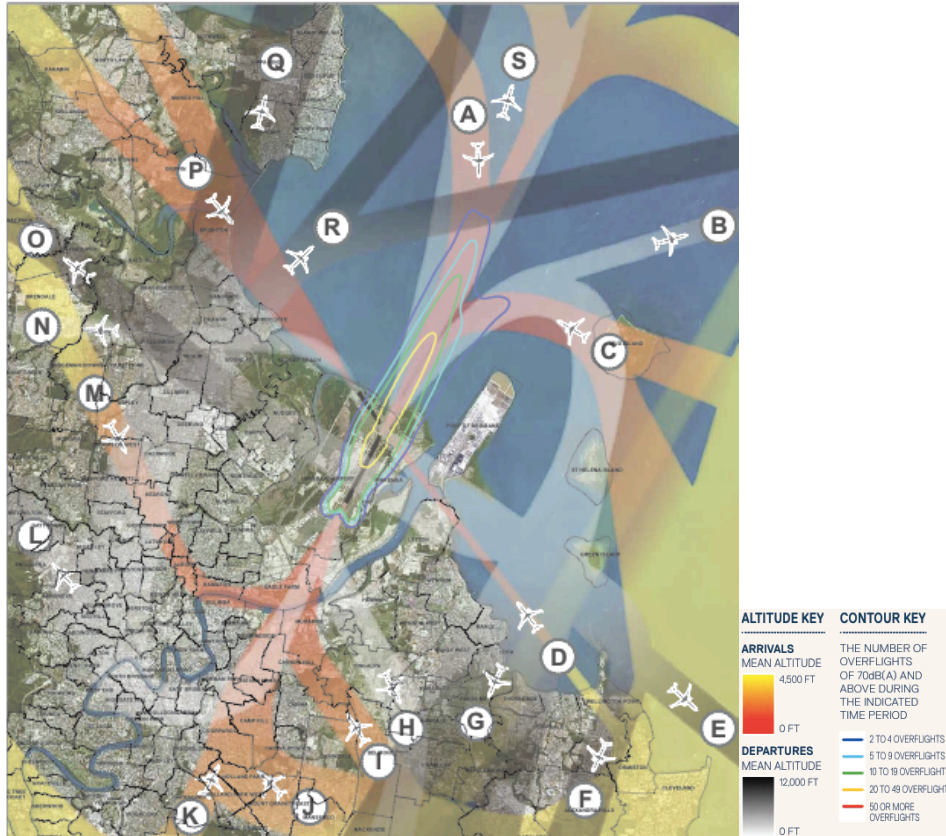
Note: Airports marked with an * are part from NextGen programme to modernise the US airspace through PBN implementation (NextGen is similar to the European SES programme)

APPENDIX 5: GRAPHICS OF RESPITE METRICS USED AT DIFFERENT AIRPORTS

Brisbane Airport. Illustration of a typical summer weekday flight path information in 2020, including respite.

Source: (Airservices Australia, 2014)

2020 SUMMER WEEKDAY NIGHT WITHOUT THE NPR – MONDAY TO FRIDAY 11PM – 5AM



FLIGHT PATH	FLIGHT PATH TYPE	AVERAGE NO. OF JET FLIGHTS ON FLIGHT PATH	EXPECTED MINIMUM & MAXIMUM NO. OF JET FLIGHTS ON PATH	% OF BRISBANE AIRPORT'S TOTAL JET FLIGHTS ON PATH	% OF DAYS WITH NO JET FLIGHTS ON PATH
A	Arrival	10	0 - 11	37%	1%
B	Departure	<1	0 - 1	<1%	1%
C	Arrival	1	0 - 2	4%	3%
D	Arrival	<1	0 - 1	<1%	87%
E	Departure	<1	0 - 0	<1%	100%
F	Departure	<1	0 - 0	<1%	100%
G	Departure	2	0 - 2	7%	0%
H	Departure	<1	0 - 2	<1%	98%
I	Arrival	<1	0 - 1	<1%	89%
J	Arrival	<1	0 - 0	<1%	100%
K	Arrival	1	0 - 7	4%	79%
L	Departure	<1	0 - 10	<1%	97%
M	Arrival	<1	0 - 5	<1%	79%
N	Departure	<1	0 - 0	<1%	100%
O	Departure	3	0 - 4	11%	0%
P	Arrival	<1	0 - 1	<1%	99%
Q	Departure	<1	0 - 3	<1%	98%
R	Departure	<1	0 - 1	<1%	99%
S	Departure	10	0 - 11	37%	0%

Sydney Airport: Jet Aircraft Respite. 1 June 2014 to 31 May 2015.



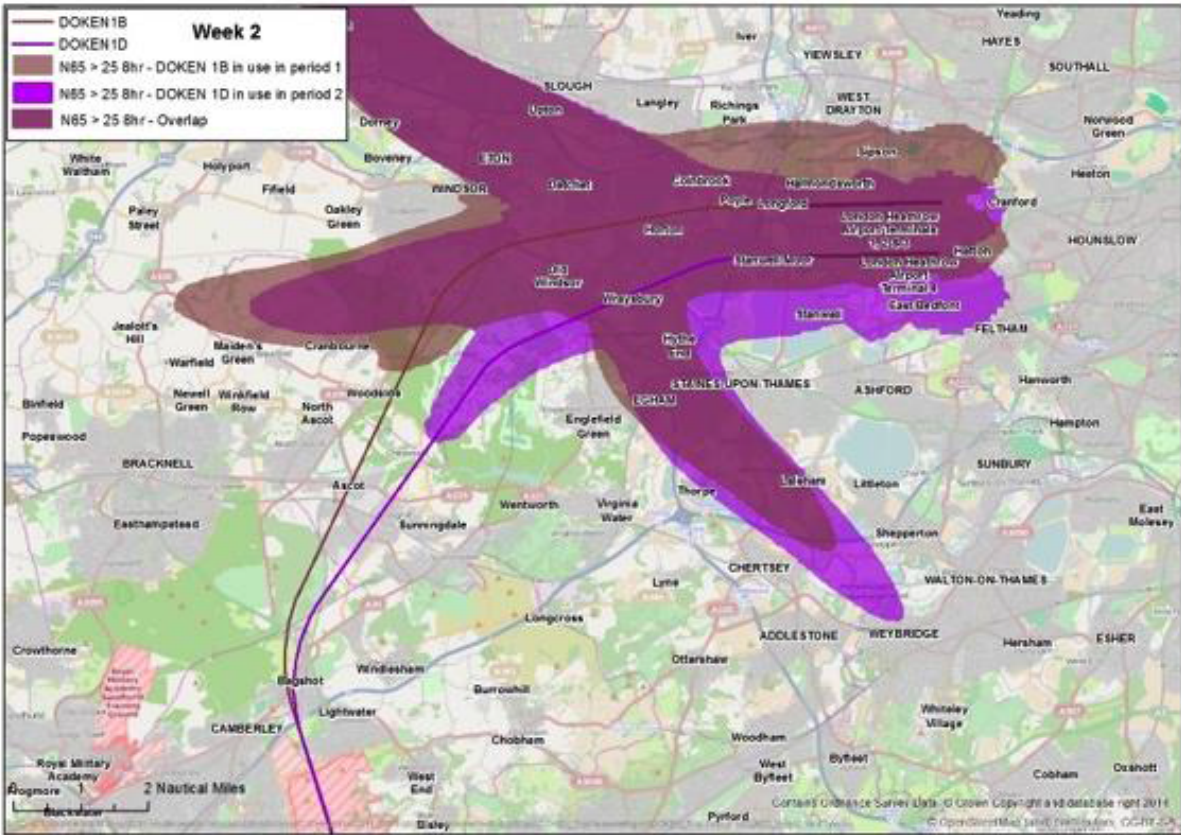
Source: (Airservices Australia, 2015).

Notes:

- Track A* is tracks B and C combined. Track K* shows departures (top box) and arrivals (bottom box)
- A respite interval is a 60 minutes period when there are not jet movements. Morning: 0600 to 0700, Day 0700 to 2000, Eve 2000-2300, Night 2300-0600, total respite 0600 to 2300. All jets included.

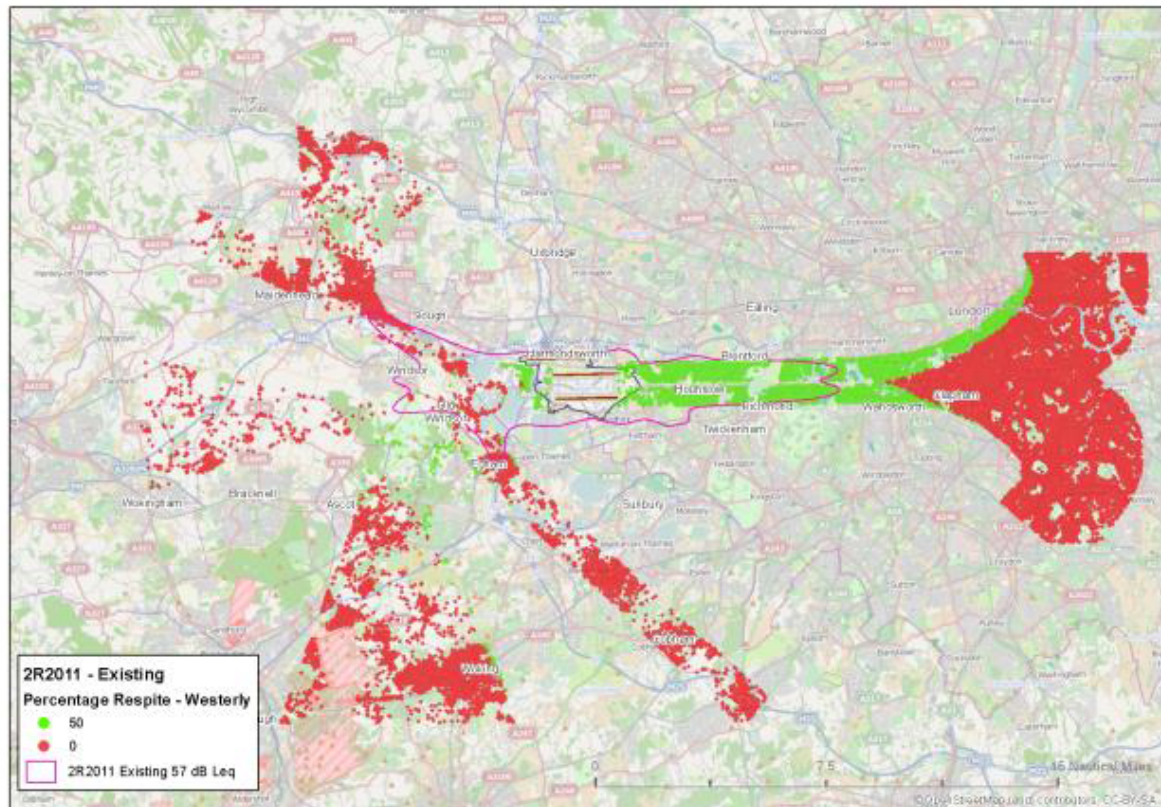
Heathrow Airport – DOKEN trial. Example of Respite information through route specific N65 values

(see DOKEN report: Where the areas of the contours do not overlap this provides an indication of areas where there may be potential for respite periods to be noticed)



Heathrow Airport – 3R proposal for airspace design

(see Technical Annex of Heathrow’s 3R North West Runway Air and Ground Noise Assessment Report)



Note from that report that:

- A property is considered to be overflowed if it is within the area contained by a 1km corridor of an arrival or departure route in a specific mode within a range of 15 nmi of the airport.
- If a property is overflowed (i.e. it is within a mode route corridor), it does not receive respite during that mode;
- It is assumed that the modes in each direction are operated evenly across a defined period. As the modes are rotated the number of modes where a property is within the area of a route are counted, these are periods when respite is not provided;
- When a property is not within a mode route corridor, the property receives respite during that mode;
- No consideration is given to the number of aircraft or frequency of flights during a mode (i.e. it could be 1 flight or 100 flights).

Following on from identification of the degree of respite provided when the modes are rotated and the likely proportion of easterly and westerly operations, it is then possible to identify the approximate number of days that an area may be overflowed in a year.