Airports Commission Discussion Paper 05

AVIATION NOISE

SUBMISSION BY THE RICHMOND HEATHROW CAMPAIGN

September 2013

This submission is the response from the Richmond Heathrow Campaign (RHC) to the Airports Commission's *Discussion Document 05: Aviation Noise*. We do not consider that the contents are confidential and we have no objections to its publication.

Richmond Heathrow Campaign

The Richmond Heathrow Campaign represents three amenity groups in the London Borough of Richmond upon Thames: The Richmond Society, The Friends of Richmond Green, and the Kew Society which together have over 2000 members. The members of our amenity groups are adversely affected by noise from Heathrow Airport's flight paths, particularly at night. Noise levels around Heathrow are too high and while the trend is for quieter aircraft the reduction in noise levels in recent years has been slow and offset by more flights. We favour a ban on air traffic at night at Heathrow. We are opposed to the introduction of mixed mode and to the development of additional runways at Heathrow. We nevertheless recognise the importance of air transport and the need to make a positive contribution to the Airport Commission's work.

Scope of Our Response

Our response focuses on aircraft noise arising from Heathrow flights over west London and particularly over the London Borough of Richmond upon Thames because this forms our knowledge base and is the prime interest of our members.

RHC has submitted to the Airports Commission both short/medium term proposals and longer term proposals which encourage better use of existing airport capacity so as to provide for, inter alia, passenger growth without runway growth over the foreseeable future. Noise from Heathrow air traffic is the reason for RHC's existence and our response here is based on the premise that existing noise levels are too high and are reducing too slowly and this situation can only be exacerbated by new runways at Heathrow. The response supports our earlier proposals and responses to the Discussion Papers.

We have given preliminary examination to the various short/medium term and six longer term proposals for Heathrow recently submitted to the Airports Commission by other parties. Our response here is not proposal specific and we intend making comments on noise and other issues specifically in reference to the proposals by 27 September, as invited by the Commission.

We are not experts on noise other than perhaps as witness to its impact in our area and community. Where we have used technical terms it is in aid of discussion rather than providing scientifically assessed evidence or evaluation. The Annex contains definitions of the key terms used. Where we refer to noise levels these are outside levels unless otherwise stated. The Airports Commission and/or others might develop the material presented if it is thought this would be helpful and we would be pleased to assist.

Key Issues

- Clarification and development of the aviation National Policy Framework ("NPF") noise objectives, and in particular the need to set aviation noise reduction targets and timetable to reduce noise to World Health Organisation ("WHO") guideline limits. Existing noise levels are far too high,

- The impact of aircraft noise is usefully considered in terms of the impact of (a) a single noise event (i.e. a flight) on humans, (b) multiple noise events from a single source (i.e. several flights) taking account of the number and pattern of events including respite, and (c) multiple noise sources (i.e. flight paths) and the significant reduction in respite as a result of cumulative low level noise from several sources and an increasing number of flights,

- The properties of noise mean there is a wide variation in type and intensity of impact from different noise sources; aircraft noise is significantly worse than road noise, which is sometimes disputed.

- Conjoint analysis, widely used in marketing and social sciences, might be used as a technique to assess and quantify peoples' subjective responses to different properties of noise,

- Noise metrics that use averaging are deficient. We suggest some new metrics to reduce the averaging effect and facilitate assessment of respite; in particular, metrics for each of the two half days of runway alternation. Night time metrics that average occasional flights between 11pm and 4:30am, 16 flights between 4:30am and 6am and around 60 flights between 6am and 7am are deficient.

- We doubt there is a noise threshold for "significant annoyance" but instead a continuum of increasing unpleasantness of noise as the noise level and other noise properties intensify above background levels. We suggest there is a band of tolerance above which any additional noise is unacceptable, as subjectively determined by each person. The 57 dB(A) $Leq_{16,}$ which was designed as an annoyance threshold, does not reflect all the properties of noise nor levels of unpleasantness and tolerance, and in any event is too high as a standard.

- Vertical sections depicting noise on north-south axes provide a more meaningful description of noise for individuals on the ground than contours; they provide a ground-up rather than top-down approach. They facilitate assessment of changes in noise climate over time as the result of improvements from aircraft performance offset by new runways, etc. They provide a basis for sharing the benefits of noise reduction and costs of growth, as sought by the NPF.

- Noise contours and population numbers effected are deficient metrics and are given more prominence by the aviation industry than is justified,

- A doubling of passengers by 2050 will require noise per passenger to be halved just to avoid an increase in noise let alone an advance towards WHO guideline limits. We recommend fewer flights with higher loads and larger aircraft rather than more flights but the relative benefit needs to be quantified.

- Background or ambient noise levels vary, ranging from quiet areas to town centres, and they are important in establishing the absolute and relative noise impact from aircraft. Kew Gardens, which is potentially a tranquil area, provides respite but is especially vulnerable to aircraft noise.

- Other sources of annoyance, such as anti-social behaviour in towns, are not usually added to the impact of aircraft noise, thus understating the overall impact of disturbance on peoples' quality of life. Evening economies that close down at 2am leave an inadequate window of quiet before first flights at 4:30am.

- Night Noise. The next 5 Year Night Flight Regime should commit to a phased extension of a no flight period resulting over time in a total ban on night flights between 11pm and 7am.

Noise Objectives

We give qualified support to the Government's high level noise objectives as stated in the recent Aviation Policy Framework and quoted in para 1.3 of the Discussion Paper, namely:

A. The government's primary objective is to limit and where possible reduce the number of people significantly affected by aircraft noise;
B. The Government wants to strike a fair balance between the negative impacts of noise and the positive economic impacts of flights; and
C. As a general principle, any benefits from future improvements in aircraft noise performance should be shared between the aviation industry and local communities.

We believe however that the objectives need further clarification and development:

1. In addition to reducing the number of people significantly affected (objective "A") the impact on those that remain affected should be reduced and we do not mean just those "significantly" affected. As discussed later we are not convinced by the widely adopted concept of a threshold and cumulative moderate levels of annoyance and harm need to be addressed.

2. Noise exposure can be concentrated on relatively few people or dispersed and the number of people affected (objective "A") should not be relied on as the only criteria to assess and manage overall noise impact. We believe this criteria is being given too much weight by the aviation industry and we examine other criteria later.

3. Existing noise impacts are too high and we believe objective "A" is inadequate in merely "limiting" noise impact to current levels or only providing the "possibility" of reduction. There needs to be targeted reduction of noise impact towards WHO guideline limits over a defined period of time.

4. For clarification we interpret "improvements in aircraft noise performance" stated in objective "C" as referring not just to quieter aircraft but to operations including steeper glide slope, runway displacement, etc.

5. When balancing the benefits of growth, as envisaged by objective "B" the resultant noise cost should be compared to the gross noise reduction from improved performance as stated in "C" so that the relative industry and community shares are transparent. Relying on a net reduction, as we often see in proposals, fails to disclose the sharing of cost and benefit between interested parties. We explore this point later.

6. In project assessments (e.g. for a new runway) it is important that reductions in noise are only attributed to the project if they arise from that project. For example, noise reduction from steeper glide paths that are not dependent on a new runway should not be netted off against the noise cost arising from additional flights. They are a benefit attributable to the existing operations. This misrepresentation occurs in proposals we have examined.

The Meaning of Noise and its Impact

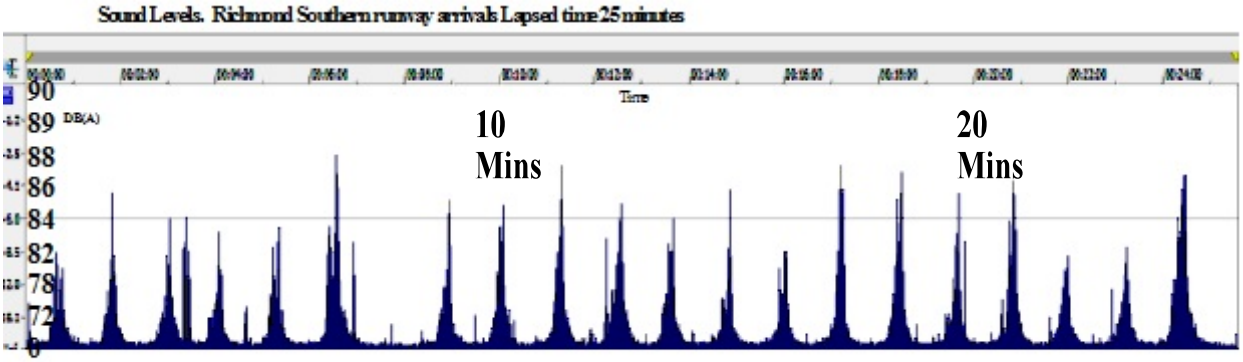
A major proportion of our response concerns what is meant by "significantly affected by aircraft noise" in objective "A" above. Noise is defined by WHO as unwanted sound. The Discussion Paper helpfully describes the resulting annoyance and harm to individuals and to the population experiencing aircraft noise.

There is general acceptance that current measurement metrics do not adequately represent the impact of aircraft noise. We suggest this is most likely because :

- measurement of the special properties of aircraft noise does not realistically represent its impact,
- the number and pattern of aircraft movements and value of respite is not properly recognised, and
- cumulative low level noise from multiple sources is not given due weight.

The following is a suggested framework for assessing the impact of noise. Figure 1 illustrates 25 minutes of recorded sound in Richmond town near the southern runway approach 8.5 km east of Heathrow starting at 16:28 hours on 16 August 2013. The sound was recorded using a video camera so the accuracy and calibration should be treated with caution. The diagram shows the noise logarithmic scale on the left ranging from zero to 90 decibels. There were 20 flights in the 25 minutes as shown by the peaks. The noise intensity cycles between a background level of about 45 dB(A) and a maximum 88 dB(A). There is momentary respite between each flight.

Figure 1



We suggest aircraft noise has three distinguishable properties. These are (1) an unpleasant sound, (2) an interruption to human activity and (3) noise from multiple sources, all of which are unwanted.

1. **Unpleasant sound from a single noise event**
   Sound can be pleasant and enjoyable in the case of music or as noise from some natural phenomena such as the gentle sound of waves at the seaside. Noise from aircraft is unlikely to be regarded by anyone as anything other than unpleasant. The point we wish to make is that sound can range from being very enjoyable to very unpleasant and that therefore in assessing the impact of a particular noise event it is essential the properties of the sound are well defined.

a. Since primaeval times the ear has provided humans with a means for responding to danger. Humans instinctively interpret the gradual crescendo of noise of an approaching aircraft as a signal of impending danger even though rational thought seeks to override this signal. Maslow's theory in psychology using a hierarchy of needs is a popular sociological framework. The physiological needs such as food, air and water are essential for survival but once relatively satisfied the safety needs take precedence and dominate behaviour. Satisfaction of these needs is followed by other needs such as self-esteem. **Safety is a basic need and aircraft noise challenges satisfaction of this need by stimulating natural human instincts towards danger. The fact that the danger is overhead compounds the impact, which may be further compounded by visual siting of the approaching aircraft. The ground noise footprint of an aircraft can be 6 or more km in diameter. Aircraft noise is quite different in these respects to road noise, which is sourced at ground level and is less pervasive since it usually diminishes in intensity rapidly with distance from the road.**

b. The other unpleasant feature of noise arises because human's senses naturally try to interpret a message from a sound signal and they seek a pattern in the frequencies or otherwise. Speech, music and sounds that have some meaning, rhythm, melody or harmony can satisfy this need but aircraft noise is an agglomeration of sound without meaningful pattern across a range of frequencies. Sound waves comprise pitch (frequency) and intensity (amplitude). Almost all sound involves multiple frequencies and the make up gives the sound its quality. Vibrations that are regular in their frequency and those comprising a fundamental frequency and related harmonics that re-enforce each other give pleasure to the hearing sensation. But when the sound source gives out multiple and changing vibrations we get noise. The succession of changing frequencies prevents the ear from dealing with a single constant sound and no fundamental note is heard and the variety of frequencies and overtones at any moment are disorderly thus adding to the suppression of any single fundamental. Generally speaking, the more conflicting overtones there are the more unpleasant the sound. Importantly, while sound generation and transmission can be considered objectively as a physical phenomenon, sound reception by the brain is subjective and will vary from one person to the next.

Aircraft noise tends to be harsh compared say to tyre sounds on a busy road; it has a large number of conflicting overtones. In fact noise events if quick and regularly repeated can tend towards a musical sound. For example, a new tyre on a tarmac road can produce a pattern of sound that is almost musical. The sound of a busy road is softer than the noise from an aircraft. Some say it is the preponderance of low frequencies in aircraft noise that makes it unpleasant but others complain about a high pitched whine. Importantly the quality of noise can vary enormously from one source to another and some types of noise are more unpleasant than other types. **We suggest that generally speaking aircraft noise is significantly more unpleasant than road noise and tolerance towards even relatively low intensity aircraft noise is significantly less than that of road noise.**

The intensity and directionality of aircraft noise distinguishes it from low level ambient sound and once it becomes audible above ambient sound levels it becomes unpleasant and an annoyance. At night for example, people may become more anxious even from low level sounds, possibly because the visual senors are unhelpful in the dark. **So it is not just high intensity noise that is unpleasant - cumulative and pervasive low intensity aircraft noise can be unpleasant also.**

2. Interruption of human activity from multiple noise events and a single source

a. The second noise property concerns interruption of human activity. Humans have a basic need for peace and quiet in order to sleep at night and for respite during parts of the day. In the

daytime people engage in purposeful activity with rising and falling levels of activity and respite, sometime momentary, many times during the day. An audible noise event potentially interrupts the activities and periods of relative peace and quiet. Behavioural response depends on the intrusiveness of the sound as represented by its unpleasantness. **We suggest there is an exponential growth in negative impact as the number of interruptions increases.**

b. If one needed to interrupt someone reading a book in the course of half an hour to discuss a matter that would take five minutes, would it be more or less intrusive to the reader to be interrupted for five minutes at the start or for one minute every six minutes? Other things being equal, the latter would almost certainly be the most intrusive and disruptive of the reading activity. **The pattern of noise events is significant to the level of noise impact.**

c. The Discussion Paper refers in para 2.35 to the benefits associated with the absence of noise. Referring again to Maslow's hierarchy of needs, peace and quiet are basic essential physiological needs, especially in the form of sleep. Periods of respite during the day, even if momentary, are also an important need. Satisfaction of this need cannot be deferred for long without serious impact on health and well being. As more of the daily cycle or rhythm of life is exposed to noise the greater is the need for peace and quiet. But the remaining time available for respite and recovery diminishes in the fixed period of the daily cycle. **So the growth in need for respite is probably exponential as the frequency of interruptions increases.**

3. Compound noise from multiple events and multiple sources

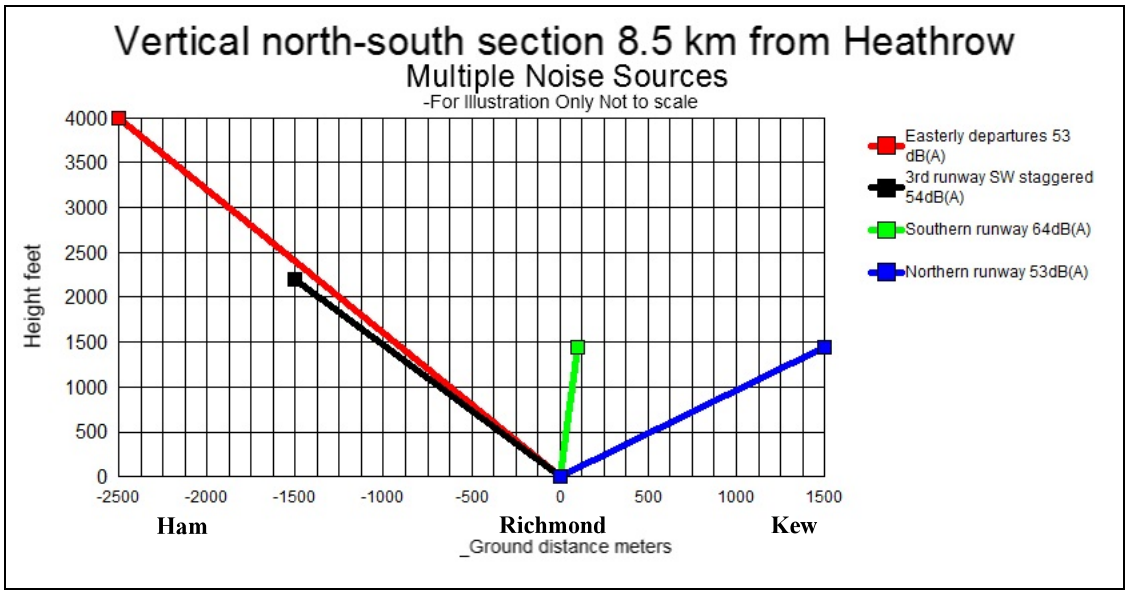
An important feature of noise interruptions is that even low level noise events can be disruptive on a cumulative basis and probably exponentially as the number of events increases. Professional evidence based research in Richmond over recent years on low level anti-social behaviour arising from a buoyant evening economy clearly demonstrates the cumulative impact of relatively trivial incidents[1]. Anti-social behaviour (often noise) incidents may impinge on different human senses to those subject to aircraft noise but they can be unpleasant and give rise to annoyance and loss of quality of life in a similar way. **The implication is that cumulative low level aircraft noise should be recognised as having a significant human impact as does high intensity noise.**

The population in West London will usually be exposed to noise from multiple sources or flight paths with different noise levels from each one at any particular location. Some noise may be relatively low level intensity but still above ambient noise levels, and when arising sequentially during periods of respite from runway alternation or otherwise, it can have a material impact, particularly on a cumulative basis. We can only guess the size of an aircraft's noise footprint at ground level and it no doubt varies, inter alia, with height and sound output at source. An aircraft at say 1,500 feet high can probably be heard above background noise levels at a distance of at least 3km from the vertical.

Figure 2 below illustrates schematically the sources of noise and their distance to a receptor in Richmond town. The schematic is a vertical cross section running north-south through Kew, Richmond and Ham. A person in Richmond will receive aircraft noise from three existing sources, to which we have added a new 3rd south-west runway offset to the west for illustration. The relative heights of aircraft are for illustration only.

[1] Reports 2007, 2009 and 2011 on low level anti-social behaviour in Richmond and Twickenham prepared for Richmond upon Thames Council by Make Associates

Figure 2



The noise levels from current Heathrow operations, as heard in Richmond town, are approximate and for illustration only and are based on noise samples taken by a simple noise meter. We have estimated the component noise levels from each source and their combined noise level which are shown in Table 1 below. Lmax estimates are also provided but they are not part of the calculations in this instance.

Table 1 Combined noise from multiple noise sources heard by a single receptor in Richmond town. For illustration only.

Average Sound levels dB(A) Leq		Combined using anti-log values of decibel noise levels				
		Lmax	Sequential noise levels	Runway Alternation	Westerlies & Easterlies	Combined
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
Arrivals	Background		45 (45%)	62	59	57
	Southern runway	88	64 (55%)			
	Background		45 (50%)	51		
	Northern runway	76	53 (50%)			
Departures	Background		45 (75%)		49	
	Southern runway (Dover)	76	53 (25%)			
	Background		0	Cranford restriction		
	Northern runway		0			

We assume a background noise level, excluding aircraft, of 45 dB(A). For example, when aircraft arrive every 90 seconds the noise typically rises to a peak of about 88 dB(A) before falling back to the background level over a total of about 50 seconds - hence the 45%/55% split (see Figure 1). The decibel noise levels have been combined to produce an average Leq16hr of 62 dB(A). Runway

alternation means this applies for half a day and when the 62 dB(A) is combined with noise at a level of 51 dB(A) from the northern runway for the other half day an average Leq of 59 dB(A) results. This is then combined with easterly departures on a 70/30 split to produce a long term overall Leq16hr of 57 dB(A).

The noise levels are logarithmic and so as sequential sounds have been combined using the weighted average of their anti-logs. E.G. Southern runway:
antilog (45dB/10) = 31623, antilog (64dB/10) = 2511886.
Combined = log (31623 x 0.45 + 2511886 x 0.55) x 10 = 62dB

A different equation would apply were the two sounds to occur at the same time.

If there were no audible noise at the Richmond receptor from the northern runway approach during alternation with the southern runway, the combined Leq16hr would be slightly quieter but the eight hour Leq during the half day respite period would be 45 dB(A) instead of 51 dB(A), which is a material reduction given that every 3 dB(A) represents a doubling of noise. **This illustrates the failure of the 16 hour Leq metric to represent the actual noise impact of multiple noise sources during eight hour respite periods.**

The fact that respite period during alternation is less than fully effective is no reason to abandon alternation. That would just make matters worse. Also, respite from average noise levels is just one factor. Respite from of 88 dB(A) Lmax produced by the southern runway approach, in other words the high intensity noise level of each flight, is also important. But even Lmax respite is compromised because a receptor in Richmond still experiences an Lmax from the northern runway of about 76 dB(A) for each flight. We stress these figures are indicative only.

A third runway to the southwest, when in full use, is likely to increase the Leq16hr at a receptor in Richmond. If the planes arrive, for example, out of sync with planes arriving on the southern runway then the sequential noise impact will arise during the brief moments of respite from southern runway approach. More significantly, the operations are likely to result in a substantial increase in noise during the half day of respite from the southern runway noise, as discussed above in the case of the northern runway. It must be stressed that the estimate for a 3rd runway is without knowing exactly whether the sound would be added sequentially or in parallel with existing noise and this would depend on the modal switches in use for all three runways. We calculate from Table 1 that the total respite at background levels accounts for 57% of the time. With a third runway this is likely to be significantly reduced.

The above example illustrates the issues for a single receptor in Richmond; the combination of multiple noise sources will vary for each and every other location in West London. One can perhaps visualise how the heights and hence ground noise would change by sliding the receptor in Figure 2 to the north or to the south. The receptor point in Richmond town is assumed to be about 8.5 km east of Heathrow touch-down, 0.1km south of the southern runway approach, 1.5km south of the northern runway approach, 2.5km north of the centre of the Dover Noise Preferential Route departures and 1.5km north of a 3rd runway arrival approach. In this position it is close to a number of official noise contours displayed in Heathrow's Noise Action Plan 2011 ERCD report 1304 (Lden 60, Lday 56, Levening 57, Lnight 50 and Leq6.5hr night 48). The receptor is also close to the 57 Leq16hr contour.

In this short discussion we have suggested that aircraft noise is unpleasant because of the way humans respond to noise and that it interrupts human activity including essential physiological need for respite from noise. We have suggested that aircraft noise can be particularly unpleasant because

of the approaching crescendo and mix of sound frequencies and that the unpleasant noise starts once it is audible above ambient noise levels from which it can rise in some locations to intense levels. As the number of interruptions increase, even at low numbers and low intensity of sound, the daily finite resource of available time for peace and quiet is consumed and the satisfaction of a basic human need for sleep and respite is inhibited. The multiple sources of aircraft noise heard at any particular location, even if relatively low level at that location, add to the noise impact, particularly during respite periods. In a nutshell it seems at times, depending on location, as though planes are all over the place with a background of distant rumbling thunder accompanied by the nearest source providing high intensity unpleasant noise.

The Discussion Paper raises the issue of quantifying and monetising the impact of noise and comparing its various properties. We mention a possible tool that might assist but we only have limited experience of its use. Conjoint Analysis is a statistical technique widely used in marketing and social sciences to assess the values people place on different features of a product and the decisions they make. It may be possible to use conjoint analysis to quantify the subjective values people place on noise, its intensity, the number of flights, sleep, respite, etc.

The following Figures 3 and 4 are complaint locations in 2008 overlaid on maps showing a typical day of westerly and a typical day of easterly operations, respectively. The maps are approximately 100 km by 70 km and have been taken from Heathrow Airport Noise Action Plan 2010-2015 - Supporting Annexes December 2010 pages 11 and 12. Apart from the complaint data the figures show the overhead flights spread across 7,000 square kilometres (2,700 square miles) of London and its environs. A 3rd runway would add half as much air traffic again and a 4th runway would double the traffic. There would be enormous impact on residents from the multiple flight paths and number of movements no doubt accompanied by a sizable growth in complaints.

Figure 3 Heathrow Westerlies

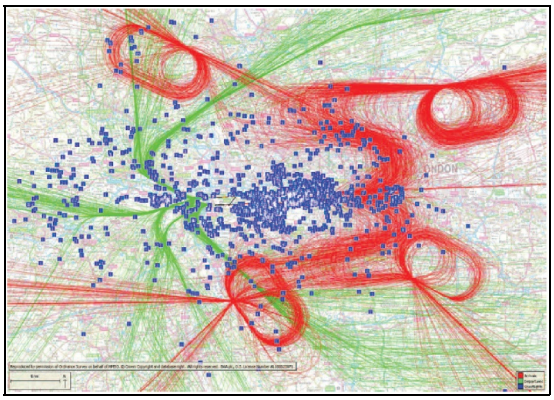
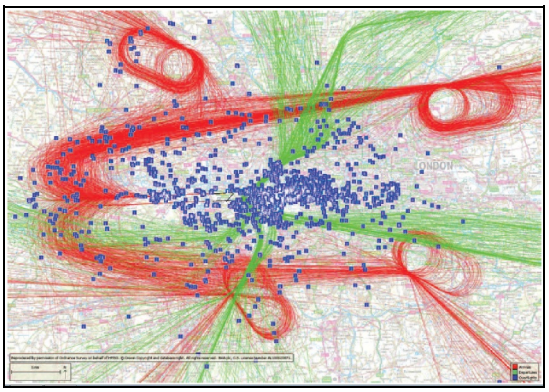


Figure 4 Heathrow Easterlies



Noise Metrics

1. Metric Issues

The metrics used for measuring noise tend to rely on noise energy and thereby tend to combine the various properties of noise in a single figure. Noise contours are constructed with the use of the UK civil aircraft noise model ANCON which is developed and maintained by ERCD on behalf of the DfT. We understand that the model applies the certified noise characteristics of each aircraft type that uses Heathrow to produce projected noise footprints at ground level across the whole fleet and over the areas covered by noise from arrivals and departures. The official UK noise index is Leq16hr measured in decibels (dBA) which averages the noise energy between 7am and 11pm over summer months. We appreciate that where there are overlapping noise sources the footprints are combined but the energy based Leq metric does not recognize all the noise properties discussed earlier and fails

to differentiate between numbers of flights and patterns of respite and multiple noise sources or the impact of cumulative pervasive low level noise events. We have not confirmed the significance but we question whether the cut of points in the model (to conserve computer time etc) are not too high to take full account of the cumulative impact of low level noise. Also, we question whether the model cuts off at the extremity of the lowest noise contour and therefore does not adequately include low level aircraft noise beyond this extremity.

In particular, the 57 Leq16hr metric fails to recognise the onset of unpleasant noise and the cumulative impact of low level noise. Research has shown that annoyance starts at 50 Leq and a significant upturn occurs at 57 Leq and for this reason the Government uses 57 Leq as the threshold for the onset of "significant annoyance". We query the threshold concept and suggest the impact of noise on an individual grows exponentially in a continuum starting at the background noise level. We also suggest the issue is about an unpleasant sound that is unwanted at any level above background level and that people tolerate unpleasant sound up to a point. The tolerance point was made earlier in discussing the impact of anti-social behaviour. The tolerance approach is different to the threshold approach which focusses on a single level of noise even though accepting that annoyance can arise below threshold.

There is a balance at which a certain amount of annoyance and harm from unpleasant noise and interruptions can be accepted or tolerated. We believe that even if the Leq metric is continued as a standard the level should be lower than 57 dB(A).

Furthermore, Leq16hr does not include the busy time during 6am to 7am.

We suggest a metric that represents high intensity noise is useful and in principle we support Lmax and SEL90. N70 is also useful in measuring the number of aircraft over 70 dB(A). But also there should be a metric that represents the cumulative impact of low level noise events from multiple sources and which removes the averaging of half day respite from alternation. Three metrics could be useful:

1. Leq8hr applied to flights when alternated onto the southern runway approach,
2. Leq8hr applied to flights when alternated onto the northern runway approach,
3. Leq16hrs applied to flights during easterly departures.

Contours based on these three metrics would enable people to relate noise levels at their location during the respite and non-respite periods separately.The three metrics would eliminate the averaging of periods of respite with non-respite. In the worked example above the non-alternation and alternation periods would have noise levels of 62 dB(A) and 51dB(A), respectively compared to the average 57 Leq16hr (the figures are indicative only). We suggest management of noise needs to deal with both periods separately because they have different sources and different impact. In our view 62 dB(A) is too high for a noise event and 51 dB(A) is too high for a respite period.

We strongly suggest that Lmax for these periods be provided also so as to provide a guide to the high intensity levels of unpleasant noise.

Air traffic noise levels at Heathrow exceed the WHO guideline limits on community noise in the day and the night periods. We suggest that before any consideration be given to adding runways at Heathrow consideration be given to setting realistic targets for both day and night that provide a reduction in noise over a set period of time and that only then can the impact of additional runways be properly evaluated.

2. Day Metrics

Major airports must map noise exposure by reference to Lden (55 dB(A) for 12-hour day and 4-hour evening and 50 dB(A) for 8-hour night) as the starting point for their Noise Action Plans (NAP). But Lden has to be measured only every five years. There is the risk that the measured year may be significantly untypical of the trend. In our view Lden should be measured annually. This would still permit 57 dBA to be measured as providing the longer term yardstick, at least until Lden has been measured for a continuous number of years. **The WHO argues that the 'onset of moderate community annoyance' starts at 50 decibels and 'severe' annoyance at 55 decibels**. The Heathrow NAP 2011 shows there was an area of 221.9 km^2 and population of 739,500 exposed to noise above 55 Lden. This substantially exceeds the WHO guideline limits.

3. Night Metrics

The Heathrow NAP 2011 shows there was an area of 41.1 km2 and population of 122,400 exposed to noise above 48 Leq 6.5night. Not only is the 48 decibels too high as far as WHO guideline limits are concerned (see below) but even at this level there should be no people impacted according to WHO guidelines. By averaging the period 11:30pm to 4:30am when there are only occasional flights with the period 4:30am to 6am when there are 16 flights the metric dilutes the noise impact, thus resulting in fewer people being impacted by night flights than by day flights, which makes no sense. Two metrics could be considered but we continue to support control of the night time by number of flights and the quota count:

1. Leq5hrs applied to the period 11:30pm to 4:30am, and
2. Leq1.5hrs applied to the period 4:30am to 6:00am.

The period 6am to 7am should perhaps be included in Lday which currently is for the period 7am to 7pm. As with the alternation measurements discussed above these proposals would reduce the averaging distortion and result in focussed metrics comparable with guidelines set by the WHO.

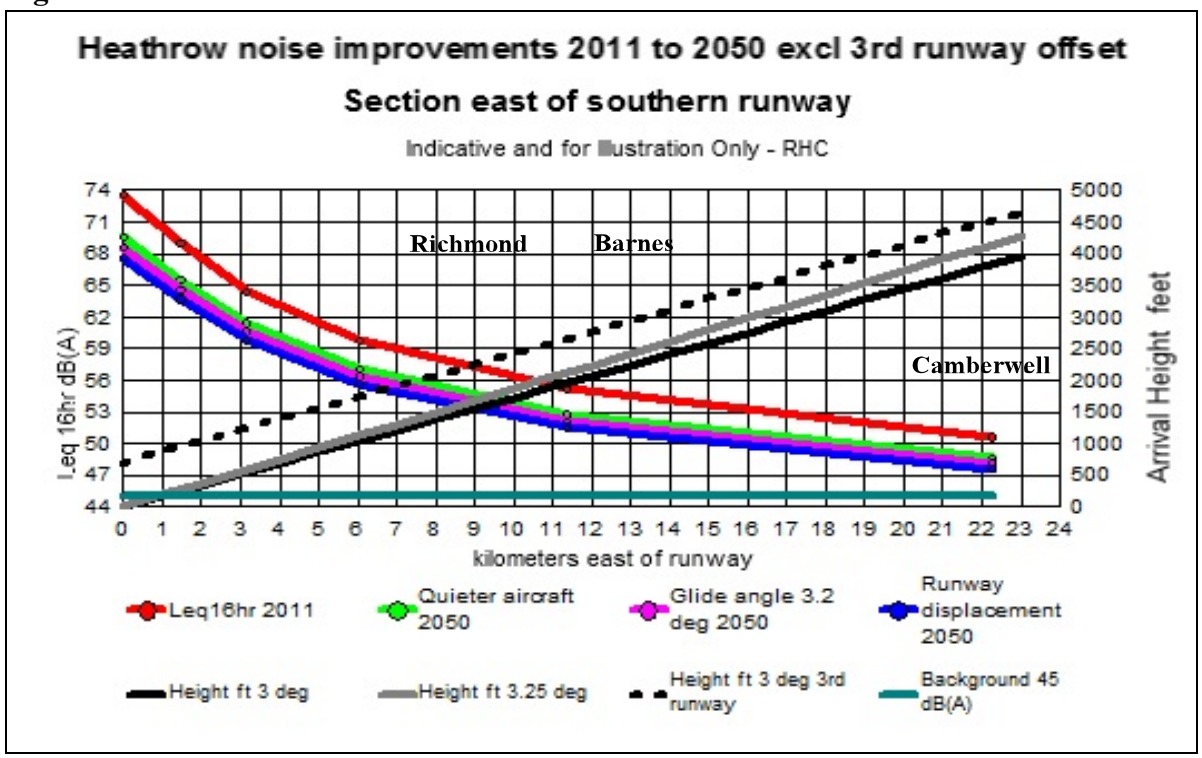
The WHO indoor guideline values inside the bedroom for avoiding sleep disturbance (the main impact of night flights) are 30 dB Leq for continuous noise and 45 dB Lmax for single sound events (45 dB Leq and 60 dB Lmax respectively when measured outside the bedroom window). Assessment of the air traffic noise exposure at night at Heathrow against the WHO guideline values would therefore require strategic maps at > 45 dB Lnight over the period 2300-0700, supplemented by indications of the number of single noise events (i.e. individual aircraft movements) at > 60 dB Lmax over the same period. The need for the supplementary indicators - permitted by Directive 2002/49/EC at the discretion of Member States - is particularly important given the pattern of movements in the night period at Heathrow, which is characterised by a limited number of movements 2300-2400, more frequent movements 0430-0600, and intense movements 0600-0700. Indeed, prior to the adoption of Directive 2002/49/EC, the UK Government decided not to produce night contours because the concentration of movements at either end of the night period made it questionable to use the averaging techniques inherent in Leq (see *Night Restrictions at Heathrow, Gatwick and Stansted: First Stage Consultation* (February 1998), Annex 5, paragraph 18).

The WHO *Guidelines on Community Noise - Night noise guidelines for Europe (6)* (2009) present new evidence of the health damage of night-time exposure to noise and recommend threshold values that, if breached at night, would threaten health. These include an annual average night-time exposure to noise not exceeding 40 decibels (dB) outdoors.

3. Vertical noise sections

Figure 5 illustrates noise along a vertical section on an east-west axis of the southern runway approach. The purpose is to present a possible analytical and presentational framework along with noise contours. The figures are indicative only. The vertical section provides information for people living directly along the section as a ground-up approach rather than a top down contour. Five

Figure 5



sections (one for each of the two runways, one in the middle and one on either side) would enable most people to extrapolate to their location with reasonable accuracy .

People can see how noise can be reduced over time by quieter aircraft, steeper arrival slopes, etc and they can also see the impact of growth in flights from say a 3rd runway and how a balance might be struck, if at all.

Aircraft performance improvements of 2 dB(A) by 2050 are shown in the diagram for illustration only. We are not suggesting this will be the case. We appreciate the work undertaken by Sustainable Aviation and presented in their 2013 report "The SA Noise Road-Map (A Blueprint for managing noise from aviation sources to 2050)". We note the estimate that with frozen technology the noise output in the UK from more flights will nearly double by 2050 and only slightly decrease below 2010 levels with the introduction of quieter aircraft. A larger reduction is apparently possible but this depends on how noise and carbon are prioritised in aircraft design. Given that the noise levels would still exceed WHO guideline limits the question arises how much room, if any, is there to share with noise from growth from a 3rd runway in line with the National Policy Framework, discussed earlier as objective "C" (see also Heathrow 3rd runway, below).

For illustration, Figure 5 also shows aircraft arrival heights as current and with an increase in angle of descent to 3.25% instead of 3% and with runway displacement where aircraft land 500 feet from the runway end, for example. These potential operational improvements are welcome in principle. The impact on noise levels is shown in Figure 5 for illustration only. The arrival heights for a possible 3rd runway staggered 4 km to the west and south of the existing runways is also shown for illustration.

Certified noise levels for aircraft currently using Heathrow range between 84 dB(A) and 93 dB(A) at 500 feet. This range enables one to experience in very approximate terms the noise reduction of say 2 dB(A) that might occur over the next 40 years by comparing a noisy aircraft and a less noisy aircraft within the current fleet. Also, experiencing the noise from the same aircraft type some 8 km

to the east of a given location should give some feel for the potential reduction over the next 40 years. It has to be said that we regard the reduced noise as still too high and that does not take account of additional noise from a 3rd runway and higher aircraft loads. The WHO argues that the 'onset of moderate community annoyance' starts at 50 decibels and 'severe' annoyance at 55. Also, these levels need to be considered in relation to background noise levels of 45 dB(A) or less.

Heathrow 3rd Runway

Given that the increase in number of flights from a 3rd runway, if given the go-ahead in the relatively near future, would be reasonably certain but the long term noise reduction would be highly uncertain, the chances of the NPA objective being met on a risked basis seem slim. Moreover the two probabilities for a 3rd runway and existing two runways are not independent and re-enforce each other in that the noise performance of the existing Heathrow operations would be the same as that of a 3rd runway, given the same aircraft fleet. In other words, if the performance improvement were overestimated for the existing 480,000 flights a year the same would be the case for the 250,000 flights from a 3rd runway. The uncertainty is generated, inter alia, by uncertainty on the CO2 issue and trade-offs with noise efficiency.

The east-west section relates to areas with a population subject to existing noise where in theory a trade-off is possible with noise from a 3rd runway, but a 3rd runway would introduce noise to a new population for the first time and no trade-off is possible with a starting position of zero noise; under these circumstances satisfying the NPF objective "C" is likely to be even more difficult.

Higher aircraft loads versus more flights

The DfT passenger demand forecasts 2013 assume that average aircraft loads at Heathrow grow from 145 passengers per aircraft in 2011 to 194 in 2050. Our long term proposal to the Airports Commission in July suggests this growth is too low and that higher loads would help avoid more flights and hence runways. Higher seat occupancy and larger aircraft will increase the weight and probably the noise, other things being equal. A comparison of the noise impact needs to be made between more flights and fewer flights with higher loads and larger aircraft. We do not have the resources to make this comparison but it is important because a doubling of passengers by 2050 will require the noise per passenger to be halved just to avoid an increase in overall noise let alone a reduction to meet WHO standards.

4. Noise Contours and population

The metric weaknesses we have discussed above extend to the contours derived from the metrics and the population numbers within those contours.

While we support the use of noise contours, we suggest there is a deficiency of information because individuals cannot easily assess the level of noise applying to their particular location and the changes over time. It is like watching a TV weather forecast for the UK when 99% of the information is not relevant to ones own location.

Figure 5 illustrates the information not shown by noise contours but shown by a vertical section. Also, one can see from Figure 5 how the concave shape of the noise curve approaching Heathrow from the east increases the noise per km distance. In other words measuring the reduction in area for a one decibel drop shows a much larger reduction at 57 dB(A) than at say 65 dB(A) nearer the airport. The message showing an improvement is highly selective. We have already commented on 57 dB(A) used in the standard as being too high.

The Environment and ambient sound levels

Background or ambient noise can be said to be any sound other than the sound being monitored (primary sound which in this case is aircraft noise). We suggest it helpful to think in terms of three ambient sound levels. Richmond Borough, for example, may be described as having (a) quiet, tranquil areas such as its parks, Kew Gardens and Richmond Park, etc.; (b) residential areas and (c) towns with the ambient noise across these three categories, excluding aircraft, ranging from 38 to 45 L_{day} (these are indicative and not scientifically based). Threading through these areas are roads and railways with relatively high noise levels and there are local noise hot spots such as event locations such as Twickenham rugby stadium and at the micro level there may be higher noise levels at specific locations.

Quiet Areas. It has been suggested that the noise impact from aircraft in rural areas is likely to be greater than in London because the former has lower ambient noise levels and the noise differential is therefore greater. But Richmond's parks and sites such as Kew Gardens have low ambient noise levels excluding aircraft and they provide valuable respite for people living in London with higher ambient noise. The impact of aircraft noise on these areas and people's quality of life when visiting these sites is considerable. Kew Gardens, for example has around 1.1 million visitors a year which for half a day each day are subjected to low flying aircraft on the northern runway approach and at the same time noise from aircraft approaching the southern runway as a secondary source. The situation is reversed for the other half of each day. Richmond Park has some 3.5 million visitors a year.

Towns. Towns have relatively high ambient noise levels. This gives rise to a number of issues:

5. Noise from air conditioning and extractor units, of which towns have many, is benchmarked in relation to background noise levels which includes aircraft noise. As a result of the aircraft noise there may be an increase in the background noise level by as much as 3 decibels at some points in the town and this in turn can lead to more disturbance from the plant and machinery benchmarked to a higher limit.

6. British Standard 4142 gives legal effect to and is based on the WHO Guidelines that are also intended to limit aircraft noise. It is somewhat perverse that council planning and environment policies are implemented and enforced in respect of buildings according to standards that are far exceeded by aircraft noise to which the WHO guidelines also relate. Given the huge pressure in London for housing it seems unrealistic to assume houses should only be built where the BS standards (i.e. WHO guidelines) can be satisfied in respect of aircraft noise. The result is that aircraft noise undermines the tighter planning and environmental controls and the "balanced approach" to aircraft noise.

7. Noise contours and noise impact assessments only take account of aircraft noise and ignore the fact that there can be other types of disturbance that cause both stress, health and mental effects and annoyance and inconvenience. For example, a town's evening economy can add to anti-social behaviour and associated noise and other forms of annoyance and harm. **A specific case in point is when a town is open until the early hours of the morning and then night flights start at 4:30am, the window for sleep can be materially shortened.**

Residential Areas. We suggest that in terms of background noise levels residential areas are in between quiet areas and towns. In practice, residents also inhabit towns and quiet areas. We raise here the issue of where people choose to live. It is sometimes said that if people live where there is aircraft noise then that is their choice and they should not complain about the noise. This surely is spurious argument. If over an area there are varying degrees of pollution it is impossible for everyone to live in the area with lowest pollution. Those that live anywhere else and hence with higher pollution could be said to have chosen to do so and should accept the higher pollution. We suggest that in principle everyone has the same right to peace and quiet and that satisfaction of their needs for tranquillity should not be compromised. Indeed those experiencing the highest levels of noise impact arguably should be given the greatest assistance in trying to reduce the impact.

Night Flights

Our full response to the DfT first stage of Night Flight Consultation April 2013 can be viewed on our website www.richmondheathrowcampaign.org The following is a brief summary:

1. The next 5 Year Night Flight Regime should commit to a phased extension of a no flight period resulting over time in a total ban on night flights:

•	Year 2	No flights 2300 to 0530
•	Year 3	No flights 2300 to 0600
•	Year 5	No flights 2300 to 0600 & reduced flights 0600 to 0630
•	Subsequent Regime	Phased extension to a complete ban 2300 to 0700

2. Banning Night Flights will provide un-interrupted Silence over 8 hours prescribed by the World Health Organisation Guideline limits. A ban is essential to all residents and in particular the vulnerable - children, chronically ill and elderly.

3. In the period leading to a full 8 hour night flight ban, the ban on noisiest aircraft should be extended to less noisy aircraft and the noise quota limits should be set to drive down the noise impact.

4. Banning Heathrow Night Flights is achievable in practice. It will have no net adverse economic impact and there is capacity to provide additional flights in the daytime to equal the number lost through a night flight ban.

5. We see nothing unique or essential about the 16 night time arrivals - they originate in a variety of time zones - the Far East, Africa, America and the Near East. Each route also has daytime arrivals. The approx. 60 flights in the shoulder period 0600-0700 generate substantial noise affecting yet more people.

Peter J. Willan, MBA, BSc(Eng), ARSM, FCMA, FEI, HonRCM
Chair, Richmond Heathrow Campaign
6 September 2013

ANNEX

Decibel (dB)	The decibel is a logarithmic unit of measurement that expresses the magnitude of a physical quantity relative to a specified or implied reference level. Being a ratio it is a dimensionless unit.
dB(A)	A unit of sound pressure level, adjusted in accordance with the A weighting scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Lday	The A weighted average sound level over the 12 hour day period 0700-1900 hours.
Lden	24 hour measurement. Lden is a logarithmic composite of Lday, Levening and Lnight levels but with 5 dB(A) added to the Levening value and 10 dB(A) added to the Lnight value.
Leq	Equivalent sound level of aircraft noise in dB(A). Based on the daily average movements that in the 16 hour period (0700-2300 LT) during the 92 day period 16 June to 15 September inclusive.
Levening	The A weighted average sound level over the 4 hour evening period 1900-2300 hours.
Lnight	The A weighted average sound level over the 8 hour night period 2300-0700 hours.
L6.5hr night	The A weighted average sound level over the 6.5 hour noise quota period 1130-0600 hours.
Noise Contour	Map contour line indicating noise exposure in dB for the area that it encloses.
SEL	Sound Exposure Level. The level generated by a single aircraft at a monitoring point normalised to a 1 second burst of sound taking account of the duration of the sound as well as its intensity.