Case Study - London Heathrow

Introduction to the airport

In 2017 London Heathrow Airport (LHR) served just under 476,000 annual aircraft movements, carrying approximately 78 million passengers. Located 21 kilometres west of central London, the airport employs over 76,000 people – half of whom live in the surrounding five London Boroughs. The airport is operated by Heathrow Airport Holdings Ltd (HAHL), a consortium comprising 7 organisations. In July 2015, the airport was recommended by the Airports Commission that the airport to be granted a third runway, so as to improve its operating capacity, and in June 2018 the UK cabinet signed off plans that had been approved by the Government's economic sub-committee. This highly contentious runway has the potential to add an additional 222,000 aircraft movements to the airport.

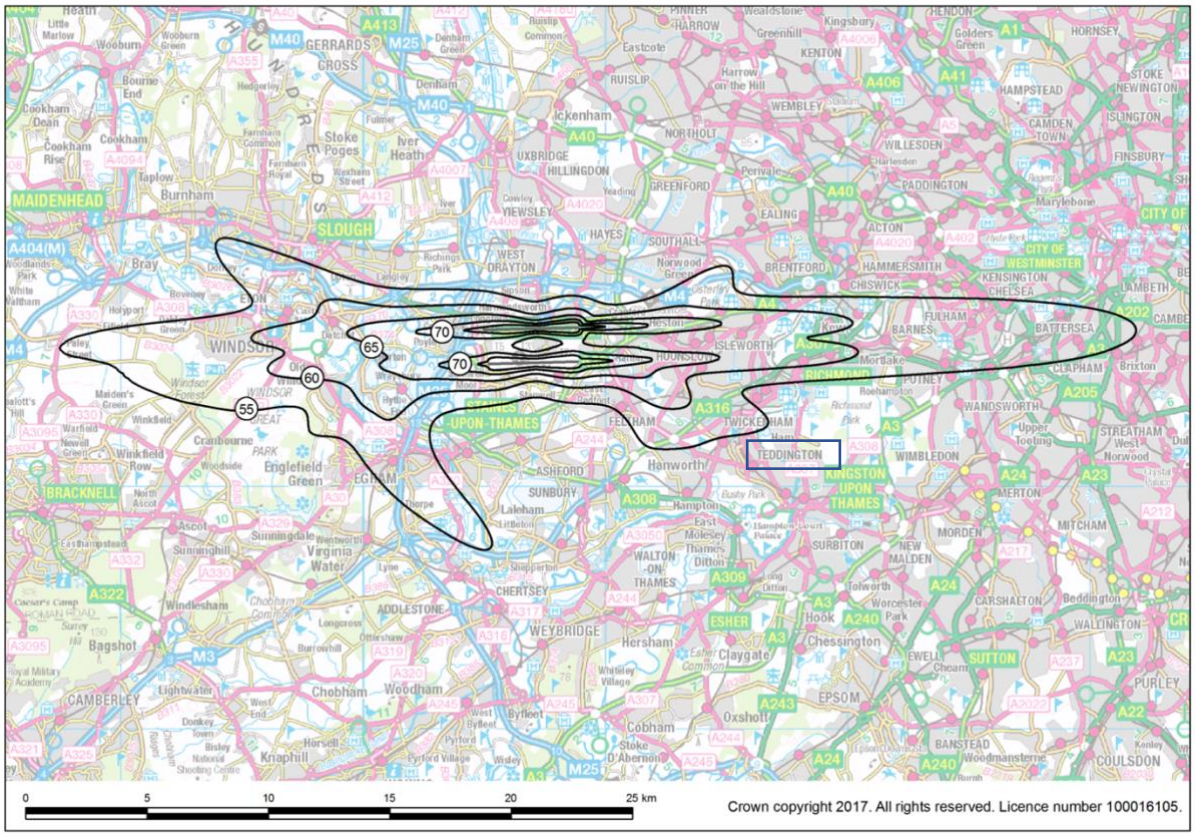


Figure 1. Heathrow Airport, its noise contours and the community of Teddington

(source: Strategic Noise Maps for Heathrow Airport 2016)

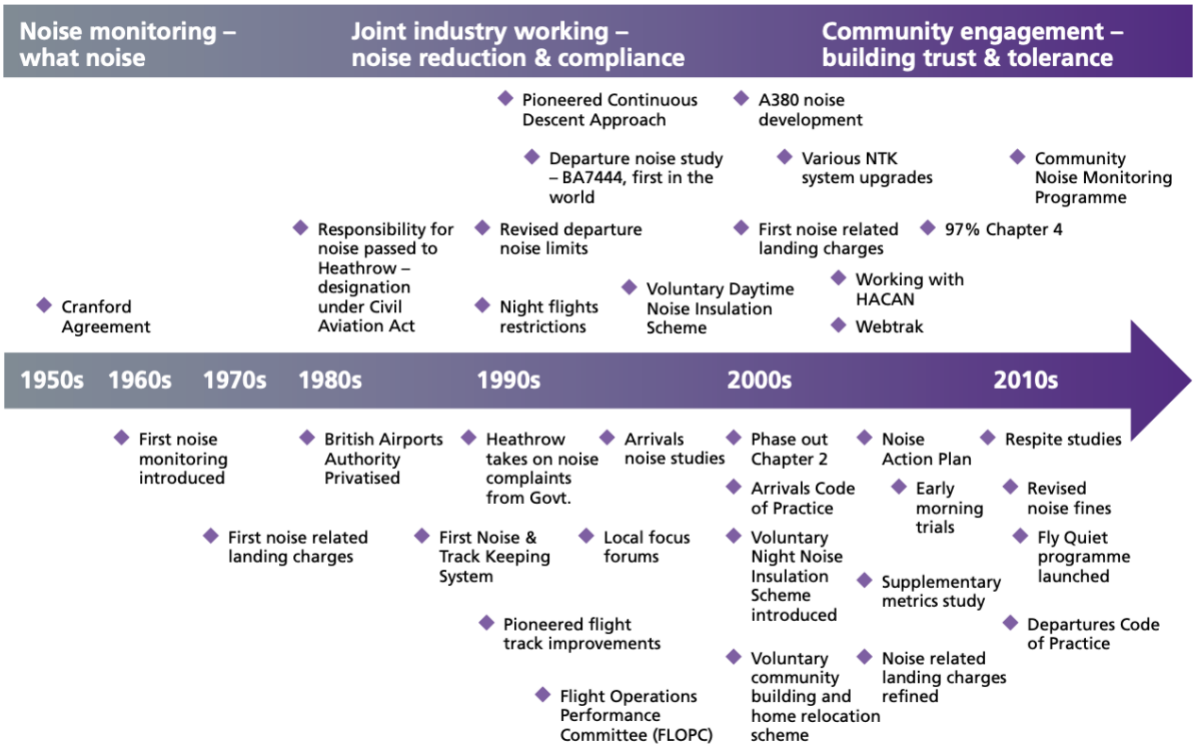
Heathrow is one of three airports designated under section 80 of the Civil Aviation Act 1982, which stipulates that relevant authorities may "specify the maximum number of occasions on which aircraft of descriptions so specified may be permitted to take off or land". For Heathrow this responsibility is held by the Secretary of State. Noise management at the airport is broadly influenced by two primary legislative acts.

Noise has been the primary constraint in Heathrow obtaining permission to develop their third runway. In response they have developed a lead-edge noise management team and today can be considered at the forefront of international efforts to tackle noise, taking a pro-active stance to the issue by accepting that noise is an important issue for local communities, and by demonstrating a long history of noise management interventions, and involvement in research programmes.

Heathrow's strategy towards noise management has been on a continuously evolving journey since the 1950s, beginning with developing an understanding of what their noise impact is (i.e. through the development of noise monitoring), through working in partnership with industry to reduce noise and comply with emerging regulation, towards its modern approach in which building trust and tolerance with its noise effected communities, through varied community engagement programmes.

The first noise implications for Heathrow can be traced back to the 1952 Cranford Agreement, which prevented aircraft from taking off over the village of Cranford except in exceptional circumstances and applied when Heathrow was on easterly operations. Subsequently, the airport began monitoring noise in the 1960's which represented its early attempts to understand it's noise impact. This has evolved to the point where today there are over 50 noise monitoring terminals around the airport, and noise data reported through a number of mechanisms, including in real-time via the website WebTrak[1].

The continued development of Heathrow's approach to noise is visualised in Figure 2.2 below, taken from the airports 2018 document "Our Approach to Noise[2]".



[1] https://webtrak.emsbk.com/lhr4

[2] https://www.heathrowconsultation.com/wp-content/uploads/2018/01/6746-Expansion-Noise-v11-KL.pdf

Figure 2.2: The evolving journey of Heathrow Airport's approach to noise

In the Figure 2.2 it can be seen how over time the airport moved from noise monitoring towards working to actively reduce noise impact, first through the implementation of noise related landing charges in the 1970s, but by the turn of the century including night flight restrictions, revised departure noise limits, voluntary daytime noise insulation schemes, flight track improvements, and the 'pioneering' of the continuous descent approach. The 1990's also saw the airport develop its first local focus forums through which noise could be discussed. This leads to the Heathrow Community Noise Forum (HNCF) being established in 2015, set up in response to local concerns regarding future changes to airspace as a result of the Governments airspace modernisation strategy, which aimed to bring airspace management into the modern era by utilising technology to improve efficiencies, reduce carbon emissions and reduce noise. The forum brings the representatives from local authorities around Heathrow together (NATS, BA, DfT, CAA and Heathrow) in the same room on a bi-monthly basis to discuss noise and to listen to community concerns resulting from airspace changes.

Hence, the airport had been effectively engaged in the four balanced approach elements prior to its official implementation into EU legislation in 2002, as well as worked closely with communities for many years. This demonstrates an increasing focus on non-acoustic factors in recent years, evidence of the airports commitment to being at the forefront of effective noise management and impact mitigation. Indeed, the airport makes explicit reference to non-acoustic factors in the two iterations of its Noise Action Plan. Both Noise Action Plans also refer to the concept of interdependencies, which refer to carbon emissions and air quality implications of the airport's operations. The reports state that operational controls need to be balanced. For example, they give the example of reducing thrust to lessen NOx emissions has the impact of increasing noise lightly for those under the same flightpath. The airport has also been in a number of studies to help investigate interdependencies in detail, and to quantify the most appropriate balance of these issues in specific situations.

Approach to the Balanced Approach

The ICAO Balanced Approach and it's four underpinning principles, as enshrined in European Law under directive 2002/30/EC was implemented in UK law by the Aerodromes (Noise Restrictions) (rules and Procedures) Regulations 2003 (SI 2003/1742). The Environmental Noise Directive (END) was brought into UK law through the Environmental Noise (England) Regulations 2006, with government guidance for airports on creating their noise action plans published by the Government in 2013 (DEFRA, 2013). This guidance stated that plans must be designed to manage noise issues and effects, including noise reduction if necessary and aim to preserve quiet areas in agglomerations.

Prior to the transposition of the END into EU Member State legislation, most large airports in England were already routinely undertaking their own Strategic noise mapping and had also implemented a range of local noise management measures specifically tailored to the size and impact of their operations. It was therefore decided that the relevant Airport Operator should be responsible for producing strategic noise maps (SNMs) and for noise action planning (in consultation with relevant stakeholders) – the exception being Heathrow, Gatwick and Stanstead, for whom the CAA are responsible for strategic noise maps, and who are regulated by the Secretary of State. These airports have consultative committees and any changes to noise control are discussed with them. The Government advises that Noise Action Plans and any other noise measures that are agreed locally should be proportionate to actual noise impacts.

Heathrow operates in line with the Government's overall policy on aviation noise, that is "to limit and, where possible, reduce the number of people in the UK significantly affected by aircraft noise as part of a policy of sharing benefits of noise reduction with industry in support of sustainable development". The overall noise strategy is, however, structured around the ICAO Balanced Approach, which is used as a framework through which good practice can be identified and implemented.

In 2013 the airport produced its 'A Quieter Heathrow' report which established a commitment to operating under the guidance established in the ICAO Balanced approach. This commitment was further established in their 2017 the airport 'Heathrow 2.0' in which the airport set out a high-level approach to noise management, further detailed in the 2013-2018 Noise action plan, produced under the END. In 2018 an updated Noise Action Plan was produced, in line with the requirements of END, with a period of consultation regarding the report closing in July 2018. Throughout all of these documents the airport has placed considerable effort to address all of the Balanced Approach elements, supplemented with a strong focus on communication and engagement with local communities.

Heathrow 2.0 set out a clear vision with three primary goals driving noise management at the airport (balanced approach elements written in bold):

1. To encourage the use of the quietest aircraft available ***(reducing noise at source),*** operated with the least noise impact practicable, within an agreed noise envelope ***(operational procedures and operating restrictions)***.
2. To influence national and international policy and engage with local planning authorities to ensure more effective land planning processes in noise affected areas, and to improve Heathrow's noise mitigation ***(land-use planning)***.
3. To continue to improve the relationship with the local community by working more transparently and collaboratively to develop noise action plans, by improving communications, monitoring, measuring and research capability ***(community engagement).***

Of note here is that three of the balanced approach elements are clearly outlined as important strategic goals for the airport, including reducing noise at source – something which the airport can only influence indirectly, by encouraging airlines to operate (and hence purchase quieter aircraft). Operating restrictions are lacking from explicit reference in these goals, however operating aircraft within an agreed noise envelope has clear implications in terms of restrictions. Moreover, lack of clear reference to operating restrictions is merely in-line with Balanced Approach guidance, which states that restrictions should not be sought as a first option. For community engagement to be listed as part of these goals, it is the evidence that the airport has a high-level understanding of noise management issues, and the importance of maintaining regular, two-way, transparent dialogues with its different stakeholders.

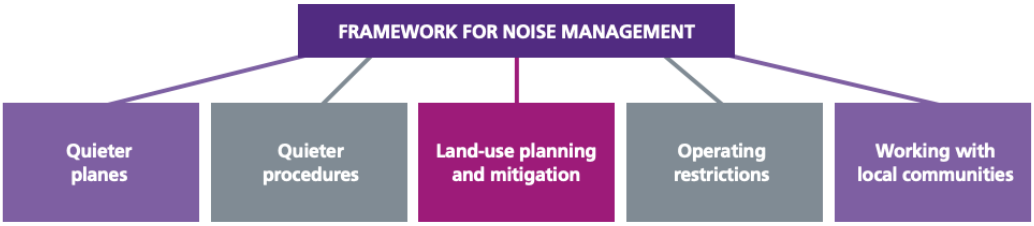
In goal two the airport can also be seen to be engaging with national and international noise policy – as proved by their involvement with ANIMA, and in other research programmes, for example on noise respite[3].

A commitment to engage with local planning authorities is evidence of the Heathrow's desire to drive better land-use planning around the airport. Heathrow's 'A Quieter Heathrow' report states that there were 16% more homes in the 57 decibel L_{eq} noise

[3] https://www.heathrow.com/noise/making-heathrow-quieter/respite-research

contour in 2013 compared to 1991. Responsibility for land-use planning in the UK lies with local authorities, with guidance previously outlined by Planning Policy Guidance 24 – although this was not always enforced. More recently this guidance was replaced by the National Planning Policy Framework (NPPF) which is less explicit about where developments can be built. The airport has committed to pushing the Government for improved guidance and is working with local authorities to focus on the development of businesses and industrial parks around the airport, rather than noise sensitive developments such as housing. The airport's commitment to engage with local authorities shows an eagerness to remain involved with such stakeholders and to find effective solutions to the construction of noise-sensitive building developments around the airport. Goal three demonstrates a high level of commitment to tackling the noise problem, by going beyond balanced approach compliance by contributing to research.

Heathrow's current approach to managing noise can be illustrated through its "Framework for Noise Management", as illustrated in Figure 2.3[4]. Beyond the high-level strategy to noise management, the airports Noise Action Plan clearly outlines a number of specific interventions through which this framework will be delivered – doing so not just by listing actions, but enhancing them with deadlines, Key Performance Indicators, targeted outcomes and impacts, and detail of those who will be affected.



Approach	General commitment
Quieter planes	As aircraft and technology improves and planes become quieter, we will continue to work to ensure that residents share in the benefits. We are committed to continuing to provide a strong financial incentive for airlines to use the quietest planes currently available, including in the early morning period, through the use of variable landing charges.
Quieter procedures	We are committed to take full advantage of opportunities to manage airspace differently, working with local communities to identify changes that could benefit them. This will include trialling new airspace management procedure to test the concept of providing predictable periods of respite from early morning arrivals and for some of our departure routes.
Land-use planning and mitigation	We are committed to continuing to help with noise insulation and mitigation through a range of schemes. We will also continue to press the Government to provide more detailed guidance on planning around airports, and to restrict noise sensitive development in high noise areas.
Operating restrictions	In line with principles of the ICAO Balanced Approach we do not see restrictions as a first resort and are committed to developing collaborative approaches which are often quicker to implement and more effective. For example the voluntary agreement with airlines not to schedule marginally compliant aircraft. Where restrictions are in place we are focused on ensuring that they are adhered to fully, for example in our administration of the night flying restrictions.
Working with local communities	Underpinning all of our work to tackle aircraft noise, we are committed to engaging openly and constructively with local communities to understand their concerns and to provide accessible information and an on-going dialogue.

Figure 2.3: Heathrow Airport's Framework for Noise Management

[4] https://www.heathrowconsultation.com/wp-content/uploads/2018/01/6746-Expansion-Noise-v11-KL.pdf

In total, 55 noise impact interventions were listed in Heathrow's recent draft of Noise Action Plan[5], which was published for public consultation. These interventions are spread across all the Balanced Approach (and community engagement), with eight focusing on noise at source, 18 focusing on operational procedures, eight addressing land-use planning, four related to operating restrictions, and 17 to help the airport work better with local communities. The airport has gone to the effort of including community engagement as a separate pillar – that suggests a strong level of commitment to tackling the noise challenge, and a high-level of awareness of the issues at play in terms of influencing noise impact. Some of the interventions across the Balanced Approach elements are described further in the text. The Noise Action Plan can be broadly summarised through Figure 2.4.

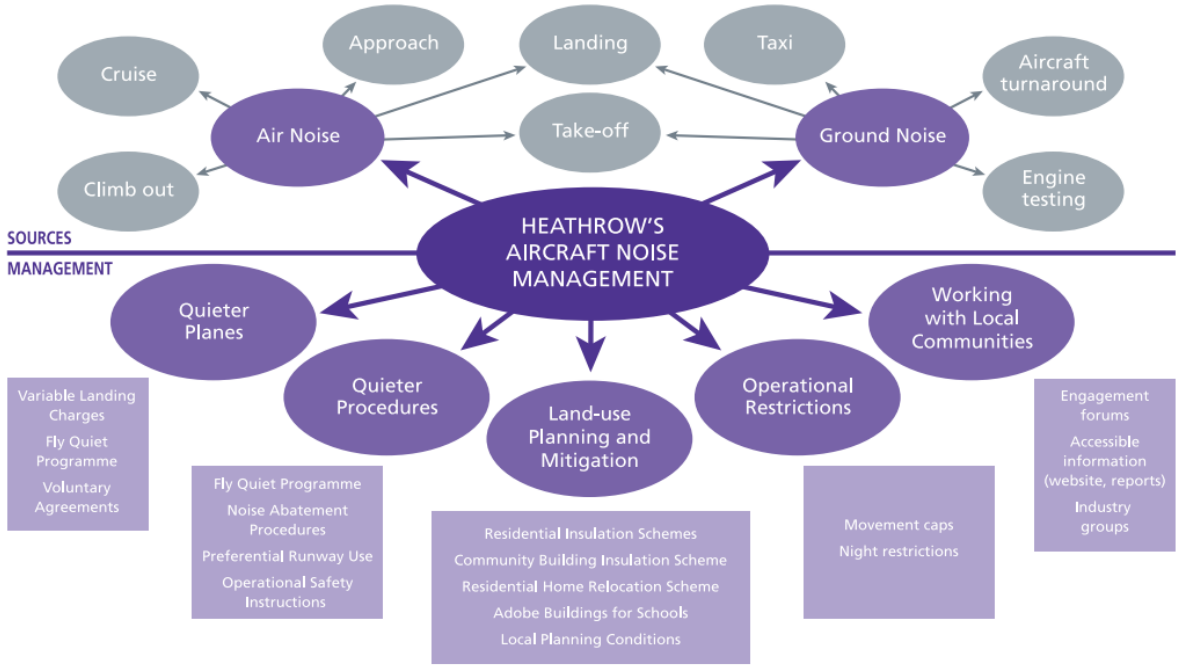


Figure 2.4: Heathrow Airport's approach to noise management

Reducing noise at source

Heathrow has a long-established system of charging for older, noisier variants of aircraft than their newer quieter counterparts. This is based on ICAO noise certification standards and the margin by which a specific aircraft exceeds that standard. Differential landing charges are reviewed annually and the percentage of the aircraft fleet meeting or exceeding this standard is tracked. The airport was the first in UK to introduce charges in relation to Chapter 14 compliance. Charges for compliance are made publicly available on the airport's website. In 2017, over 55% of take-offs and landings were met by aircraft that met or exceeded the Chapter 14 standard. Only one percent of aircraft met the oldest standard (Chapter 3). Such variable landing charges promote the use of "best in class" aircraft using the airport.

The airport also operates a "Fly Quiet and Green Programme", which benchmarks aircraft in terms of noisiness. Results are published quarterly in a league table that enables good

5 https://www.heathrowconsultation.com/wp-content/uploads/2018/05/FINAL-DRAFT-NAP-2019-2023.pdf

performing airlines and those who have been identified to improve. For noise, airlines are ranked against "noise quota per seat", Chapter certification, early or late movements (between 23:30 and 04:30), continuous descent approach violations, and compliance of flying "noise preferential routes".

Operational Procedures

Heathrow airspace is managed with the aim of reducing noise impact (considering interdependencies such as safety, carbon emissions and air quality), doing so by working with local communities to identify potential changes and their impacts. This includes a focus on providing respite to communities from early morning arrivals and on some departure routes. Heathrow defines three broad categories that aim to make operations quieter:

- Making individual aircraft quieter (i.e. by changing thrust settings during take-off and approach);
- Making aircraft higher (i.e. when flying over communities);
- Managing aircraft routes differently (to avoid populated areas).

The airport works with the UK Civil Aviation Authority, NATS and airlines to explore and employ smarter operating procedures that fulfil these objectives, with measures reported by the airport including:

- Aircraft are required to be at a height of not less than 1000 ft AAL (Above Aerodrome Level) at 6.5 km from the start of roll, as measured along the departure track of that aircraft;
- Noise limits are applied at fixed noise monitors for departing aircraft and fines are enforced for breaches;
- Aircraft departing from Heathrow are required to follow specific paths called noise preferential routes (NPRs) up to an altitude of 4000 ft;
- 4% minimum climb gradient between 1000 and 4000 ft;
- Westerly preference on departures to reduce the number of aircraft flying over London;
- Continuous Descent Approaches to reduce noise for communities under arriving aircraft en-route to the final approach;
- Limiting use of reverse thrust at night by arrivals;
- Runway alternation/rotation: During westerly operations, wherever practicable the arrival runway is alternated according to a published schedule;
- Joining point rules: between given times for aircraft approaching specific runways and using the Instrument Landing System (ILS) the aircraft shall not descend on the glide path below a given altitude before being established on the localiser, nor thereafter fly below the glide path;
- Slightly steeper approaches of 3.2 degrees compared to the standard 3 degrees.

Land-use planning

A range of schemes are listed in relation to land-use planning, however, of particular note is the airport's commitment to challenge the Government to provide better guidance on planning around airports, so as to restrict noise sensitive developments being built in high-noise areas. Without such guidance the airport can see their efforts to reduce noise exposure limited as more people move to live within the noise contours that they have been working to reduce.

Interviews conducted as part of ANIMA Diverable D2.1 highlighted that the airport believes there is an **absence of clear national policy on land-use planning**. They have, therefore, committed to press the Government to provide guidance on planning around

airports and to engage with local authorities on local planning strategy, to ensure a more coherent and consistent approach which adheres to the guidance set out in the Noise Policy Statement for England (NPSE) and National Planning Policy Framework (NPPF). This will be tracked together with annual population statistics published with their noise contours. Subject to the definition of Quiet Areas by the government, the airport also works with local authorities, government and local community groups to develop a plan to protect these areas in line with the Aviation Policy Framework (APF), Noise Policy Statement for England (NPSE) and National Planning Policy Framework (NPPF).

The airport engages with local authorities to ensure that aircraft operations are considered in planning applications for noise sensitive developments such as hospitals and schools, who are also offered acoustic insulation if they are exposed to levels of noise of 63dB L_{eq} 16h or more. Other interventions detailed in the Noise Action Plan (2018) include:

- Conducting a review of noise insulation and mitigation schemes;
- Delivering the Quieter Homes Scheme; providing acoustic insulation to resident buildings. This includes full secondary glazing, double glazing, loft insulation and ceiling over-boarding in bedrooms. It is based on the 16 hour 2011 69 L_{eq} contour;
- Expanding a school insulation programme to include ventilation;
- Undertaking a research programme to determine the overall satisfaction of insulation schemes from those who have been in receipt of such programmes;
- Working with local authorities to agree on new local planning guidance, consistent with NPSE and NPPF;
- Identifying new ways to monitor population growth and encroachment to better understand the impacts on noise contours and metrics. This will include working with local authorities to monitor new building developments annually and tracking this with noise population statistics;
- Working with community stakeholders to identify a common position on encroachment and development near the airport and set out this position for the Government;
- Assisting in home relocation scheme, providing eligible home owners with financial assistance with the costs of moving away from areas of high levels of airport noise. For properties that fall within the 2002 69dB A_{Leq} noise contour at Heathrow;
- Assisting in community buildings noise insulation scheme, which offers acoustic insulation to noise-sensitive buildings in the community – hospitals, schools and colleges, nurseries attached to schools and hospices, nursing homes, registered nurseries, libraries and community halls. The scheme provides noise mitigation to the buildings which can extend to window replacement, mechanical ventilation or any other activity related to provision of noise insulation. Eligible community buildings are those that fall within the 2002 63dB A_{Leq} noise contour;
- There is a night noise insulation scheme - based on the noise 'footprint' of the noisiest aircraft regularly operating between 11.30PM–6.00AM in 2004/05 90dBA SEL contours. Since the scheme is intended to mitigate the impact of night flights, rooms eligible for insulation are bedrooms or bedsitting rooms only (which are used as bedrooms on most days of the year).
- Residential day noise insulation scheme provides acoustic insulation to residential buildings in the community. This includes free secondary glazing or half price double glazing plus loft insulation to external windows and doors only. It is restricted to the 18-hour 1994 69dB A_{Leq} noise contour, enhanced to take account of early morning arrival noise.
- Vortex Protection Scheme designed to protect and repair homes around the airport. Includes fixing and maintaining properties near the airport that are susceptible to vortex damage.

- Home Relocation Assistance Scheme which sees Eligible homeowners receive a lump sum of £5,000, plus 1.5% of the sale price of the property (up to a maximum of £12,500) when moving to a quieter area. The scheme applies to residential properties around Heathrow within the 2002 69 decibel L_{eq} noise contour.

Operating restrictions

The airport acknowledges the ICAO Balanced Approach principle of focusing on other elements of noise management before considering restrictions. That said, there is an air traffic movement cap in place of 480,000 movements per year, and night flight restrictions enforced at the airport. The latter has seen the airport work with airlines to not schedule aircraft arriving before 4:30 – this is a voluntary measure and has only been breached in the case of one emergency. A further voluntary measure is not to schedule cargo flights between 11:30PM and 6AM. There are no scheduled flights between 11PM[6] and 4:30AM. Between 11:30PM and 6AM Heathrow is restricted by the Government to 5,800 night-time take-offs and landings a year. Further restrictions apply to the chapter certification of aircraft than can operate – known as a Quota Count. From October 2017, all aircraft movements count towards the movement limit. From October 2018 noise quota limits were reduced to 2,415 in winter (currently 4,080) and 2,735 in summer (currently 5,100), with the aim of securing the benefits of newer, quieter aircraft.

Community Engagement

Supported by the Government's Aviation Policy Framework call to focus on collaboration and transparency, Heathrow has long operated a thorough portfolio of engagement activities with its local communities and other stakeholders. One such group is the Heathrow Community Noise Forum (HCNF), which aims to establish a common level of understanding of Heathrow's operations amongst communities and stakeholders, not least NATS, British Airways, Virgin, the Department for Transport, and the Civil Aviation Authority. The HCNF meets every two months and there are also two working groups which feed into the main

Forum – one is focused on "Monitoring, Research and Policy" and the other focused on "Operating Procedures". Community groups and local authorities are also represented through the bodies like the Heathrow Strategic Noise Advisory Group (HSNAG) and we engage directly with some community groups such as the Richings Park Residents Association.

Communication outside of these forums is driven by the airport's dedicated noise website, which hosts (or links to) numerous tools made available to the public. These include:

- Information on Heathrow's operations (arrivals/departures, wind, night flights);
- Monthly and daily statistics;
- WebTrak – an on-line facility which show aircraft type, flight number, speed, altitude and noise levels at over 40 noise monitors;
- xPlane – a web-based tool for residents to access flight data based on their specifications;
- WebTrak My Neighbourhood, which provides a broader view of how often particular flight paths are generally used on a monthly, quarterly or yearly basis;
- Reports, HCNF meeting notes and presentations, annual and quarterly performance reports.

The airport also operates a dedicated Twitter service to provide real-time runway updates for those in noise affected areas. The airport runs a Community Trust Fund which is funded

[6] There is one flight at 2310.

from noise track infringements (http://www.heathrowcommunityfund.com/). The fund generates approximately £80,000 - £90,000 per year, with awards for individual projects being between £500 and £2,500. Projects typically include youth programmes (e.g. funding a scout troop to go hiking), biodiversity programmes (e.g. Transforming an unused area into a wilderness garden), and community neighbourhood activities (e.g. an artwork trail produced by people with emotional difficulties, hampered by isolation, social deprivation and exclusion).

Regarding complaints, the airport has a dedicated noise complaints website form, email address and free-phone number. Complaints handling is supported by a three page complaints handling policy document. Complaint information regarding noise is easily found on the airport website in a dedicated section. The Operational Data website is also linked where complaints data can be viewed. A key performance indicator of the airports noise action plan is to respond to all noise complaints within five working days. All complaints are reported daily on the Heathrow Operational Data website, in the airport's quarterly Flight Performance Reports and to the Heathrow Airport Consultative Committee (HACC). Complaints are monitored for trends to inform the airports noise management priorities, but flight paths are not changed purely on the basis of the number of complaints received from a particular area.

Future priorities

Based on an analysis of its noise contours and affected populations, Heathrow has highlighted a number of areas that are central to noise management during the period of its soon to be announced noise action plan (2019-2023). These are:

- Continuing to encourage ever-quieter aircraft using Heathrow;
- Implementing noise abatement procedures in greater consistency and working on new opportunities when possible;
- Delivering the quiet night charter to support predictable operations, fewer off-schedule movements, greater transparency and quieter operations;
- Continuing working with local authorities to avoid encroachment and reducing the number of dwellings and people living in the highest noise areas;
- Reviewing and delivering sound insulation whilst working to ensure that new homes are built with appropriate insulation ratings; and
- Improving the management of noise from ground-based sources, including monitoring and mitigation.

Case Study (Operational Procedures): Heathrow DET09 Steeper Departure Trial

The intention of introducing this case study is to investigate the processes that underpin best practice at London Heathrow and provide context surrounding the actions undertaken, and decisions made in reducing noise impact. This process takes the airport from an initial awareness of a noise problem or requirement for change, through to the design of interventions, the selection of an appropriate intervention option, and its subsequent implementation, and post-implementation evaluation.

Aircraft leaving Heathrow are required to be at an altitude of at least 1000ft, 6.5 km after the start of their take-off roll (UK AIP EGLL AD 2.21). From this point, they are required to maintain a gradient of at least 4% until reaching 4000ft AAL. This is not a part of the standard Instrument Flight Procedure (IFD), rather it is something implemented by the airport for noise abatement purposes to ensure that noise is progressively reduced along the ground (see Figure 2.5).

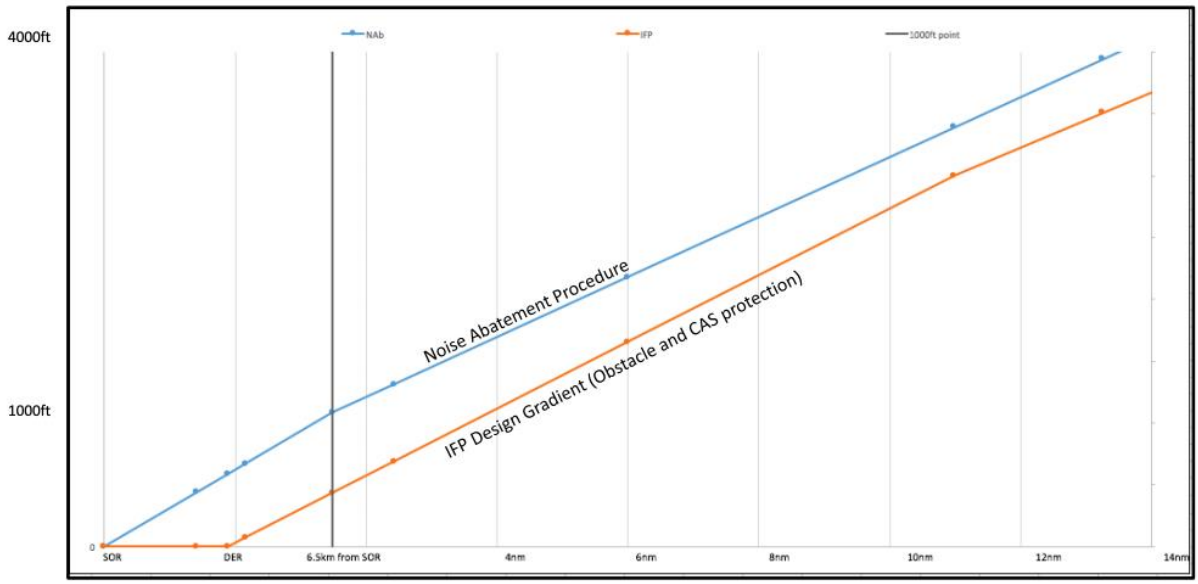


Figure 2.5 Illustrating how the airport's noise abatement procedure results in aircraft being higher than they would be following the IFP design gradient

Although this gradient has existed for many decades, technology to monitor compliance has been invented only recently, with Heathrow only collecting and reporting data since January 2017, as part of the airports regular flight performance reporting. The overall compliance rate in 2017 was 99.8%, with the majority of compliance failures being due to A380 operations.

The roots of this intervention can be traced to when the community of Teddington (approximately 9 km South East of Heathrow) raised concerns with Heathrow Community Noise Forum. The community group 'Teddington Action Group' (TAG) believed that a gradual decrease in climb performance on the DET 09R departures route had occurred over previous years which had led to aircraft flying lower over their community. Moreover, the group had noted that the minimum departure gradient at Heathrow of 4% was somewhat lower than that found at other large airports. In response they requested that this minimum departure gradient for DET 09R departures be increased to reduce noise exposure over the Teddington Community. The location of Teddington in relation to Heathrow, can be seen in Figure 2.6.

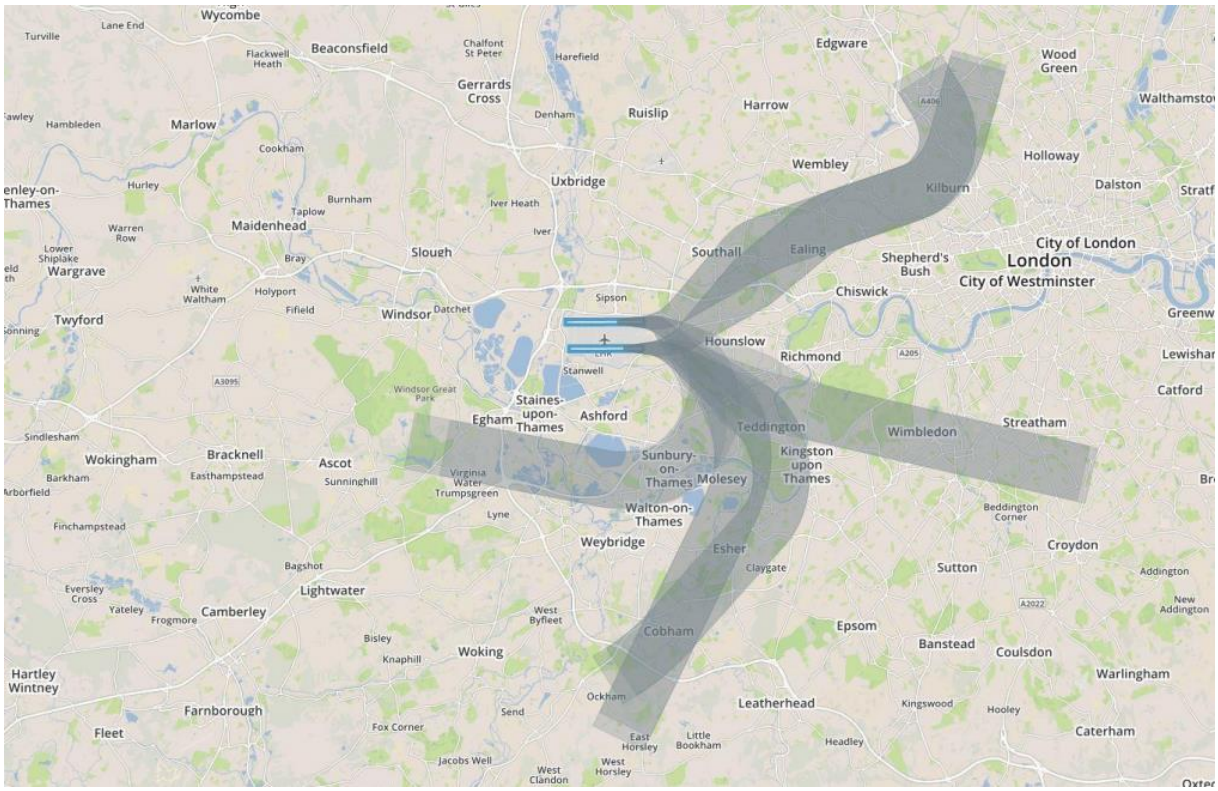


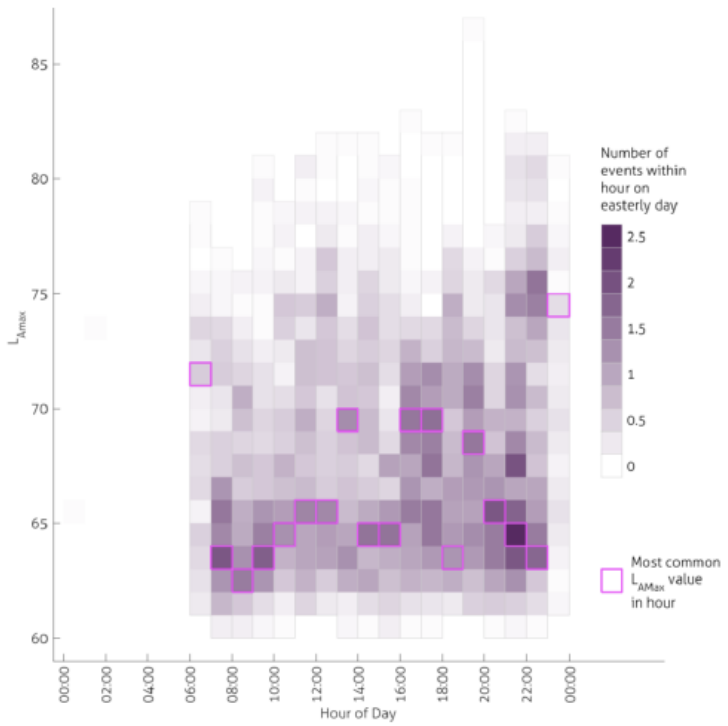
Figure 2.6. Location of Teddington in relation to London Heathrow, including the flight paths overflying the community

Heathrow has a long-standing commitment to developing its capacity to effectively communicate noise to its stakeholders, and has demonstrated an awareness that different stakeholders want to know different matters and, hence, require different types of information (explained to them through a variety of different ways – as appropriate to their comprehension of aviation noise). The report published for the Teddington community about noise in their area[7] is a useful example to help demonstrate this commitment. For instance, it describes:

- How wind direction affects aircraft operations (describing the rationale behind Westerly and Easterly operations);
- Flight path analysis (over which areas aircraft are flying);
- Operational and gate analysis data;
- Measured noise data and levels in the community;
- Overview of flight track data and changes over time;
- Changes to the concentration of flights (location on the ground and altitude);
- Changes to the fleet mix;
- Overview of noise monitoring data:
  - loudness and duration of aircraft events;
  - types of aircraft responsible, average maximum noise levels (LA_{max}) for different aircraft;
  - average Sound Event Levels (SELs);
  - numbers of noise events over different levels (N60, N65, N70);

7 https://www.heathrow.com/file_source/HeathrowNoise/Static/CIR_NPL_Teddington_0815_0316.pdf

- average minutes an hour where monitoring thresholds were exceeded;
- contribution to ambient noise level;
- Longer-term average daytime (LA_{eq}, 16hr/N65) and Night-time (LA_{eh}, 8h, N60) noise levels.



The number of events per hour on easterly day

This case provides an interesting example – already established engagement platforms helped the airport to recognise community concerns regarding the DET09R flight path. The community was able to raise its concerns about aircraft departure profiles by approaching the HCNF directly and making these concerns clear to airport representatives and industry stakeholders. This is a clear example of the importance of airports establishing such community engagement platforms, and importantly, to ensure that they provide for a two-way dialogue, as to merely speaking to communities in an attempt to raise their awareness of airport activities.

The airport took a pragmatic approach to these concerns, firstly, by listening to the community groups, and, secondly, by looking to validate their concerns through extensive testing and analysis of flight track data. Multiple studies were conducted and were found to broadly support the views of the HCNF members. Aircraft were outperforming the Instrument Flight Procedure (IFP) climb gradient. Approximately 99.7% of departures adhere to the current 1000ft Noise Abatement requirement, with 99% then adhering to the 4% to 4000ft requirement. However, the analysis also showed that whilst all heavy departures climbed in excess of the minimum departure gradient at some point between 1000ft and 4000ft, approximately 17% were, at some point, climbing at shallower gradients. This is thought to be largely down to the differing Noise Abatement Departure Procedures being executed by a mix of airlines and aircraft types. Other findings included that:

- There was an increase in A380 departures from Heathrow;
- There had been approximately 30 more DET09 departures per day;
- There was a small increase in concentration along SID centrelines;

- There was a small decrease in climb performance (210ft);
- The claimed noise benefits of the A380 were not being realised by overflown communities;
- Departures significantly outperform Instrument Flight Procedure (IFP) climb gradient of the standard instrument departure (SID);
- Aircraft were now concentrated in two distinct swathes rather than one;
- Daytime average aircraft noise levels had not changed substantially between 2011 and 2015, but that there was up to seven additional noise events per day (where L_{AMAX} was greater than 65dB).
- There had been approximately 1dB (L_{Aeq}, 8h from 23:00 to 07:00) increase in night noise, with no significant increase in the number of individual events.

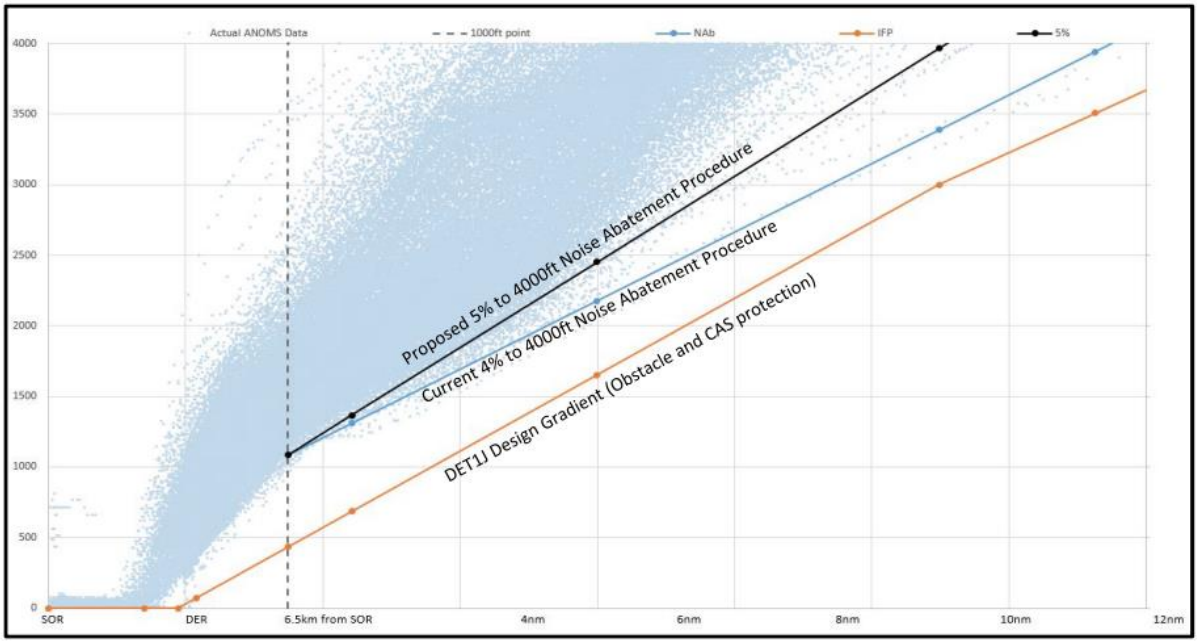


Figure 2.7. Illustration of the results of the analysis, showing how the vast majority of flights were well in exceedance of the 4% and 5% departure gradients (source: Teddington Community Noise Information Report)

The conclusions of this testing were made publicly available through a number of publications, including the Teddington Community Noise Information Report. This document is an excellent example of lead-edge noise data communication. It clearly states its objectives, methodologies and displays its findings through a wide range of novel metrics. This document is clear evidence that the concerns raised by the community group had been taken seriously by the airport, and that the airport had made the effort to communicate noise data clearly and transparently.

The report was based on data collected from noise monitoring terminals in the area and on the Heathrow INM model – for the wider geographical area. The airport uses the INM model as its primary tool for noise modelling, however, they acknowledged that modelling is complementary to monitoring and should not be used exclusively. For this reason, data was also assessed from the airport's existing noise monitors in the area.

This analysis showed that community concerns were to extent valid, but that these concerns were only in association with a limited number of aircraft, namely "heavy" and "super-heavy" aircraft such as the A380.

Following the analysis of the monitoring and modelling data, the decision was made to increase the minimum departure gradient for aircraft following the Detling departure route from 4% to 5%. Increasing the departure profile in this way was seen as an optimal solution in that it would demonstrate positive action to the local community, address the small number of non-compliant and underperforming heavy aircraft, but have relatively minimal impact to the majority of flights which were operating well in exceedance of the both the 4% and 5% gradients. The local communities had desired an even steeper departure gradient, however, operational factors (technical feasibility and trade-offs with changes to noise exposure and interdependencies) meant that this request's implementation would not be possible. Increasing the gradient from 4% to 5% would, however, ensure that larger aircraft would be encouraged to fly higher. Impacts in terms of extra fuel burn, engine wear and emissions were all considered when selecting the 5% gradient. Negative implications for noise were also considered as steeper departure profiles result in greater noise near the start of roll and to the side of departure route centrelines. Noise data was communicated to residents via a number of reports, made publicly available on the www.Heathrow.com/noise website.

In terms of interdependencies, the CAA made it clear that any changes made to the departure profile would not be allowed to result in an increase in emissions below 1000ft (hence another reason why the 5% departure profile was selected – steeper profiles would not have been in compliance). Safety was also a concern as it is the main priority underpinning all operations at Heathrow. A joint risk assessment was held with airlines and NATS to determine any other operational impacts. It determined that a steeper departure would have affected the flow of aircraft leaving the airport as steeper climbing results in slower speeds. Moreover, aircraft that would not be able to meet steeper profiles would need accounting for and would also cause significant logistical issues. Steeper climbs also meant that aircraft would reach 600ft more quickly (the restriction altitude for Heathrow SIDs). The airport had to consider how this would interact with other airports' routes and how that is affecting continuous climb operations.

Rather than go immediately ahead with implementing the new departure gradient as part of their SID, Heathrow decided to first trial the new procedure. This decision was made based on an awareness that changes to a flight path would have implications in terms of interdependencies – namely, fuel burn, emissions, safety, and changes to the distribution of noise along the ground based on the fact that changes to operational procedures do not reduce noise, but rather move it into different places. The suspicion here would be that whilst a steeper departure profile would reduce noise exposure in the Teddington community, it would increase noise closer to the runway, and along the side lines of the flight path. This is clear evidence of a high-level of knowledge about noise distribution and the consideration of interdependencies in the noise management process.

The trial allowed Heathrow to analyse the variance in noise profiles associated with different airline Noise Abatement Departure Procedures which are Standard Operating Procedures (SOPs) not within the control of the airport. At the same time, it enabled a detailed comparison and comprehensive environmental and operational analysis of aircraft operating on the DET 1J (09R) SID before and after the introduction of a steeper IFP design gradient. For comparison, data was collected during a pre-trial (January-December 2017) and in-trial (January-December 2018) period, with an interim report compiled in July 2018. An annual period was selected for the trial in recognition of the fact that prevailing meteorological conditions at Heathrow mean that Easterly operations occur approximately 30% of the time, however, this can vary. For reliability in the study, it was decided that if by 30th September 2018, the number of easterly days of operation was not at least 70% of the size of the number of easterly days over the same period in 2017, the trial would be extended beyond the 5th January 2019. Eventually, it was not required. Safety

implications of the trials were taken into consideration via a Hazard Analysis forum held at NATS (Swanwick) on 31 March 2017.

Two years before the trials began, the airport commenced its standard stakeholder liaison process. This process is a robust communications plan, particularly considering that over 90 airlines fly from Heathrow. Along with the airlines, Heathrow consulted the UK CAA and the DfT (their regulatory authorities). As a study that had not previously been undertaken, they also consulted with the UK Flight Safety Committee and other safety related forums. Regarding local communities, communication was held between the airports deafferent Consultative Committees – i.e. the Heathrow Community Noise Forum, and other working groups (such as the Teddington Noise Action Group). In planning the procedure, the airport also collaborated with NATS, who played a key role in its development. Results from the trials will be fed to all the above parties and the Sustainable Aviation Operations Improvement Group. Information will also be fed to EUROCONTROL.

Engaged communities resisted the 1% increase in departure gradient (demanded more), stating that they believed it was unambitious. As a result, the airport embarked on a campaign to explain the reasons why steeper gradients were not achievable. In response, communities highlighted that steeper gradients had been achieved at other airports, however, this demonstrated a lack of understanding of where those gradients were measured and they cannot be compared to Heathrow. For instance, Paris is often cited as having a 6.5% departure gradient, however, Paris measures its gradient from a different point on the ground, nor do they monitor airline adherence to the profile. Heathrow believes that on a like to like basis their gradient is actually higher than the one of Paris.

Communities were not presented with a suite of different options regarding the intervention because of the specific circumstances (interdependencies) surrounding the intervention (and the fact that the airport was responding directly to a community request by increasing the departure profile as requested). Increasing to steeper departure profiles would have required changes to NADP procedures which the airport did not see as viable, hence this increasing to a 5% profile was seen as the only possible option.

An additional 11 noise monitoring terminals (NMT) were deployed in the region to help capture data with a high level of granularity, bringing the total number of terminals in the area to 20. The purpose of increasing the number of NMTs is to enable the gathering of pre-trial and trial datasets which are large and diverse enough to fully understand the distribution and density of noise energy underneath and to the side of the DET departure route. This was important as a report from the CAA suggested that steeper departure profiles would increase noise at the side lines of the flight path, and increase the duration of the noise event for everybody[8].

Data collection began on 1 January 2017 and took place by gathering Airport Noise Monitoring and Management (ANOMS) data of aircraft using the extant DET 1J SID as well as from the existing Noise Monitoring Terminals and the additional NMTs deployed to the area.

The trial aims to gather aircraft performance and noise data for a pre-trial period and an in-trial period so that changes to noise distribution, and its interdependencies could be evaluated, by enabling a detailed comparison and comprehensive environmental and operational analysis of aircraft operating on the DET 1J (09R) SID before and after the

8 https://publicapps.caa.co.uk/docs/33/20180719%20CAP1691a%20Departure%20Noise%20Mitigation%20Summary%20Report.pdf

introduction of a steeper IFP design gradient. This detailed analysis of the operation of a vertical departure profile will be the first of its kind within the United Kingdom.

Aircraft crews were engaged via the airlines before the trials began to understand their capacities to deal with the new departure profile and to help shape the trials and what would be expected of the crews.

The objectives of the trial are outlined in Table 1, with success criteria outlined in Table 2. A reversion process put in place to ensure that if the trial went wrong in attempting to accomplish these objectives (i.e. massive noise increase or safety concerns) that the airport could revert back to the old SID quickly.

Table 1: Objectives of the Detling Departure Trials

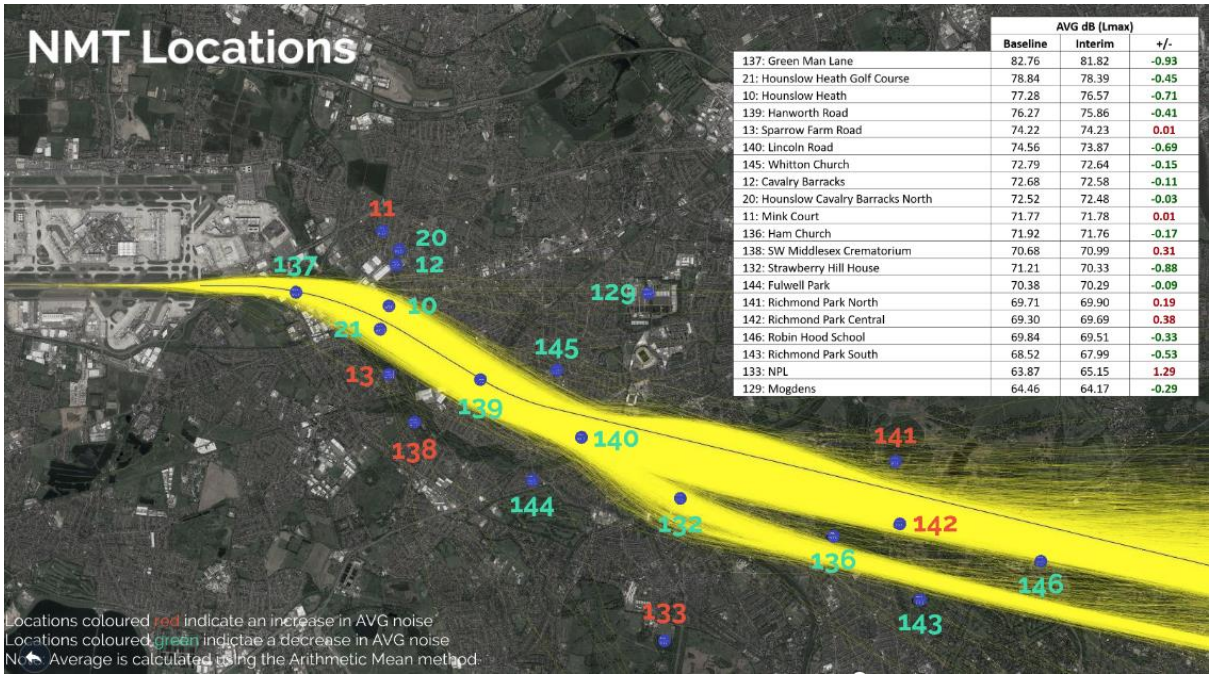
Objectives	**Method of Verification**
Understand the change in noise distribution associated with aircraft climb gradients.	NMT measurements, ANOMS data
Validate the modelled variation in noise distribution attributed to differing airline NADP procedures	NMT measurements to validate industry theory of how aircraft noise is distributed as a result of aircraft climb gradients. ANOMS data
Gather sufficient data against which to compare baseline and trial findings across a wide range of meteorological and aircraft operating conditions and aircraft types	Total number of DET 2Z departures in 2018 is at least 70% of the total number of DET 1J departures in 2017 Total number of Heavy/Super Heavy DET 2Z departures is at least 80% of the number of Heavy/Super Heavy DET 1J departures in 2017
Ensure the trial gradient results in an actual change in aircraft climb performance	Pre-trial analysis and 12-month baseline/trial periods
Enable a steeper SID trial without dictating a change in airline NADP procedure(s)	The trial does not dictate a change in NADP procedure Qualitative unless airlines willing to share quantitative data. Airline workshops
Understand the impact of a steeper SID gradient on airline operations (engine wear/fuel burn/SOPs)	Qualitative unless airlines willing to share quantitative data. Airline workshops
Understand any impacts on Local Air Quality as a result of the steeper SID	Should airlines report a change in thrust settings below 1000ft, Heathrow will perform a Local Air Quality assessment
Understand all the consequences of increasing the height of aircraft on departure over specific communities. (Similar requests have been made of Heathrow by other industry members for airspace design purposes)	Final report detailing changes in noise distribution and operational consequences

Support the establishment of future airspace design principles for Heathrow Airport, shared with industry via FASIIG	Final Report

Table 2: Success criteria for the Detling Departure Trials

Criteria	**Method of Verification**
The trial has not had any direct impact on the safety of aircraft and/or Heathrow operations	No MORs filed with resultant investigation finding DET 2Z a contributory factor
Total number of DET 2Z departures in 2018 is at least 70% of the total number of DET 1J departures in 2017	Data collection – Trial extension procedure
Total number of Heavy/Super Heavy DET 2Z departures is at least 80% of the number of Heavy/Super Heavy DET 1J departures in 2017	Data collection – Trial extension procedure
Sufficient good quality data has been collected for aircraft operations as well as from the noise monitors so as to allow for understanding changes in noise distribution as a direct result of an increased climb gradient	Final Report findings
The trial has not had a detrimental effect on local air quality	If an airline reports an increase in thrust settings on departure as a result of DET 2Z it will trigger a Local Air Quality assessment.

Initial results from the trials (January - July 2018) found that Heathrow's aircraft movements grew by 5.7% and cargo by 2.2%, with a 10% increase in Easterly departures (45% from 35%) and departures increasing from 9,816 to 13,773. Heavy departures (i.e. those previously underperforming over the Delting flight path) increased from 3,999 to 5,393 movements. Only 0.52% of aircraft did not maintain the desired 5% climb gradient – down from 0.72% in the same period in the previous year. Findings from the trials have broadly demonstrated a success, with the majority of aircraft flying at higher altitudes than during the baseline period. Moreover, as illustrated in Figure 2.8, 14 of the 20 NMTs showed a reduction in average dB(max) – albeit the benefits were mostly marginal. Of the six NMTS to experience an increase in average dB(max), all but one was located on the side lines of aircraft noise exposure cones (i.e. the extremes of noise exposure). Essentially, the noise contours along the Detling departure route became shorter and fatter. This outcome was predicted by the airports.



	AVG dB (Lmax)		
	Baseline	Interim	+/-
137: Green Man Lane	82.76	81.82	-0.93
21: Hounslow Heath Golf Course	78.84	78.39	-0.45
10: Hounslow Heath	77.28	76.57	-0.71
139: Hanworth Road	76.27	75.86	-0.41
13: Sparrow Farm Road	74.22	74.23	0.01
140: Lincoln Road	74.56	73.87	-0.69
145: Whitton Church	72.79	72.64	-0.15
12: Cavalry Barracks	72.68	72.58	-0.11
20: Hounslow Cavalry Barracks North	72.52	72.48	-0.03
11: Mink Court	71.77	71.78	0.01
136: Ham Church	71.92	71.76	-0.17
138: SW Middlesex Crematorium	70.68	70.99	0.31
132: Strawberry Hill House	71.21	70.33	-0.88
144: Fulwell Park	70.38	70.29	-0.09
141: Richmond Park North	69.71	69.90	0.19
142: Richmond Park Central	69.30	69.69	0.38
146: Robin Hood School	69.84	69.51	-0.33
143: Richmond Park South	68.52	67.99	-0.53
133: NPL	63.87	65.15	1.29
129: Mogdens	64.46	64.17	-0.29

Figure 2.8: Location of Noise Monitoring Terminals and differences in AVG dB (max) between the baseline period and interim trial results.

One aspect of the trials was to understand the implications of slower speed associated with steeper climbing (impacting the "flow" of aircraft departing the airport). The impacts of this are currently under analysis. During the trials it also became apparent that some aircraft gave crews an indication of whether the aircraft could successfully make the departure profile whereas some aircraft did not give an indication until the aircraft became airborne. This presented a new operational challenge that had to be considered. Another impact of the intervention was that a new SID name for the trials required an Electronic Flight Progress Strip change.

Following the above described processes, modelling and regulatory procedures have ensured a safe and successful trial. Success was determined through the array of class-one microphones and monitoring stations deployed around the airport and the subsequent analysis of collected data. A final report documenting the results of the trials is in the process of being written, once full and detailed analysis of the data has been completed. The interim trial report data showed that the impacts of the new procedure were broadly in line with what was expected. The limits and tolerances of aircraft flight management systems and been learned and the airport are in the process of feeding in airline data to understand fuel flows, implications for interdependencies, and associated fuel costs.

No qualitative analysis (for instance, regarding non-acoustic factors) is taking place with communities.

Summary

As the first such study of its kind in the world, the Detling Steeper Departure Trials can be seen as a leading example of an operational procedure intervention. A community concern was escalated to airport management via existing communication channels. This concern was listened to and acted upon via the airport, with such action involving a wide range of industry stakeholders and considering a raft of interdependencies throughout. The trials were established by initial data modelling and analysis of noise monitoring data (with

results given back to the community), which validated community concerns and calls for an increase in the steeper departure gradient. A range of novel communication methods were used to help describe noise to community members. This led to a year-long trial being conducted to ascertain the full implications of implementing a steeper minimum departure gradient which involved the following cooperation and collaboration of industry stakeholders (airlines, NATS, CAA, DfT, and Safety regulators). Currently, there are no existing plans to assess the impact of the new departure routes in terms of impacts on quality of life of the Teddington residents, however existing communication channels will ensure that any concerns can be captured going forward.