



Aviation in a sustainable world

OMEGA Community Noise Study

Indices to enhance understanding & management
of community responses to aircraft noise exposure

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About Omega

About Omega

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Executive Summary

Noise disturbance is often the most significant issue raised by local communities concerned about airport expansion and also accounts for the vast majority of complaints about airport operations. As aviation growth is forecast to outstrip the rate of technical and operational improvement the number of people exposed to noise around UK airports could potentially increase; a trend that is unsustainable.

The absence of a common language of reporting, communication and negotiation in relation to aircraft noise is a key obstacle to more effective noise management. In order to help address this deficiency and thereby facilitate better communication and dialogue with local communities on the issue of aircraft noise, this study undertook a preliminary, systematic evaluation of public understanding of conventional and supplementary noise metrics. The intention here was not to undermine the existing contour based metrics but rather to establish whether these could be enhanced if other explanatory indices are added.

The literature review demonstrated that:

- There is no consensus as to the best means of illustrating aircraft noise exposure.
- What is measured and/or modelled is the physical phenomenon of exposure to aircraft sound; however, it is the human response to this (i.e. disturbance) that explains opposition to airport development. Thus, any attempt to improve noise management should engage with the physiological, psychological and sociological determinants of disturbance.
- Conventional metrics are primarily designed to 'capture' the aggregate level of noise exposure through single event measurements or noise contour modelling and, thereby, provide a (legally) defensible basis for planning and other strategic developmental decisions.
- Aggregating the elements of aircraft sound generation can often inhibit public scrutiny and understanding of the influence of specific elements (e.g. maximum levels, duration and frequency of events) on levels of disturbance.
- Supplementary indicators of noise exposure have made a positive contribution to consultation exercises undertaken in Australia; however, no systematic assessment of public understanding of the metrics has been attempted.

Given the shortcomings of conventional metrics, in terms of reflecting perceptions of noise disturbance and the reported benefit of supplementary indicators in enhancing the public engagement in air transport decision-making in Australia, this study set about exploring public understanding of a range of noise exposure metrics. This was achieved through a series of focus groups in which participants' understanding of specific noise illustrations was assessed through a succession of questions and then further explored in a period of group discussion.

The focus groups were undertaken with both sensitised (located close to airports) and non-sensitised (remote from airports) members of the public and also Local Authority Officers who have an interest in aircraft noise issues and revealed:

- Considerable variation in the interpretation of different metrics used to illustrate the same noise environment.
- General dissatisfaction and indeed mistrust in some cases among members of the public with the aggregated indicators such as Leq and Lden.
- All the aggregated indicators (Leq, Lden, Lnight, N60 and N70) required considerable explanation before participants understood the illustrations.
- A preference for metrics that disaggregate key elements of aircraft noise; namely, time, frequency of events and individual sound levels.
- A desire for a wider range of noise exposure illustrations, especially among members of the public living close to airports.
- Universal acknowledgement that bar charts, for specific locations illustrating the numbers of events within ranges of maximum sound levels for given periods of the day, were the most informative and easiest to interpret of all the metrics viewed.
- Consensus that the flight path densities maps were the most visually attractive despite the lack of specific noise data contained therein. To combat this, a number of participants suggested that this image could be overlaid on aggregated noise footprints such as N70 or Leq contours.
- That the public is more interested in site specific information that is easy to interpret in relation to their own personal exposure, rather than more complex images that may provide a comprehensive overview of the whole noise environment around an airport, as conventionally used by planners and decision-makers.

Given the small sample size and the exploratory nature of this research, care must be taken when attaching significance to these findings; nevertheless, the results point to the potential value of:

- A more substantive UK study to 'test' these preliminary findings.
- Providing appropriately differentiated information to different user groups depending on their individual requirements.
- More detailed investigation of the supplementary noise indicators such as those developed in Australia and the novel location-specific histograms evaluated here for the first time, in terms of their:
 - Contribution to improved understanding of aircraft noise exposure.
 - Potential to aid in establishing effective dialogue with the communities most affected by aircraft noise and most cynical about the conventional metrics.
- Contributing to the development of future noise metrics in such a way as to enhance public acceptance of future aviation development.

1.0 Introduction

Noise disturbance is the single most significant issue raised by local residents and is often cited as the primary reason for objecting to airport growth. It continues to be one of the principal environmental issues for the aviation industry notwithstanding the very significant improvements in airframe and engine noise technology that have been achieved over the past 50 years. Consequently, noise disturbance has given rise to operational constraints and capacity limits at airports across the World.

The aim of this study is to contribute to improving the dialogue between airports and their neighbouring communities on the issue of noise disturbance. A key part of the study is to determine how much members of the public truly understand about the noise climate around an airport from the current aircraft noise metrics. In addition to this some of the issues surrounding present and supplemental metrics, in particular those developed in Australia, are discussed

A number of focus groups were undertaken with members of the public who are both sensitised and non-sensitised to the issue of aircraft noise, and also Local Authority Officers who also have an interest in the issue. Participants were asked to consider a number of noise metrics, both current and supplemental and then their understanding of the metrics was tested by means of a questionnaire and by group discussions.

The findings of this research will inform recommendations, which set out to clarify the suite of current and supplemental indicators that is most valuable in communicating aircraft noise. More effective communication of aircraft noise issues should have a significant impact on the relationship between airports and their stakeholders.

2.0 Aircraft noise – A review of the most widely used noise metrics and other supplementary indicators.

2.1 Introduction

The annoyance generated by aircraft noise has been investigated in a number of studies in the UK including the Wilson Report in 1963, which was based on a social survey at Heathrow, and which introduced the Noise and Number Index as a measure of aircraft noise, the 1982 ANIS survey, and the most recent 2005 ANASE study. All emphasise the importance of effective dialogue between airports and their neighbouring communities is key to resolving the challenge of aircraft noise disturbance. A major issue in the success of this dialogue is that current indicators of noise exposure, whilst being widely used within the UK planning system, are often poorly understood and mistrusted by the general public. An example of one method of addressing this issue can be found in Australia where a suite of new supplementary noise indicators was introduced in response to local opposition to developments at Sydney Airport. The use of appropriate indicators is considered vital in ensuring wider public understanding of aircraft noise and, thus, a prerequisite of effective consultation. This study begins to examine the level of understanding of present indicators and establish the potential value of supplementary indicators for future use by UK airports.

2.2 Sound and Noise

A good understanding of aircraft noise issues requires an appreciation of the physics of sound, which can be described in terms of changes in air pressure, wavelength, frequency, amplitude or purity (Sekjuler & Blake, 1994; Veitch & Arkkelin, 1995). However, while these factors describe how sound is transmitted through the air to the ear, they do not measure the level of disturbance caused in response to hearing that sound. Thus, noise is generally defined as a sound that has an undesirable effect upon people and is therefore unwanted (Berglund and Lindvall, 1995). Prolonged exposure to high levels of noise has been shown to cause serious psychological and physiological effects upon the human body, including hearing impairment or loss and sleep deprivation leading to stress and immunological problems (Veitch & Arkkelin, 1995).

There is unequivocal evidence that the auditory system can be damaged by exposure to extremely high levels of noise. However, despite considerable research into the possible non-auditory health effects of noise, the results are often inconclusive. The broader World Health Organisation (WHO) definition of health helps to resolve this apparent paradox (WHO 1999). This definition

states that health is a state of complete physical, mental and social well-being and not merely the absence of disease and infirmity. The inclusion of well being in the definition expands the concept of health beyond clinical significance, to encompass a number of effects of aircraft noise that are well known (annoyance, sleep disturbance, interference with speech communication, detrimental cognitive and performance effects).

The problem of aircraft noise disturbance has long been recognised as involving the complex interaction of a number of physical, biological, psychological and sociological processes (Schultz, 1978). The relevant physical factors include those associated with noise generation: aircraft type, mode of operation and the resulting physical sound level. The other critical components are the human factors, which include the basic biological systems of audition, followed by the psychological processes that interpret these signals, which again can be influenced by additional factors such as health status, annoyance and stress (Job, 1996). The further interpretation of noise disturbance can be influenced by social conditions that may include factors such as socio-economic status, cultural and lifestyle differences (Morley & Hume, 2003). Finally, although individuals may complain about the 'noise' of aircraft, a variety of other factors such as fear of air accidents, time of day, airport development bias or disturbance from other airport activities (e.g. increased road traffic) can be involved in the underlying causes of annoyance and complaint (Moss et al., 1997; Hume et al, 2001).

The level of perceived nuisance is therefore only in part a function of the frequency and noisiness of aircraft movements. Tolerance to aircraft noise is also affected by factors such as people's expectations in terms of quality of life or their understanding of the social and economic consequences of constraining airport growth (Bristow, *et al.*, 2003). It is exactly for these reasons that there has been an inability of acoustic variables on their own, to satisfactorily predict self reported annoyance due to environmental noise.

In order to discuss and assess both the impact of aircraft noise and the ways in which it is measured, it is also important to first have a reasonable appreciation of the units by which sound level is expressed. The human ear's response to noise relates to sound pressure in a way that is approximately logarithmic. This means that a significant reduction in the physical magnitude of sound usually results in only a comparatively small reduction in the perceived loudness of the sound as heard by the human ear. The most widely used unit when measuring sound levels is the decibel (dB). This is commonly filtered, or weighted, to reduce the influence of extremes in frequency, thereby attempting to correlate more closely with the human assessment of the loudness of a sound (FAA, 1985). The internationally standardised A-frequency weighting is most often used for the measurement of environmental noise. The key issue relating to this weighting is to what extent human response is accurately represented. Similarly this issue has been raised regarding the use of a C-weighting to assess low frequency noise and which has been adopted for the expression of limit values in some

regulations in Nordic countries for assessing low frequency noise (Parmanen, 2007). The Federal Aviation Administration (FAA) also apply a D-weighting to sound levels which results in a reduction in the effect of low frequency noise whilst recognising annoyance at higher frequencies.

The issue of noise weighting factors has been a topic for debate over many years. Hellman & Zwicker (1987) found that in some cases applying the A weighting to sound levels resulted in an inverse relationship with loudness and hence annoyance. Despite this, the A weighting is still used widely in the prediction of annoyance by environmental sources such as aircraft; indeed Parmanen (2006) found the A-weighting to be reasonably similar to weightings derived from recent research, to the extent that it is suggested that perhaps the A-weighting should be improved, to relate more closely to actual loudness, rather than be replaced. The main issue underlying this debate is that human listeners can selectively attend to different features of a disturbing or intruding sound on different occasions or in different contexts and it is perhaps unreasonable to expect any simple, single frequency weighting scheme to represent this diversity properly. Standardising on the A-frequency weighting or any other weighting is essentially an administrative convenience that is generally helpful but sometimes slightly misleading.

2.3 Aircraft noise metrics

In addition to the issue of frequency weightings there are many decibel (dB) based metrics that are used to describe sound from aircraft (reviewed in Ollerhead et al, 1992). These can be categorised as in Table 1 and are discussed in more detail below. At the most basic level the determination of aircraft sound levels is dependent on three basic factors; the sound level (in dB), the frequency or pitch of the sound and time of day – when aggregation is involved (FAA, 1985). All of the noise metrics commonly in use depend on these factors.

Table 1 - Aircraft noise metric classifications and example metrics

Classification	Example Metric
Single Event Maximum Sound Levels	LAMax (dB) – maximum sound level
Single Event Energy Dose	SEL (dB) – sound exposure level
Cumulative Energy Average Metrics	Leq (dB) – equivalent sound level
Cumulative Time Metrics	TA (minutes) – 24-hr time above

After FAA (1985)

As a result of difficulties in precisely determining the effect of (or response to) aircraft noise, it has become common to quantify overall noise exposure. This

can be determined by representing single events (e.g. LAMax in dBA – the maximum sound level) or by calculating an average or a total of multiple noise events experienced over a particular period of time (e.g., 8 hours, 12 hours, or 16 hours) with additional weightings for the time-of-day of the event, e.g., night-time (reviewed by Ollerhead et al, 1992). The resulting output is normally presented in the form of sound level or noise contours. Various versions of the A-weighted equivalent continuous sound level metric (LAeq) are used in the UK and across Europe. This metric is also accepted as the preferred method for calculating aircraft noise levels by the World Health Organisation (WHO), and in the USA by the DNL (Day-Night sound level, expressed in dB), which enhances the LAeq 24 hour by applying a 10 dB adjustment for night time noise intrusions (FAA, 1985). Criticism of the DNL has led to the development and use of supplemental metrics such as the NA and TA (number above and time above) which can help the general public to understand the impact of airport noise changes due to changes in operations or fleet mixes.

The LAeq is calculated by integrating the sound energy from all noise events over a given time period and applying a factor for the number of events. It is, in effect, a means of averaging out the sound energy exposure, and in the UK is usually expressed as a 16hr LAeq to represent daytime exposure. The LAeq is used for all UK planning guidance and, as such is the most commonly used metric for environmental noise in the UK. Under current procedures, the UK Department for Transport interprets the 57 LAeq (16 hour day-time) aircraft sound level contour as indicating the 'onset of significant annoyance' (Thomas et al, 2003). This interpretation is largely based on the results of the first Heathrow aircraft noise survey in 1961 and then re-enforced by the results of the 1982 ANIS study. It is interesting that if the most recent 2005 ANASE study data is interpreted in the same way, then this suggests a much lower threshold for the 'onset of significant annoyance'.

As a long term average measure of the total amount of sound energy present, LAeq takes into account the sound levels, durations of separate events and the numbers of those events. This can be problematical under conditions where the number of events appears to be relatively more important than the sound levels of those events, or vice versa. The results of the most recent 2005 ANASE study (published in 2007) suggest that the average sensitivity to sound levels vs. number of events has changed since the previous ANIS study carried out in 1982. Perhaps the main problem here is that any measure that attempts to combine the numbers of events and the average sound levels of those events into a single combined indicator cannot represent situations where the relative importance of sound levels and number of events changes.

Reflecting an increasing administrative consensus towards the more widespread adoption of LAeq based indicators, the recent EC Directive 2002/49/EC (Assessment and Management of Environmental Noise) mandates noise maps based on Lden (day-evening-night level) which aggregates separate measures of annual average daytime (0700-1900), evening (1900-

2300) and night-time (2300-0700) LAeq with +5dB and +10 dB weightings for the evening and night-time periods respectively. The Directive also requires reporting of population exposure and the development of action plans for high noise areas.

Table 2 provides an indication of the range of noise metrics which have been most commonly used in Europe and America.

Table 2 - Examples of commonly used noise metrics.

Metric	Meaning	Comment
PNdB	Perceived noise level	A more sophisticated alternative to the A-frequency weighting devised to represent jet aircraft noise in the late 1950s.
EPNdB	Effective perceived noise level	A more complex derivative of PNdB which takes single tone frequencies and event duration into account.
LAmx	Maximum instantaneous A-weighted sound level	Usually expressed as dBA
SEL	Sound exposure level	The effect of duration and magnitude for a single event above a specified threshold.
LAeq	Equivalent sound level	Energy average sound level integrated over a specified time.
Lden	Day-evening-night level	As LAeq with 5dB and 10 dB weightings for evening (1900 to 2300) and night-time (2300 to 0700) periods respectively
NA	Number Above -	Combine single event noise level information with aircraft movement data. Contours commonly show the number of aircraft above a given threshold over a specified time period (e.g. 70dB(A) and 24 hrs)
DNL	Day-night average sound level	Used by the FAA. As LAeq with a 10 dB weighting for the 2200 to 0700 night-time period.

The perceived noise (PNdB) and effective perceived noise (EPNdB) indicators incorporate the different frequencies and duration of noise patterns, resulting from various speeds and modes of operation of aircraft. There is no agreement, even amongst experts, on which measurement is the most representative, or the most relevant in a particular situation, however, the International Civil Aviation Organisation (ICAO) uses EPNdB for defining aircraft noise certification standards.

In terms of communicating aircraft noise effectively many commentators recognise that, while the common noise metrics used remain complex and difficult for a member of the general public to understand, a climate of misunderstanding and misinterpretation will remain (e.g. Eagan, 2006). This contributes to community concerns and impacts upon levels of constructive communication of noise impact between airports and their local communities. In response to this a number of airports have developed, often in consultation with community representatives, a variety of different targets that can be

used to guide or drive noise management and at the same time act as an indicator of environmental quality. These are informed by the fact that very often local residents are more interested in, or can better understand, the number of aircraft that will affect them during a particular time period, how high they are flying and how noisy each will be. The use of such supplementary indicators is discussed below.

2.4 Supplementary Indicators Case Study - The Transparent Noise Information Package (TNIP)

In response to community concerns and the need for more effective communication, the Commonwealth Department of Transport and Regional Services (DOTARS) and the Department of the Environmental and Heritage of Australia developed a package of less-technical supplementary noise indicators (DOTARS, 2000). Feedback on the DOTARS report indicated that many people believe that the conventional ways of describing aircraft noise have significant limitations and that there is need to move towards noise descriptors that are less technical and more transparent to the non-expert, including being provided in a disaggregated form where possible – i.e. by separating the elements of intensity, frequency of events and timing (DOTARS, 2003). The fundamental aim of the DOTARS work is to encourage airports, acoustical experts and planners to use the same terminology when engaging in dialogue with non-experts. The descriptors developed are based on treating aircraft noise as a series of single events, rather than as a cumulative, calculated average. This enables a more understandable mental picture to be drawn of exposure. A summary of the descriptors used is provided in Table 3.

Table 3 - DOTARS supplementary noise descriptors

Descriptor/Indicator	Comment
Flight Path Movements	Show individual movements or numbers of movements over a given time period
Respite Charts	Number of hours with no jet movements, expressed as a % of the total number of hours during the period of interest
N70 Contours	Combine single event noise level information with aircraft movement data. Maps show number of events louder than 70dB(A) (see also N65 or N60)
Person-Events Index	Allows total noise load generated by an airport to be computed by summing, over the exposed population, the total number of instances where an individual is exposed to an aircraft event above a specified noise level over a given time period.

In order to ensure that the descriptors are communicated easily, they can be accessed via a simple computer package - the Transparent Noise Information Package (TNIP) which can be downloaded via the internet (http://www.infrastructure.gov.au/aviation/environmental/transparent_noise/tnip.aspx) This is a suite of software which was developed for Sydney Airport in response to community concern following the opening of a new runway at

Sydney Airport in 1994. Negative community response to the new runway led to the development of a tool which could describe and assess aircraft noise in a more simplified and transparent manner. Subsequently the tool has been used at several airports in Australia and at Vienna Airport and Stockholm Arlanda Airport in Europe, both for technical assessment for runway placement and in the public consultation process. TNIP Expert is the latest version of the TNIP applications. It takes data either from Noise and Flight Path Monitoring systems, or from noise modelling studies carried out using the US Federal Aviation Administration's Integrated Noise Model (INM), and produces a range of flight path and aircraft movement based noise descriptors along with more conventional noise contours.

2.5 Summary and Discussion

A range of traditional aircraft noise metrics have been discussed. A fundamental problem with traditional noise metrics or descriptors is that they may not portray noise exposure patterns in ways that a member of the general public can relate to or understand. For this reason there is a need to assess the depth of understanding of such descriptors as well as consider how effective supplementary descriptors are as tools for communicating aircraft noise climates to the non-expert. More specifically, this review has demonstrated that:

- There is no consensus as to the best means of illustrating aircraft noise exposure.
- What is measured and/or modelled is the physical phenomenon of noise exposure; however, it is the human response to this (i.e. disturbance) that explains opposition to airport development. Thus, any attempt to improve noise management should engage with the physiological, psychological and sociological determinants of disturbance. For this reason many commentators argue that comprehensive and effective dialogue with local communities should underpin airport noise management programmes.
- Conventional metrics are primarily designed to 'capture' the aggregate level of noise exposure and thereby provide a (legally) defensible basis for planning and other strategic developmental decisions.
- Aggregating the elements of aircraft sound generation (maximum levels, duration and frequency of events) acts to obscure other elements that can affect disturbance from public scrutiny and understanding.
- Supplementary indicators of noise exposure have made a positive contribution to consultation exercises undertaken in Australia; however, no systematic assessment of public understanding of the metrics has been attempted.

3.0 Focus Groups – Methodology and Results

To provide an assessment of the level of understanding of current noise metrics and other supplementary metrics and indicators focus groups were undertaken at a number of locations. These are summarised in Table 4

Table 4 - Focus group locations and group types.

Location	Group Type	Participants
Knutsford (Cheshire)	Public (high exposure)	7
	Local Authority Officers	2
Brereton (Cheshire)	Public (low exposure)	8
Southampton	Public (low exposure)	11 + 12 (two groups)
Windsor (London)	Community Groups	13
	Local Authority Officers	4

The aim was to access the understanding of the general public with a range of different personal experiences of aircraft noise exposure. Thus, locations both close to and remote from airports were chosen for the focus groups.

The focus groups were advertised by means of a flyer (Appendix 1) in local health centres, libraries and schools. Approximately 2000 flyers were distributed. Unfortunately the initial response rate was too low to allow effective focus groups to be undertaken. Word of mouth dissemination of the focus groups proved the most effective means of attracting participants and resulted in the levels of engagement identified in Table 4. In the case of the general public and community focus groups, participants number were within the range considered effective for properly functioning focus groups (Fern, 2001). The low numbers in the LA officers groups was considered to be less of an issue as these participants often already knew one another and had some relevant expertise and were therefore willing and able to contribute to discussions effectively. The poor response to the original flyer may indicate that many people they were distributed to have a low level concern for aircraft noise or that the channels of distribution were insufficient and requiring further review should future work be considered.

Focus groups diverged from more conventional formats as the intention was to establish participants' understanding of the illustrative noise metrics before engaging in collaborative dialogue. Thus, after a brief introduction to the study and to the aims of the focus groups by the facilitator, participants were asked to consider a number of Illustrations relating to the description of aircraft noise around either Manchester Airport or Heathrow Airport and complete a questionnaire relating to the illustrations¹. This part of the focus group took between 35 and 40 minutes, during which time the participants engaged quietly and productively in the process.

¹ At this point the intention was to establish the participants' initial understanding of the noise metrics with as little intervention as possible by the study team. Thus, with the exception of the brief introduction and responses to specific enquiries as to the exact nature of the task, participants were very much left alone to complete the questionnaire around the focus group table.

The purpose of the questionnaire was to investigate the ease with which the different groups of people were able to understand the conventional noise metrics and also a number of supplemental indicators or metrics. For each illustration there were three general questions and three follow up questions. The general questions aimed to find out how much information the participant was able to extract from the illustrations relating to three key areas:

- Number of aircraft;
- Sound/noise levels; and
- Time of day.

Follow up questions were intended to determine the quality of interpretation of the illustrations at three different locations (A, B and C). Questionnaire results were analysed as % of the total and also sub-divided into participant type. No other statistical tests were carried out due to the small sample size.

The illustrations presented at the focus group meetings (all illustrations were presented at the meetings in A3 format) were as follows²:

Heathrow Airport

Illustration 1: Heathrow Summer 2006 contours standard average mode (76% west 24% east) terrain adjusted dBA Leq 16 hours 0700-2300 BST

Illustration 2: Heathrow Summer 2006 contours actual average mode (70% west 30% east) terrain adjusted dB(A) Leq 16 hours 0700-2300 BST

Illustration 3: The Environmental Noise Regulations (England) 2006 – Heathrow Airport (EGLL). Lden

Illustration 4: The Environmental Noise Regulations (England) 2006 – Heathrow Airport (EGLL). Lnight

Illustration 5: Heathrow Summer 2006 0700-2300 BST – Flight Path Movement Chart Along Standard Instrument Departure Routes – Based on Average Runway Mode (70% west 30% east)

Illustration 6: Heathrow Summer 2006 0700-2300 BST – Flight Path Movement Chart Along Standard Arrival Routes – Based on Average Runway Mode (70% west 30% east)

² Illustrations 1-4 for both Manchester and Heathrow reproduce publicly available noise contours and are reproduced in Appendix 2. The remainder of the illustrations were produced by Darran Humpheson of the RPS Group from original flight path data supplied by Manchester and Heathrow Airports for 2006, these illustrations are not published here as they were never intended as accurate representations of the noise environment at these airports; rather non-assured processes have been used to produce illustrations for experimental purposes only that allowed focus group participants to differentiate between three different locations near the airports. Appendix 2 therefore simply contains examples of these types of metric rather than the actual ones used in the focus groups.

Illustration 7: Heathrow Summer 2006 0700-2300 BST – N70 Contours [Number above 70dB(A)] Based on Average Runway Mode (70% west 30% east)

Illustration 8: Heathrow Summer 2006 0700-2300 BST – N60 Contours [Number above 60dB(A)] Based on Average Runway Mode (70% west 30% east)

Illustrations 9(a), (b) and (c) – Heathrow Airport – Sites A, B & C. Maximum Sound Level and Number of Aircraft Events histograms

Manchester Airport

Illustration 1: Manchester Airport Average Summer day 16 hour 2006 Leq noise contours Actual modal split 82% west 18% east

Illustration 2: Unlike Heathrow Manchester Airport has never published standard average mode Leq contours thus participants were only asked to comment on one Leq contour map for Manchester (i.e. Illustration 1)

Illustration 3: The Environmental Noise Regulations (England) 2006 – Manchester International Airport (EGCC), Lden

Illustration 4: The Environmental Noise Regulations (England) 2006 – Manchester International Airport (EGCC), Lnight

Illustration 5: Manchester summer 2006 0700-2300 BST – Flight Path Movement Chart Along Standard Instrument Departure Routes – Based on Average Runway Mode (82% west 18% east)

Illustration 6: Manchester summer 2006 0700-2300 BST – Flight Path Movement Chart Along Standard Arrival Routes – Based on Average Runway Mode (82% west 18% east)

Illustration 7: Manchester Summer 2006 0700-2300 BST – N70 Contours [Number above 70dB(A)], Based on Average Runway Mode (82% west 18% east)

Illustration 8: Manchester Summer 2006 0700-2300 BST – N60 Contours [Number above 60dB(A)], Based on Average Runway Mode (82% west 18% east)

Illustrations 9(a), (b) and (c): Manchester Airport – Sites A, B & C. Maximum Sound Level and Number of Aircraft Events histograms

Attendees were asked to consider the illustrations in turn and to answer a number of questions relating to each illustration. A copy of the questionnaire is provided in Appendix 3.

Following on from the questionnaire phase of the focus group, the facilitator then encouraged group discussion on the specific illustrations in turn, to help elaborate on levels of understanding and on the broader value of the metrics in illustrating levels of disturbance/concern for aircraft noise. This enabled a broader discussion of the significance of aircraft noise intrusion and those elements contributing to participants' expressed experiences. These discussions were recorded using a boundary microphone supplemented by note taking by members of the study team. Summaries of the discussions at each of the focus groups are provided in Appendix 4.

4.0 Results

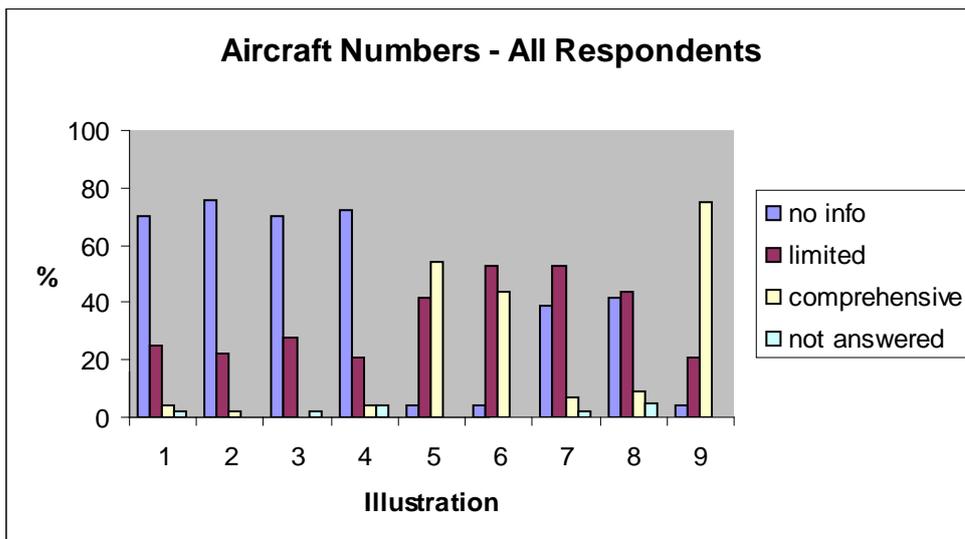
Summaries of the questionnaire results are provided here. Since the number of attendees and hence participants was limited only basic trend analysis has been undertaken.

4.1 Question 1

“To what extent does this illustration provide you with information about the number of aircraft flying into and out of the airport?”

Options: Provides no information on aircraft numbers.
 Provides limited information on aircraft numbers.
 Provides comprehensive information on aircraft numbers.

A summary of questionnaire results for all participants is provided here with responses by participant type being provided in Appendix 5.

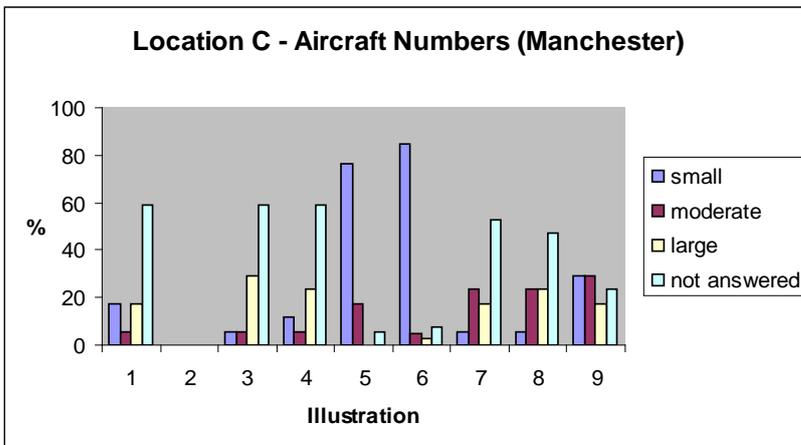
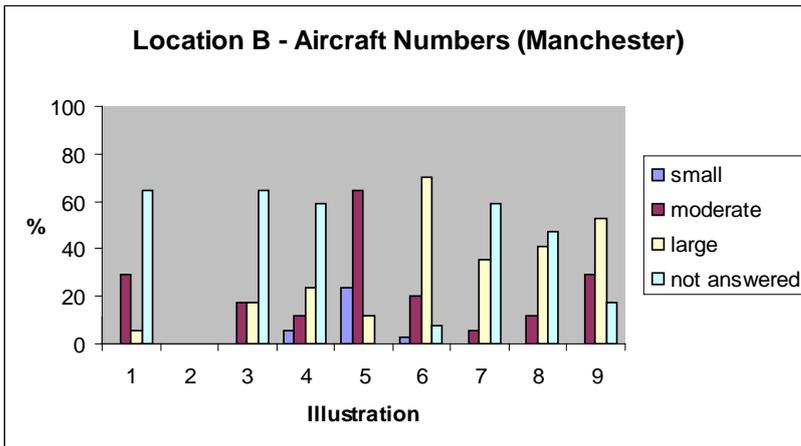
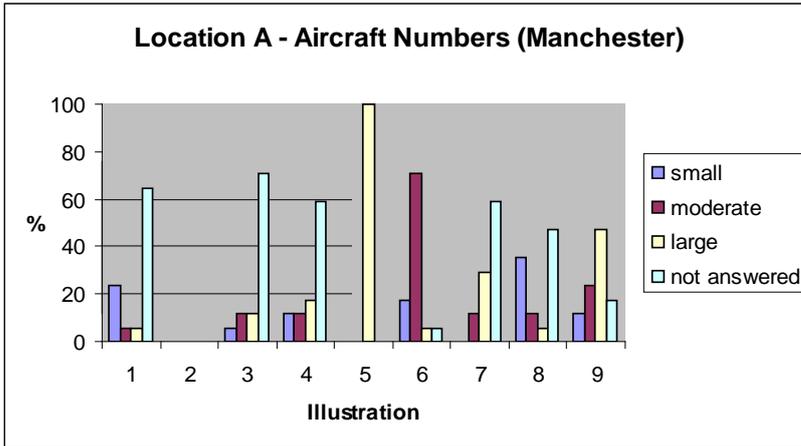


Responses to this question indicate that there is some level of comprehension of aircraft numbers and about what level of information the different illustrations provide. Participants generally felt that Illustrations 1 to 4 had little or limited information on aircraft numbers, with illustrations 9, 5 and 6 providing the most comprehensive and illustrations, 7 and 8 providing more limited information. The responses to this question appear to indicate that most people have been able to engage with the material, however some discrepancies can be noted, for example about one quarter of participants felt that Illustrations 1, 2 (Leq) and 4 (Lnight) provided comprehensive or limited information on aircraft numbers., when in fact illustrations 1-4 do not provide any specific information on this feature.

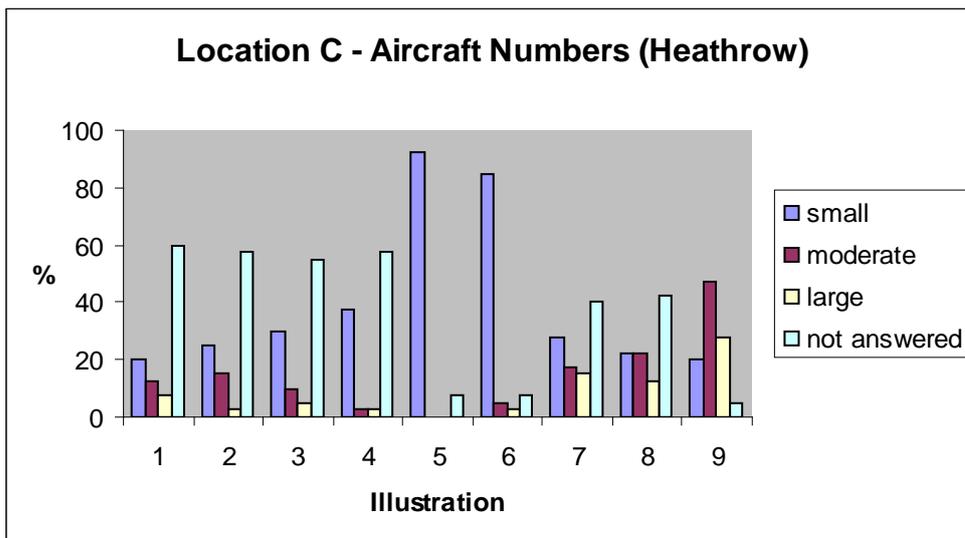
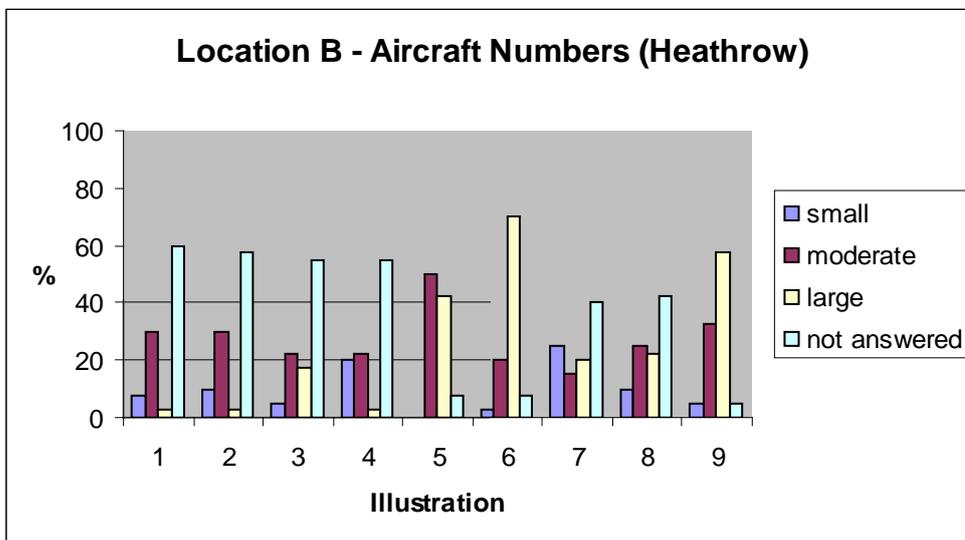
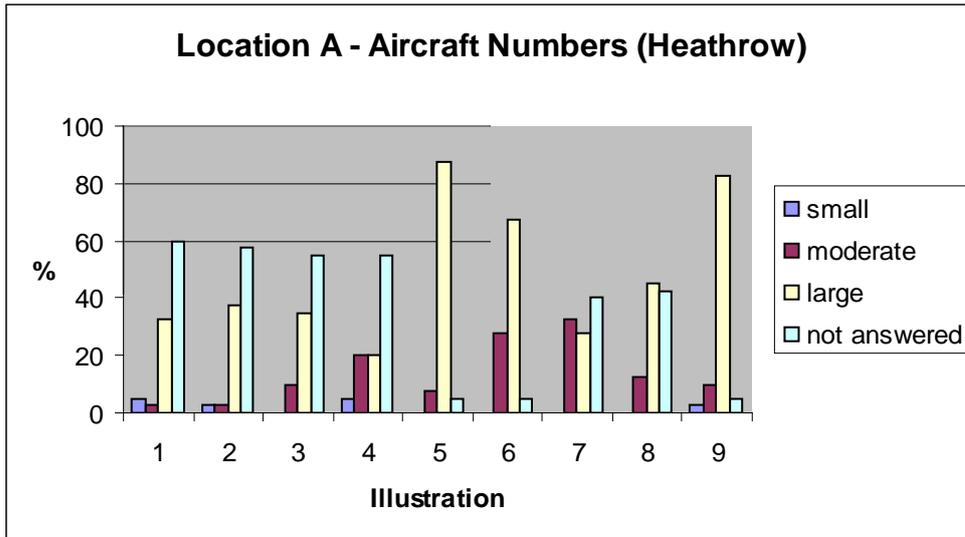
4.2 Question 1a

"How would you describe the aircraft numbers overflying each location?".

Options³: Small number of aircraft.
 Moderate number of aircraft.
 Large number of aircraft



³ Given the different aircraft noise environments at Manchester and Heathrow and the fact that the illustrations serve to demonstrate different aspects of the noise environment (e.g. total aggregate averaged noise exposure, numbers of aircraft above specified noise levels, number of overflights, etc) interpretation of individual illustrations differed between airports and thus responses to the questions have been presented for each airport location



The purpose of Question 1a was to determine if participants were able to interpret the illustrations correctly. The percentage of participants who did

not answer this question for illustrations 1-4 accorded with the percentages of participants who felt those illustrations provided no information on aircraft numbers in Question 1, thereby demonstrating a consistency in their understanding of these illustrations.

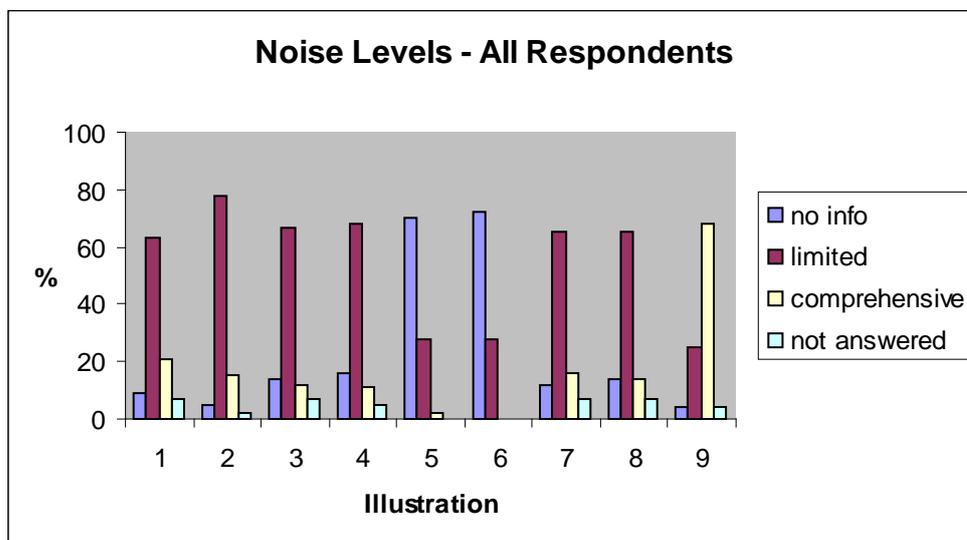
It is impossible to provide a definitive answer to this question as the categories are open to interpretation; thus what for one participant may be regarded as a moderate numbers may be viewed by another as large. Nevertheless, on a strictly quantitative comparative basis departure overflights for both airports were highest at Location A, followed by Location B and with no overflights at C, which is offset to the side of the runways. In terms of arrivals, at Manchester Location B was highest, followed by A with C again offset, and at Heathrow, Locations A and B were very similar with C offset. Most participants were able to interpret this correctly from illustrations 5 and 6 which showed aircraft flight paths and movements numbers, and also to a lesser degree for Illustration 9 which provided number of aircraft and noise levels.

Reponses analysed by participant type for the 3 locations are presented in Appendix 6. Worthy of note is the proportion of Local Authority Officers who felt that illustrations 1 to 4 provided sufficient information on aircraft numbers to determine comparative levels of aircraft numbers for the three locations, perhaps indicating some degree of prior knowledge of aircraft numbers at the locations, or, alternatively a degree of misunderstanding of the metrics.

4.3 Question 2

“To what extent does this illustration provide you with information about aircraft noise levels on the ground?”

- Options:
- Provides no information on aircraft noise levels.
 - Provides limited information on aircraft noise levels.
 - Provides comprehensive information on aircraft noise levels.



The responses from this question demonstrate that generally there was an overall appreciation that the contour chart illustrations (1-4 and 7 & 8) provide some degree of information on noise levels. A high percentage of participants also recognised that the flight path movements charts do not provide information on noise levels (around 70%), although between just less than one third felt that that they do provide some information. This may mean that some participants are utilising local knowledge in their interpretation of the movement charts or that they relate numbers of movements to noise levels and thus infer noise information in this way. Participants felt that the illustration providing the most comprehensive information on aircraft noise was illustration 9, which consisted of bar charts providing information on both aircraft numbers and noise levels. This was despite the fact that the information was only available for the 3 locations and not for the whole area around the airport, as is provided by the contour type illustrations.

Further resolution on those participants indicating that they extracted noise information from the flight movements charts (illustrations 5 and 6) is provided in Table 5 where results are presented by participant type (see Appendix 7 for full summary).

Table 5 - % Participants (by type) indicating limited/comprehensive information for illustrations 5 and 6 (movement charts)

Participant Type	% indicating limited/comprehensive information on noise levels	
	Illustration 5 (departures)	Illustration 6 (arrivals)
Local Authority Officers	50	33
Community Groups	31	31
Public Low Exposure	29	29
Public High Exposure	14	14

The high percentage of Local Authority Officers who felt that the departures chart (illustration 5) in particular provided some information on noise levels may mean that they are utilising local knowledge in their interpretation of the illustrations or that they relate numbers of movements to noise levels and thus infer noise information in this way. Alternatively even amongst the regulators there may be a lack of understanding of such charts.

4.4 Question 2a

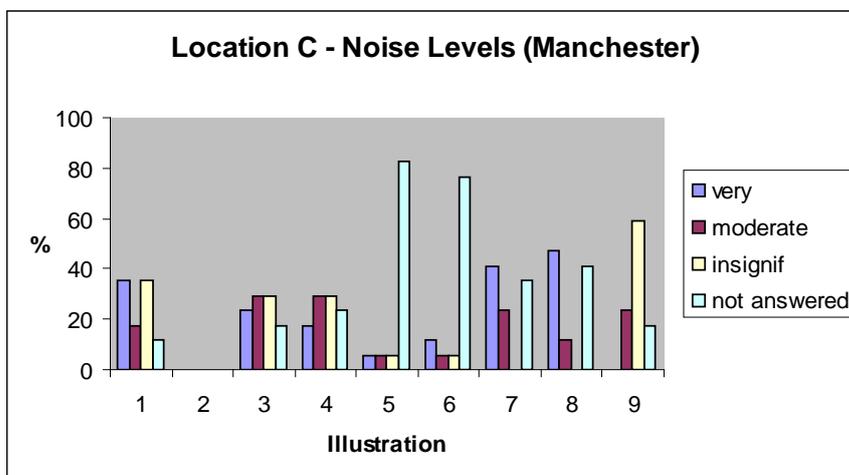
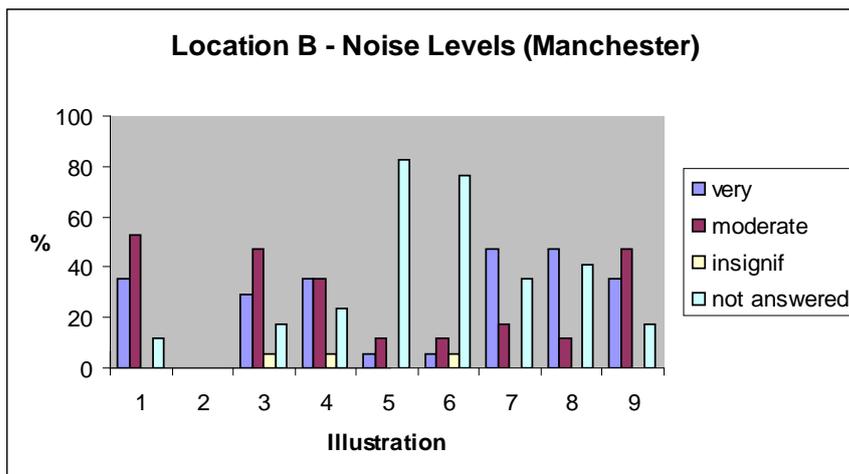
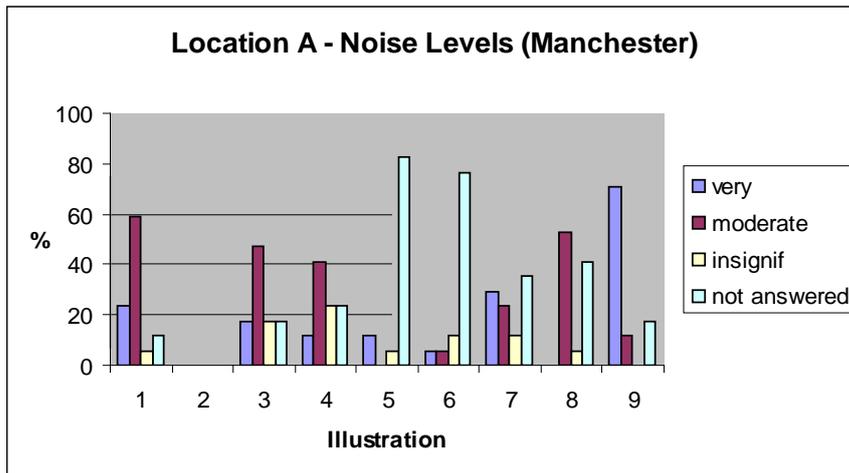
"How would you describe the aircraft noise levels on the ground at each location?"

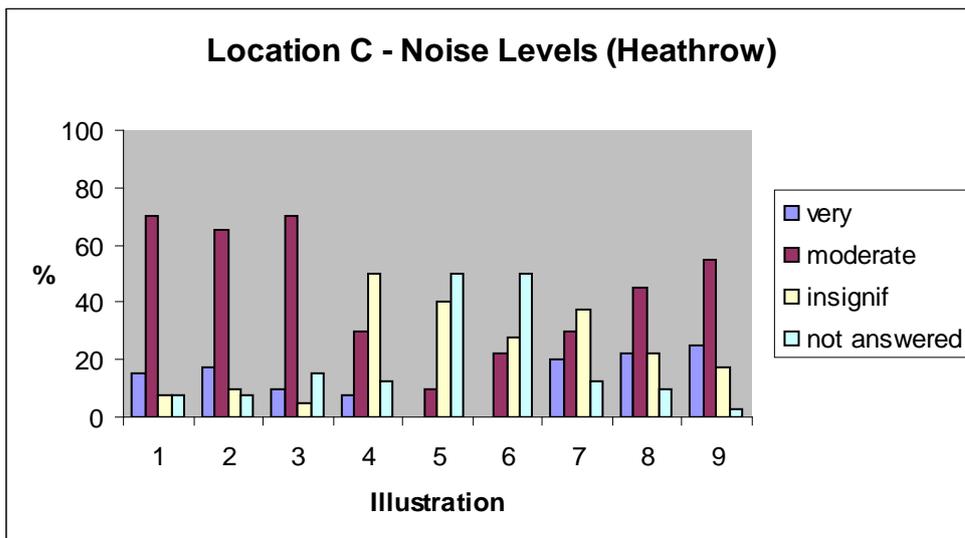
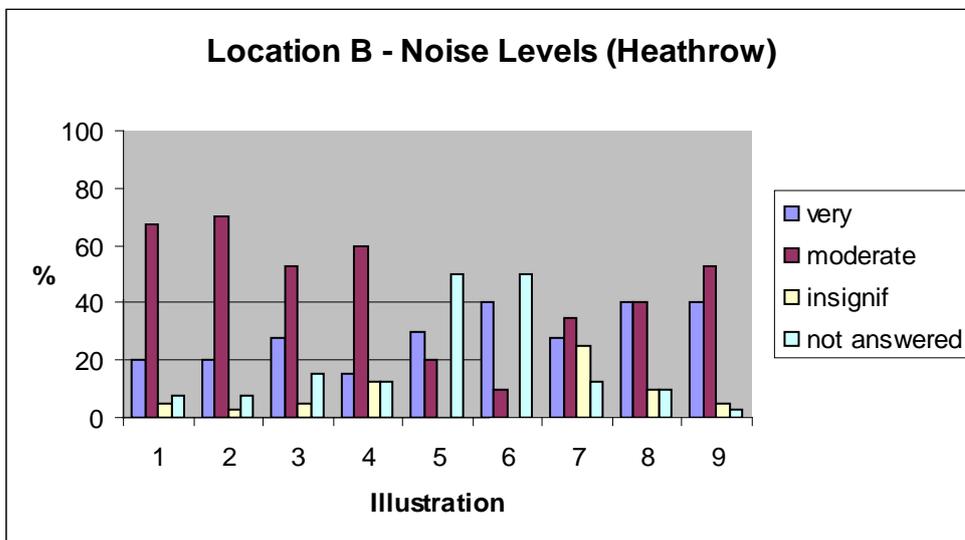
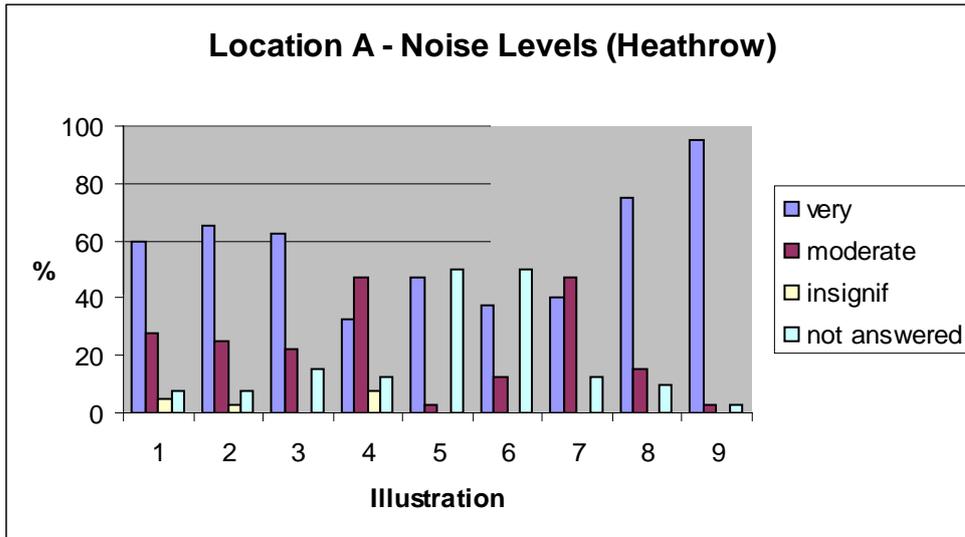
(Participants were asked to tick an option for Locations A, B and C)

Options: Insignificant noise from aircraft.

Moderately noisy.

Very noisy.





As with Question 1a, the percentage of participants, who did not answer this question for illustrations 5 and 6, although somewhat reduced, reflected the large majority of participants who indicated that no information on noise

levels was available from these illustrations; thereby demonstrating a consistency in their understanding of these illustrations.

Again it is impossible to provide a definitive answer to this question as the categories of noise exposure are open to individual interpretation. This issue was discussed at each of the focus groups with many participants indicating varying tolerances, not only to noise levels, but also noise types. Nevertheless, in terms of relative quantitative measures of noise (and based upon Leq contours) exposures at Manchester, Locations A and B are considered to have a similar noise climate, with Location C exposed to less aircraft noise. For Heathrow, Location A is considered to be noisier than B, which in turn is noisier than C.

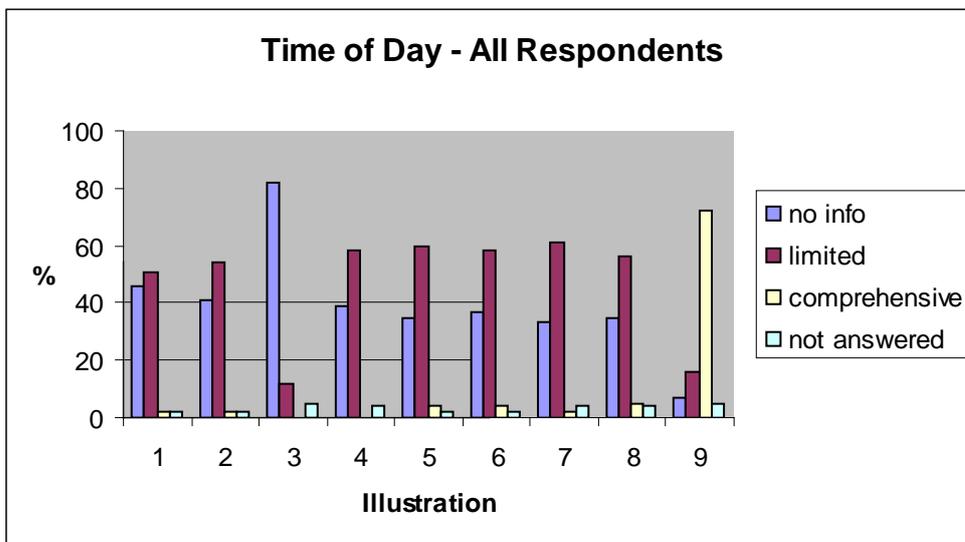
At Heathrow, most participants were able to differentiate Location A from Locations B and C, associating this location with the highest noise levels from illustrations 1-4 and 7-9, but found it harder to differentiate between Locations B and C.

In contrast, for Manchester, no distinct pattern was evident in the characterisation of the locations derived from the same illustrations (although the 'very noisy' categorisation for location B is noticeably higher for illustrations 3 and 4 compared to A, and may reflect subtle changes in the contours arising from these different aggregation calculations). The inconsistency in the interpretation of the metrics may indicate a general misunderstanding of the contours, or that a degree of local knowledge of the noise climate is influencing the interpretation made by some participants. This may particularly be the case for participants such as the Local Authority Officers and Community Group members, where we observed a tendency for some participants to answer the questions based on their local knowledge rather than on a strictly technical interpretation of the graphic materials being reviewed. Under such circumstances, where participants are tending to think of the questionnaires as tests of their own competence rather than as tests of the materials themselves, it is not surprising that they will use whatever information they can (such as local knowledge) to obtain the highest possible 'marks'.

4.5 Question 3

“To what extent does this illustration provide you with information about time of day when aircraft noise events occur?”

- Options:
- Provides no information on the time of day when aircraft noise events occur.
 - Provides limited information on the time of day when aircraft noise events occur.
 - Provides comprehensive information on the time of day when aircraft noise events occur.



The only illustration that a large percentage of participants (just over 70%) felt provided comprehensive information on time of day was illustration 9, which provided a time series (3 phases of the day) of bar charts indicating numbers of aircraft events segregated by maximum sound levels. Between 40 and 60% of participants felt that the averaged aggregate noise illustrations (1,2 and 4) and N60/70 illustrations (7 and 8) provided some information on time of day. One possible explanation is that these charts all identify time periods in their titles even though no differentiation in noise exposure over those periods is available.

By contrast, illustration 3, the Lden contour map - an aggregated metric specifically modified to account for time of day by adding weightings to aircraft movements at more sensitive times (i.e. evenings and nights) - was highlighted by over 80% of participants as providing no information on the time of day when aircraft events occur. Again, the explanation may be that there is no reference to time in the title of the illustration. A summary of the percentage of participants (by participant type) who noted that illustration 3 (Lden) provided no information on time of day is provided in Table 6 with bar charts for all responses by participant type provided in Appendix 8.

Table 6 - % of participants (by participant type) who felt that illustration 3 provided no information on time of day

Participant Type	% who responded "no information" on time of day Illustration 3
Local Authority Officers	67
Community Groups	77
Public Low Exposure	84
Public High Exposure	100

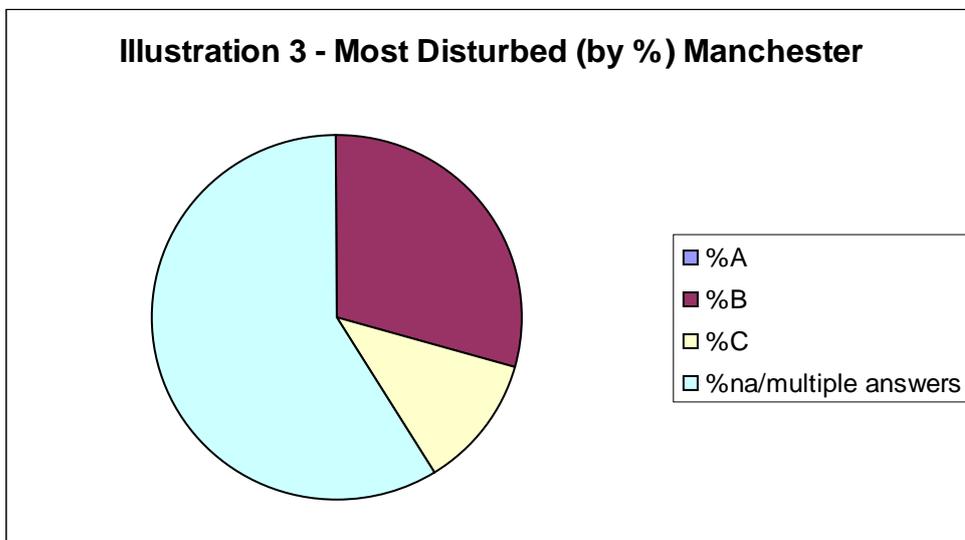
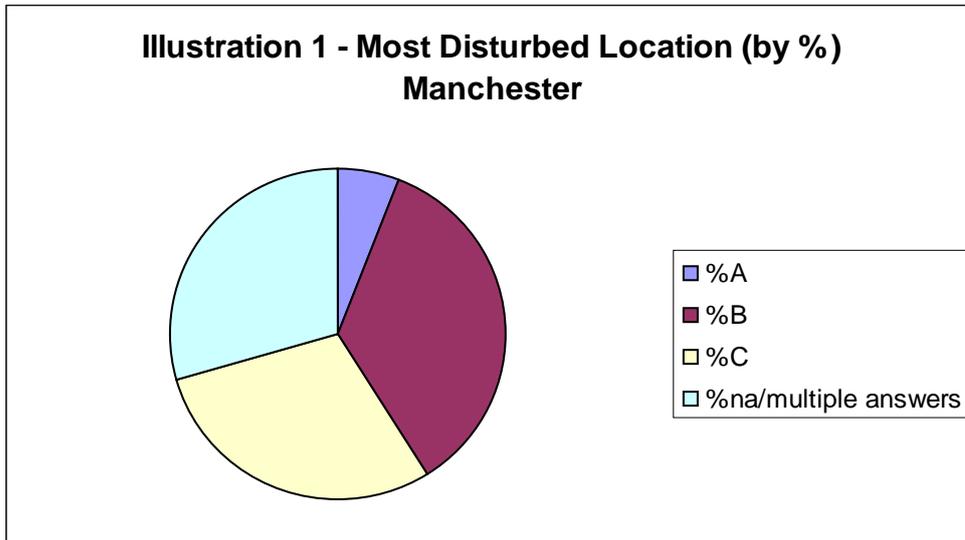
Of interest here is the fact that such a high percentage of Local Authority Officers and Community Group participants felt that the Lden illustration (3) provided no information on time of day, demonstrating a possible lack of understanding of the metric amongst the type of groups it is particularly aimed at.

Generally speaking it could be considered that where a reference to time was clearly provided in the title of the illustration (even where this was simply a reference to 'night' as with Lnight), participants felt more confident that the illustration provided information on time of day and that the level of misunderstanding of the Lden metric may possibly be due to their notation rather than any complexities of the actual metric. It is possible that some participants felt that simply because the illustration title referred to specific times of day, then this implied that the graphic conveyed time of day information even if the nature of the information was not fully understood.

4.5 Question 4

"On the basis of this illustration, how would you rank the locations in terms of scale of their aircraft noise disturbance?"

Options: Most disturbed.
 Moderately disturbed.
 Very noisy.



⁴ Unlike Heathrow Manchester Airport has never published standard average mode Leq contours thus participants were only asked to comment on one Leq contour map for Manchester (i.e. Illustration 1). In the case of Heathrow both standard and actual contours were commented upon by participants (i.e. Illustrations 1 and 2).

Illustration 4 - Most Disturbed (by %) Manchester

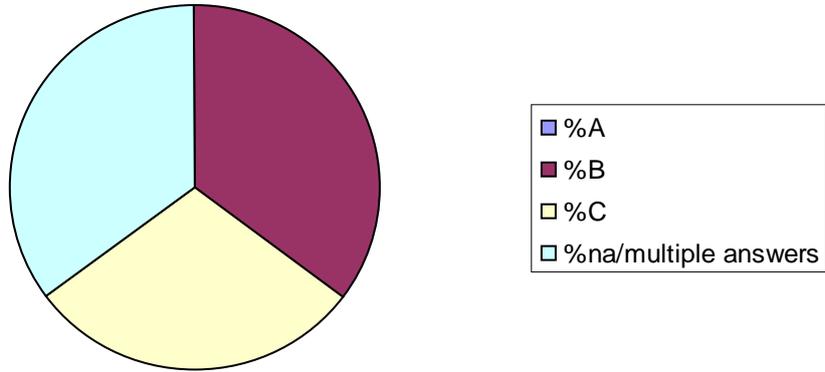


Illustration 5 - Most Disturbed (by %) Manchester

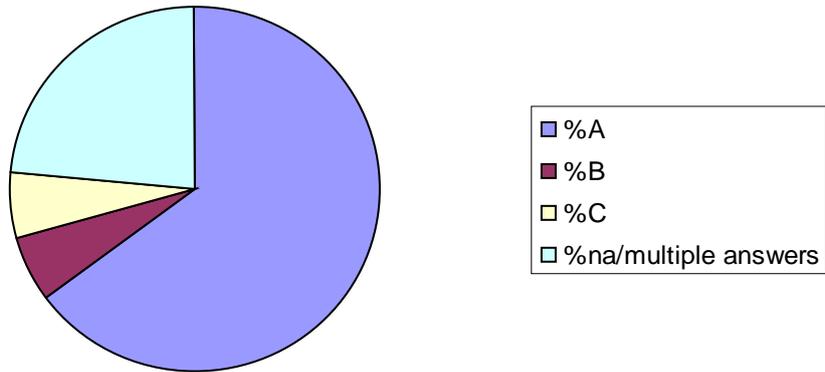


Illustration 6 - Most Disturbed (By %) Manchester

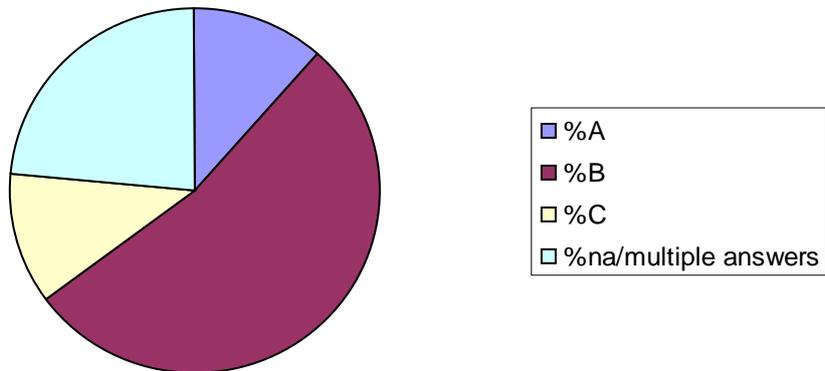


Illustration 7 - Most Disturbed (By %) Manchester

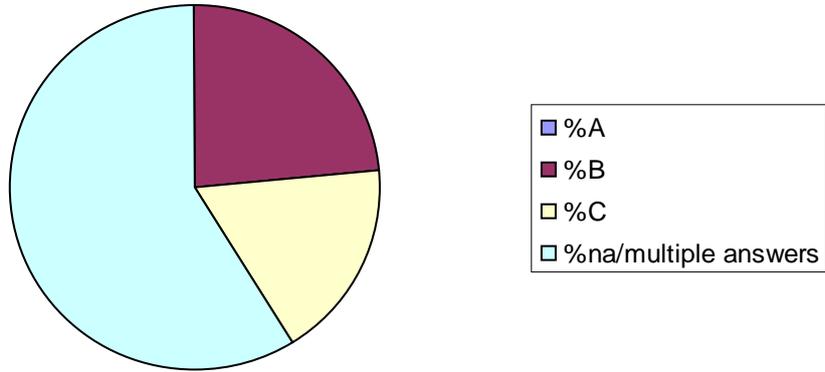


Illustration 8 - Most Disturbed (By %) Manchester

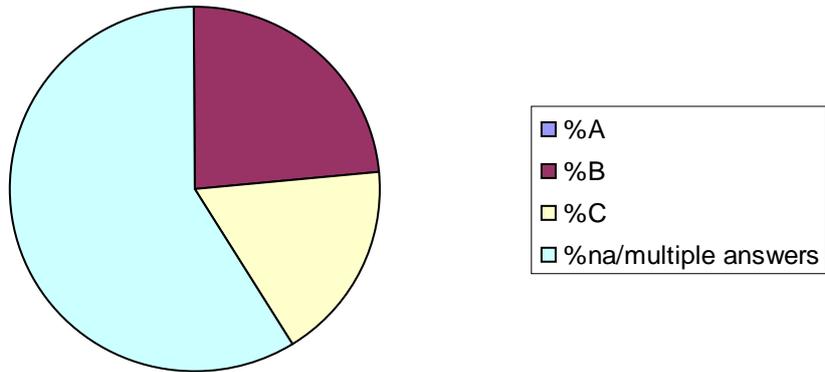


Illustration 9 - Most Disturbed (By %) Manchester

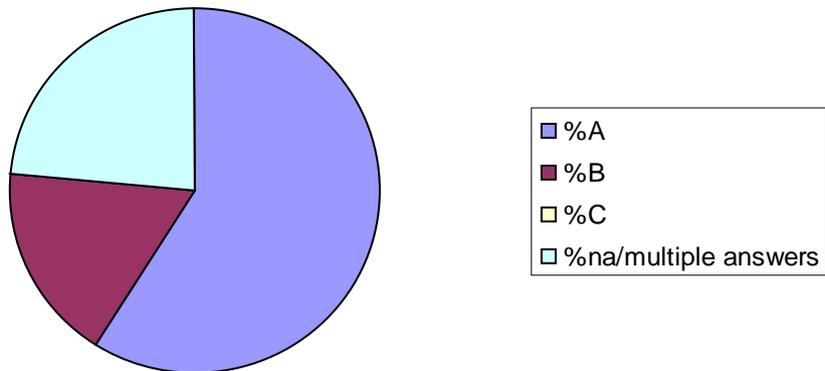


Illustration 1 - Most Disturbed Location (by %) Heathrow



Illustration 2 - Most Disturbed (by %) Heathrow

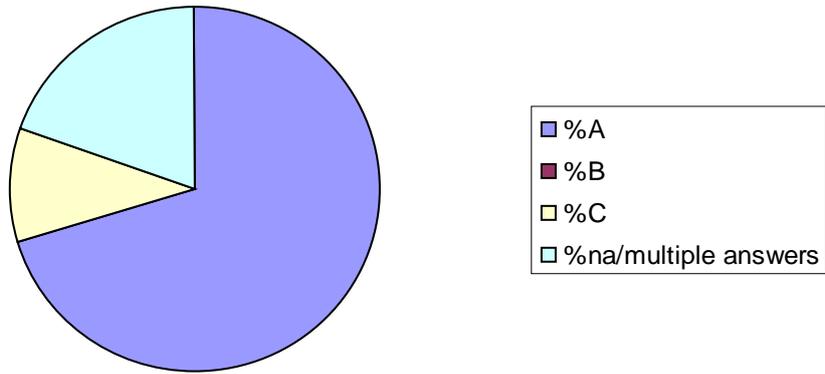


Illustration 3 - Most Disturbed (by %) Heathrow

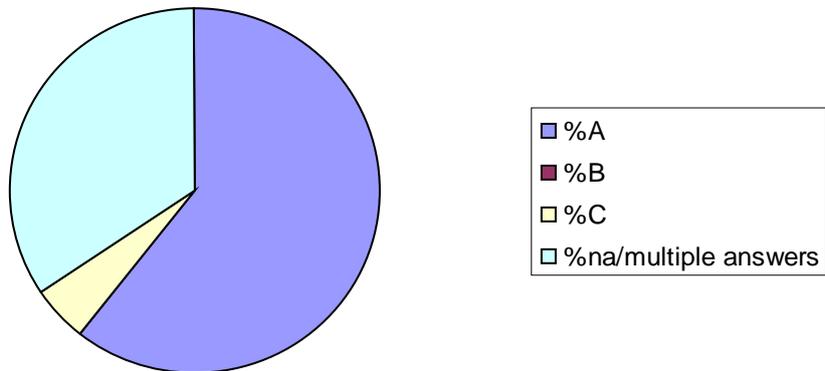


Illustration 4 - Most Disturbed (by %) Heathrow

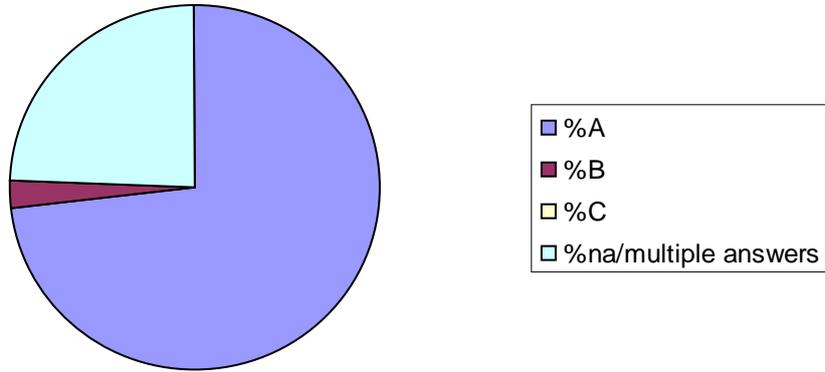


Illustration 5 - Most Disturbed (by %) Heathrow

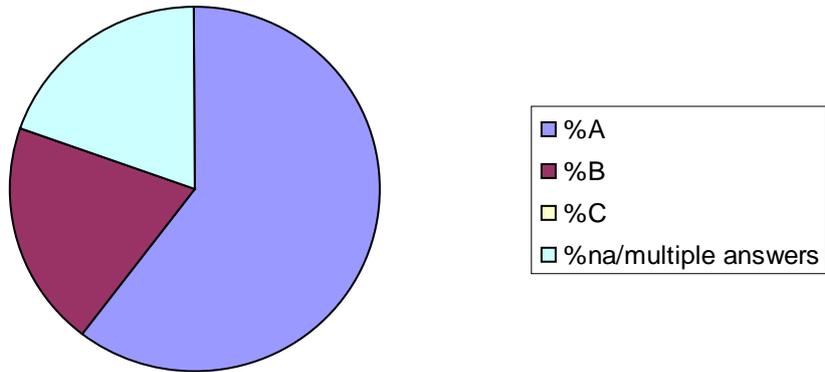


Illustration 6 - Most Disturbed (By %) Heathrow

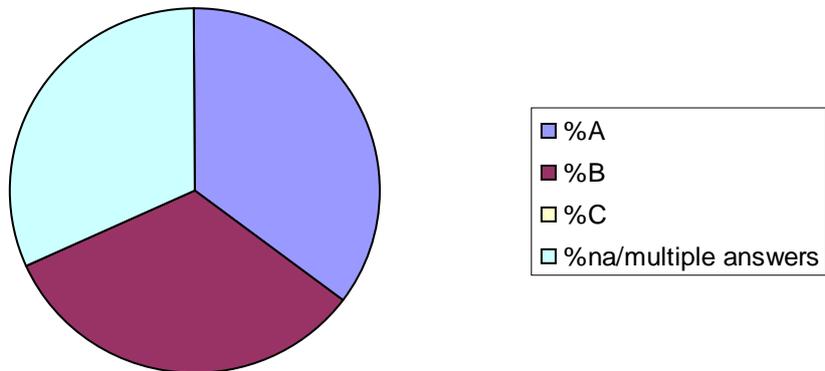


Illustration 7 - Most Disturbed (By %) Heathrow

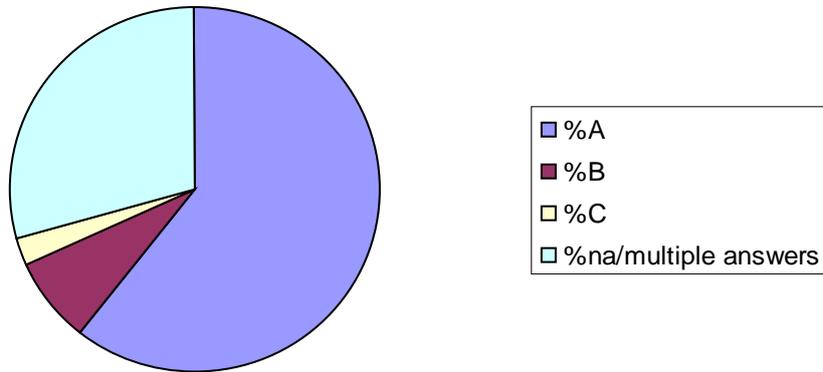


Illustration 8 - Most Disturbed (By %) Heathrow

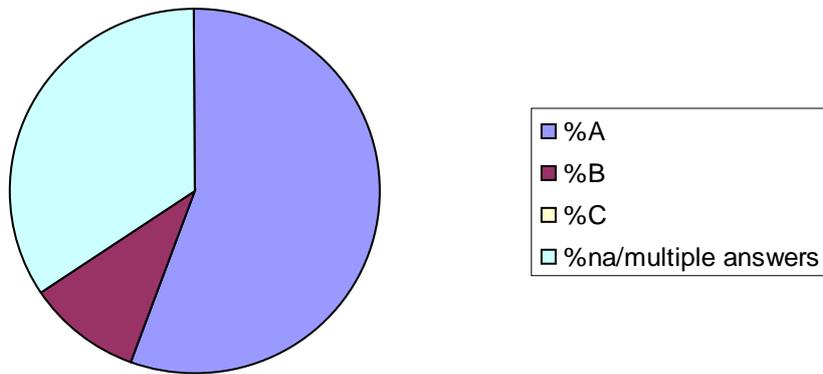


Illustration 9 - Most Disturbed (by %) Heathrow



As already noted, performance categories are open to individual interpretation, arguable this is particularly true of the perception of disturbance as this is known to be influenced by a range of physical, biological, psychological and sociological processes. However, as

acknowledged in the discussion of Question 2a in terms of relative quantitative measures of noise exposure (and based upon Leq contours, i.e. Illustrations 1 & 2), Manchester Locations A and B are considered to be similar (for Lden and Lnight Illustrations 3 & 4 location B is marginally more exposed than A), with Location C exposed to less aircraft noise. For Heathrow, Location A is considered to be noisier than B, which in turn is noisier than C. Given that, for illustrations 1 to 4, this is the only information available on which to make a judgement about the relative levels of disturbance at each location, it might be expected that this hierarchy of exposure would be reflected in participants' interpretation of relative disturbance.

At Manchester, for illustrations 1, 3 and 4 there is no consistent pattern of identifying Locations A and B as being more exposed than Location C; although B is identified as being more exposed than A consistently even where the contours indicate no significant difference between the location (i.e. in Illustration 1). Similarly the interpretation of the N70 contours did not reflect the positions of the locations relative to the contours, which were that locations A and B fell within the same contour and C was exposed to less events above 70dBA. The most obvious explanation for the fact that Location C was regarded as more disturbed than these illustrations would imply may be due to the fact that it is geographically located closer to the runways than Locations A and B. Interestingly, with the N60 contour, where B and C fall within the same contour and A is exposed to noticeably fewer events at this level, participants' interpretations were entirely consistent with the illustration.

The flight path movements for departures for Manchester show much higher levels of overflights for Location A than B with C clearly not overflown. This order was reflected in participants' responses. With arrivals Location B has a significantly greater number of overflights than Location A, with Location C not overflown. Again this order is reflected in participants' interpretation in levels of disturbance.

The variable scales on the bar charts for Manchester made comparing the different locations more difficult for participants, nevertheless their interpretation appears to have been dominated by the number of events at the higher noise levels, with location A identified as the most disturbed by the majority of participants.

At Heathrow, interpretation of the aggregate averaged metrics i.e. illustrations 1-4 showed some consistency in identifying Location A as the most disturbed location, however differentiation between B and C showed no particular pattern. Where contours make it very difficult to distinguish between the locations (i.e. all three locations fall within the same contour), as in the case of the N70 and N60 illustrations, the majority of participants still identified A as the most disturbed location, although this was slightly reduced from the proportions for illustrations 1 to 4.

The flight path movements for departures at Heathrow show much higher levels of overflights for Location A than B with C clearly not overflowed. This order was reflected in participants' responses. With arrivals Locations A and B are indistinguishable with Location C again not overflowed. Again this order is reflected in participants' interpretation in levels of disturbance.

The bar charts for Heathrow were amended to have the same scales in the light of experiences with the Manchester focus groups. Again, interpretation appears to have been dominated by the frequency of events at higher levels which is greater for Location A than B and also C.

The pie charts above demonstrate the wide variance in the interpretation of the aggregated averaged contours (illustrations 1 to 4 and 7 & 8) by participants, although there is some consistency in the identification of Location A as the most disturbed at Heathrow.

There is greater consensus in the interpretation of the flight path movement charts (illustrations 5 and 6) and the series of bar charts (illustration 9), which may indicate that these representations of the noise environment were most easily understood by the participants. This explanation would appear to be borne out by the responses to the last questions on the questionnaire as outlined below.

In addition to questions 1-4, each participant was asked to compare all the illustrations and indicate which they found to be the:

- Most informative;
- Least informative;
- Easiest to understand;
- Hardest to understand;
- Most visually attractive; and
- Least visually attractive.

Table 7 provides the results of this comparison and summarises overall response (all participants) as well as by participant type.

Table 7 - Comparison of illustrations.

	Most informative	Least informative	Easiest	Hardest	Most attractive	Least attractive
All participants	Illus 9	Illus 3	Illus 9	Illus 3	Illus 5	Illus 3
Local Authority Officers	Illus 9	Illus 7	Illus 9	Illus 8	Illus 5	Illus 6
Community Groups	Illus 9	Illus 1	Illus 9	Illus 3	Illus 5	Illus 7
Public (low exposure)	Illus 9	Illus 3	Illus 9	Illus 3	Illus 5	Illus 3
Public (high exposure)	Illus 9	Illus 1	Illus 5 & 9	Illus 9	Illus 5	Illus 9

For all groups the bar charts (illustration 9) were considered to be most informative and easiest to understand. By contrast a similar number of participants from the Public high exposure group also found illustration 9 one of the hardest to understand. In terms of overall perceptions the Lden chart

(Illustration 3) was considered to be the least informative, hardest to understand and the least attractive. All participant groups found the departures movement chart (Illustration 5) the most attractive.

4.6 Participant Comments

Participants were also encouraged to provide written comments on each of the illustrations. A list of these comments is provided in Appendix 9. In broad terms the comments serve to support many of the implications derived from the responses to the questionnaire. For example with respect to the aggregated averaged metrics (illustrations 1 to 4) participants highlighted:

- Problems arising from the lack of explanation of key terms and abbreviations such as Lden, Leq, standard average mode and Lnight. Particular confusion was caused by the overlay on areas of 'agglomeration' in illustrations 3 and 4 (the European metrics of Lden and Lnight); these shaded areas were regarded as 'off-putting' and irrelevant to interpretation.
- The failure of the illustrations to identify significant contributors to disturbance, namely information on; 'peaks of noise at any time', 'numbers' and 'types' of aircraft, times of movements, and the influence of changes to mode of operation.

These concerns explain the conclusions drawn by some participants that:

"lay persons would have little use for the maps at all"

"Leq is meaningless for most"

In contrast more positive comments were made about the flight path movement charts (illustrations 5 & 6) with participants noting that these were the:

- 'Clearest diagrams of all', 'the most valuable chart' and that they provided 'better, clearer information. Colours make it easier to see zones'

Nevertheless, participants also highlighted shortcomings with the illustrations relating to:

- Lack of information on; noise levels – especially sideline noise, the impact of each mode of operation, daily maximum movement numbers, height and thus noise levels, and noise impacts suffered by residents not overflown.
- Problems with the presentations such as; the separation of arrival and departure data, confusing use of colours, and the need for clearer definitions.

The numbers above contours charts (illustrations 7 & 8) were generally regarded as difficult to interpret given the close grouping of the contours (especially on the N70 map) and as only providing limited information on

events above a certain threshold the significance of which was not clear. However, one participant noted that the N70 chart was the 'most valuable' of all the illustrations.

The final illustrations (9) composed of bar charts indicating the average number of events across a range of maximum sound levels for three periods of the day were acknowledged as providing a level of 'detail that really helps to reveal the extent of the problems – if only for these specific locations'. However, some found the charts 'harder to evaluate' and 'not easy to assimilate'

Overall, therefore no on illustration was regarded as providing the most comprehensive and digestible aircraft noise data, which may explain some of the more negative summary comments:

"Really the illustrations are very poor and of little value to readily understand"

"Didn't find these easy to understand"

However, there was an acknowledgement that considerable value lay in providing a range of illustrations that served to capture different qualities of the noise environment:

"All the factors help create a better informed picture"

"They are all part of the story, but on their own none do the whole job – for me"

"Could understand all the charts but obviously some contained more data than others – depends on what you want to determine from the data provided"

4.7 General Focus Group Feedback

In addition to the written comments on the illustrations the discussion phase of the focus groups that followed the questionnaire provided an opportunity for participants to raise particular issues with the illustrations and highlight more general concerns regarding the communication of aircraft noise. During these sessions it became obvious that with some explanation most participants were able to understand the various metrics but, particularly in terms of members of the public, they felt that many of the conventional metrics lacked any real relevance to personal perceptions/experiences of noise exposure and ensuing disturbance. Many participants suggested that time of day and the number of aircraft movements was more important to them in terms of determining the level of disturbance or annoyance likely from aircraft noise than metrics such as the Leq, Lden and Lnight. Many had

little or no understanding of these metrics, including some Local Authority Officers, and commented that they had no appreciation of what different sound levels actually meant in practice (i.e. they had no reference point against which to compare the levels delineated by the contours). The level of mistrust of the metrics felt by many participants from community groups may also relate to the lack of understanding of how the metric is calculated with many participants wrongly believing that it is determined from measured rather than modelled data. There was also evidence of some fundamental misunderstanding of the use of contours on a map as some participants thought that the closer the lines are together the noisier it is.

The most common criticism was that the charts failed to illustrate actual experiences of aircraft noise, which were dominated by peak levels of sound, time of day and number of events. A key determinant of these qualities was identified as the mode of operation and concerns were raised that any illustration that averaged the impact of mixed modes failed to 'capture' the experiences of local residents on any one day, which would normally be dominated by a particular mode of operation. For this reason it was suggested that the departure and arrival flight path movement charts would have been more informative if presented by mode rather than segregated into mixed mode landings and take-offs.

Detailed summaries of the feedback sessions are provided in Appendix 4.

5.0 Summary

The response to the flyer campaign to recruit focus group participants was very low, possibly indicating that either people in the areas targeted have no wish to learn more about aircraft noise, have no interest in aircraft noise, or that the channels of distribution and persuasion of the flyers require further assessment.

However, those focus group participants who did turn up engaged in the process in a thorough and logical manner and provided a valuable insight into the varying levels of understanding of the metrics.

Conventional metrics such as the Leq, Lden and Lnight that involve the use of contour charts are generally difficult or impossible for members of the public to understand. Even in more informed groups such as Local Authority Officers and Community Group representatives there was evidence of misunderstanding of these metrics. Flight path movement charts (illustrations 5 and 6) were considered to be the most visually attractive by the majority of participants however a number failed to appreciate that one chart showed departures and the other one arrivals. It should also be noted that these charts give no indication of sound levels on the ground, which of course decrease with increasing distance from the airport as the altitude of aircraft increases. The N70 and N60 charts (illustrations 7 and 8) were often initially misinterpreted by participants, partly due to the lack of understanding and interpretation of contour plots but were nevertheless more easily understood after some explanation than the other contour plots. Participant feedback indicated that it would be useful to have the N70 and N60 charts superimposed with flightpath data. Illustration 9, which comprised of bar charts for each of the 3 locations was the most easily understood by the majority of participants. A key disadvantage of this type of illustration, as identified by some participants is that the information presented is limited to the 3 geographical locations. It was therefore felt that this type of information would be most useful when combined with other maps. Additionally, issues of misinterpretation due to differences in scale were noted with the Manchester focus groups.

During the focus groups it became evident that with some explanation most people are then able to understand the illustrations, however for most the lack of relevance of the metrics to personal experience of aircraft noise makes them meaningless. Most participants agreed that a suite of metrics providing information on flight paths, number of flights at peak times and maximum sound levels would be particularly useful.

6.0 Conclusion and Recommendations

In summary, the focus groups were undertaken with both sensitised and non-sensitised members of the public and also Local Authority Officers who have an interest in aircraft noise issues and revealed:

- Considerable variation in the interpretation of different metrics used to illustrate the same noise environment.
- General dissatisfaction and indeed mistrust in some cases among members of the public with the aggregated indicators such as Leq and Lden.
- All the aggregated indicators (Leq, Lden, Lnight, N60 and N70) required considerable explanation in the latter part of the focus groups before participants understood the illustrations.
- An affinity for metrics that disaggregate key elements of aircraft noise; namely, time, frequency of events and individual sound levels.
- A desire for a wider range of noise exposure illustrations, especially among members of the public living close to airports.
- Universal acknowledgement that bar charts, for specific locations illustrating the numbers of events within ranges of maximum sound levels for given periods of the day, were the most informative and easiest to interpret of all the metrics viewed.
- Consensus that the flight path densities maps were the most visually attractive despite the lack of specific noise data contained therein. To combat this, a number of participants suggested that this image could be overlaid on aggregated noise footprints such as N70 or Leq contours.
- That the public is more interested in site specific information that is easy to interpret in relation to their own personal exposure, rather than more complex images that may provide a comprehensive overview of the whole noise environment around an airport as conventionally used by planners and decision-makers.

Given the small sample size and the exploratory nature of this research, care must be taken when attaching significance to these findings; nevertheless, the results point to the potential value of:

- A more substantive UK study to 'test' these preliminary findings.
- Providing appropriately differentiated information to different user groups depending on their individual requirements.
- More detailed investigation of the supplementary noise indicators such as those developed in Australia and the novel location-specific histograms evaluated here for the first time, in terms of their:
 - Contribution to improved understanding of aircraft noise exposure.

- Potential to aid in establishing effective dialogue with the communities most affected by aircraft noise and most cynical about the conventional metrics.
- Contributing to the development of future noise metrics in such a way as to enhance public acceptance of future aviation development.

7.0 References

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