# Appendix B

## Noise Definitions and Terminology

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### Noise levels

The ratio between the quietest audible sound and the loudest tolerable sound is a million to one in terms of the change in sound pressure. Due to this wide range, a scale based on logarithms is used in noise level measurement. The scale used to express the sound pressure level is the decibel (dB) scale. Most sound pressure levels encountered lie in the range 0 to 140 dB.

An important characteristic of human hearing is its relative insensitivity to low frequency and very high frequency sound. A system of weighting curves for sound level meters, denoted A, B and C was developed to take account of this. The A curve was designed to follow the equal loudness curve at an A-weighted level of about 40 dB; the B curve was designed for B-weighted levels of around 70 dB and the C curve was for noise at a C-weighted level around 120 dB.

The correlation between environmental noise measured using the A-weighting scale and social survey responses to questions about noise annoyance was not significantly worse than correlations using more elaborate scales, and today environmental and occupational noise is almost exclusively measured and assessed using indices based on the dB scale.

Noise levels in dB, like the basic decibel scale, measure proportions so that a 10 dB increase is approximately a doubling of loudness and a 10 dB decrease is approximately a halving of loudness. Judgement of loudness is subjective, and dependent on the characteristics of the sound, but the ‘10 dB increase is a doubling of loudness' rule is a useful general guide. For example, ten identical noise sources located close together sound only about twice as loud as one source, and certainly not ten times as loud; the same is true of one source that emits ten times as much sound power as another. As a further guide, one may say that a sound level of less than 20 dB is virtual silence, 30 dB is very quiet, 50 dB is a moderate level of noise, 70 dB is quite noisy and at a noise level of 90 dB one has to shout to be understood. If the sound is predominantly of low frequency, a doubling of loudness may be perceived with an increase of less than 10 dB.

The measurement of sound levels in decibels involves a kind of averaging process in which the fluctuating pressure signal is squared, averaged, and the square root obtained. This process is known as root-mean-square or ‘r.m.s.’ averaging, and it takes place over a defined time period. A sound level expressed in decibels is denoted by the symbol ‘L’ which indicates a value expressed in decibels (abbreviated dB) relative to a standard reference level (0 dB = 20 micropascals of r.m.s. sound pressure). In this way the dB scale can measure absolute levels as well as relative levels. When instantaneous levels are measured, the result is dependent on the choice of r.m.s. averaging time, particularly with measurements of sounds of fluctuating level. There are two standard averaging times, “fast” and “slow”. Measurements of the instantaneous sound level are denoted by the symbols $L_{AS}$ or $L_{AF}$. The subscript ‘S’ or ‘F’ specifies a method of exponential averaging as defined in IEC 61672, using the standard ‘slow’ time constant of 1 second or the ‘F’ or ‘fast’ time constant of 1/8 second. ‘S’ has a greater smoothing effect on sound that varies in level. The subscript ‘max’ means the highest averaged value reached during an event. The value of $L_{Amax,S}$ nearly equals the value of $L_{Amax,F}$ for a steady sound that lasts for one second or more, otherwise $L_{Amax,F}$ levels exceed $L_{Amax,S}$ levels by an amount dependent on the rapidity and magnitude of the variations. $L_{Amax,S}$ can alternatively be written as $L_{Asmax}$ and is defined in IEC 61672.

## Noise Indicators

The basic dB scale can only measure the instantaneous level of sound, and where the level of sound fluctuates up and down, as it normally does in the environment, the dB level also fluctuates. When it is necessary to measure a fluctuating noise environment by means of single number, an index known as equivalent continuous sound level, or $L_{Aeq}$, is employed. $L_{Aeq}$ (which in some documents is referred to as $L_{eq}$ in units of dB(A) rather than $L_{Aeq}$ in units of dB– the two terms have the same meaning) is a long term average of the amount of energy in the fluctuating sound, expressed in A-weighted decibels. In the case of a continuous, unchanging sound, its $L_{Aeq}$ level is the same as its sound level, $L_A$, in dB. Since $L_{Aeq}$ always relates to a specified time period, the notation $L_{Aeq,T}$ is used with T representing the time over which the index is determined.

The $L_{Aeq}$ scale is effectively a composite measure of sound level, duration and number of occurrences where there are discrete noise events. In the case of a noise environment which is entirely dominated by discrete events it can in fact be synthesised from measurements of the energy content of each event. This is done by integrating, over a time at least as long as the event duration, the squared pressure, and taking the square root. The resultant index is known as Sound Exposure Level (or Single Event Level), denoted SEL. Because the integration is in units of seconds, SEL is equivalent to $L_{Aeq}$ corrected for the hypothetical case that the noise has a duration of one second. SEL is also denoted as $L_{AE}$. The $L_{AX}$ index is very similar, except that the integration takes place only of the part of the noise event that is not more than 10 dB below the maximum level.

The Environmental Noise Directive, the “END”, (2002/49/EC) introduced a variant of the $L_{Aeq}$ index intended to address the increased annoyance/disturbance value of noise at night, and to a lesser extent in the evening. The day-evening-night level denoted $L_{den}$ is $L_{Aeq}$ computed over 24 hours, but with noise between 2300 and 0700 increased by the addition of 10 dB and noise between 1900 and 2300 hours increased by the addition of 5 dB. This index is used for the preparation of the statutory noise maps by the Department of Environment, Food and Rural Affairs (Defra) in accordance with the END.

## Noise Definitions

Noise effects from airports and associated development and operations can be generally classified into four main areas:

- Air noise;
- Ground noise;
- Surface access noise; and
- Construction noise.

***Air noise*** is defined as all noise caused by departing and arriving aircraft between start-of-roll (SOR) and completion of the landing run, including the use of reverse thrust where relevant. The consideration of noise issues at Heathrow Airport has largely focused on air noise as the main issue.

Air noise is typically represented by a series of noise contours that portray noise levels in areas surrounding airports. At Heathrow Airport, air noise contours are generated produced by the UK CAA

using its Aircraft Noise Contour Model (ANCON) model. In simple terms, the model works by using the characteristics of the airport and its airspace along with arrival and departure track distribution information which includes the numbers and types of aircraft that will use the airport, to calculate noise levels at various grid points surrounding the airport. The noise grid results are then used to plot noise contours which identify locations of equivalent noise exposure.

The contours enable information such as population(s), number of dwellings and areas exposed to certain noise levels to be calculated, and may also be processed in order to display incremental changes. Specific locations and sensitive receptors such as schools and hospitals may also be assessed. The contours are used along with relevant policy and guidance to assess the effects of air noise upon the receptors.

In the UK, aircraft noise is typically measured using 'average-mode' noise contours which take account of the number of aircraft movements over an average 16 hour summer day (0700-2300 mid-June to mid-September) in terms of the $L_{Aeq,\ 16h}$ index. Current government policy[1] adopts the noise indicator $L_{Aeq,\ 16h}$[2] due to its correlation with community annoyance and government policy is that air noise levels of 57 dB $L_{Aeq,\ 16h}$ and above mark the '*approximate onset of significant community annoyance'* however it is acknowledged within Government policy that $L_{Aeq,\ 16h}$ is not the only measure of aircraft noise. $L_{Aeq,\ 16h}$ air noise contours for Heathrow airport are produced annually by the UK CAA. To reports are produced to inform surrounding communities of noise exposure and trends in exposure over time.

Noise contours are produced for other noise indicators, notably $L_{den}$ and $L_{night}$. Heathrow Airport has produced $L_{den}$ contours for levels of 55 dB $L_{den}$ and above and 50 dB $L_{night}$ and above, as required by the European Union under Directive 2002/*49/EC.* It is a mandatory requirement that these contours are produced every 5-years corresponding with the cycle of the Directive. Under voluntary commitments made by the Airport is its Noise Action Plan, these contours are now produced on an annual basis.

A full description of Government policy and legislation relating to air noise is discussed in Section 6.2.

***Ground noise*** is defined as all noise emitted from airside sources that contribute materially to noise levels heard outside the airport, including aircraft up to SOR and after completion of the ground run on landing, i.e. including taxiing to the runway, queuing and holding prior to the SOR, and taxiing from the runway via taxiways to their stand locations. Typical airside noise sources comprise aircraft engine idling and taxiing, the running of aircraft auxiliary power units (APUs) whilst on stands, ground power and preconditioned air units where relevant, aircraft engine ground running and maintenance, as well as ground support vehicles and airside road traffic. As with air noise, assessments involve the development of noise models. This practice allows airside noise sources to be modelled and noise to be calculated at receptors surrounding the airfield although unlike the air noise contours these are not annually produced for Heathrow Airport.

***Surface access*** noise is generated by different modes of transport serving traveller needs to and from an airport. This predominantly comprises road traffic (including public transport such as bus and coach services), heavy and light rail traffic. It can also include noise from 'on-/off-airport' car parks and traffic related to 'off-airport' activities such as catering.

***Construction noise*** is defined as noise from construction activities occurring at the airport.