Appendix 13.1 – Introduction to Noise

Introduction to Noise

Noise is defined as unwanted sound, and the unit of measurement is the decibel (dB(A)). Noise levels range from the threshold of hearing at 0(A) to levels of over 130(A) at which point noise becomes painful.

Sound consists of vibrations transmitted to the ear as rapid variations in air pressure. The more rapid the fluctuation the higher the frequency of the sound. Frequency is the number of pressure fluctuations per second and is expressed in Hertz (Hz).

The sensitivity of the human ear varies with frequency. To allow for this phenomenon, sound level meters are often equipped with a set of filters that modify the response of the sound level meter in a similar way to the human ear; these filters are referred to as the 'A-weighting network'. The 'dB(A)' notation is used to indicate when noise levels have been filtered using the A-weighting network. It has been found that changes in noise level when measured in(A) correlate better with changes in subjective reaction than to changes in noise measured without using the A-weighting network.

Some common levels of noise on the A-weighted scale are given in the table below, which was published in a now superseded edition of the Design Manual for Roads and Bridges.

Source	Sound Pressure Level,(A)
Threshold of hearing – silent	0
Quiet bedroom	25-35
Quiet rural area	45-50
Suburban areas away from main traffic routes	50-60
Conversational speech at 1m distance	60-70
Busy urban street corner	70-80
Passenger car at 60 kph (37 mph) at 7m distance	72
Heavy diesel lorry at 40 Km/hr (25 mph) and 7 m distance	85
Hazard to hearing from continuous exposure	90*
Pneumatic drill (un-silenced) at 7 m distance	95
Threshold of pain	130-140

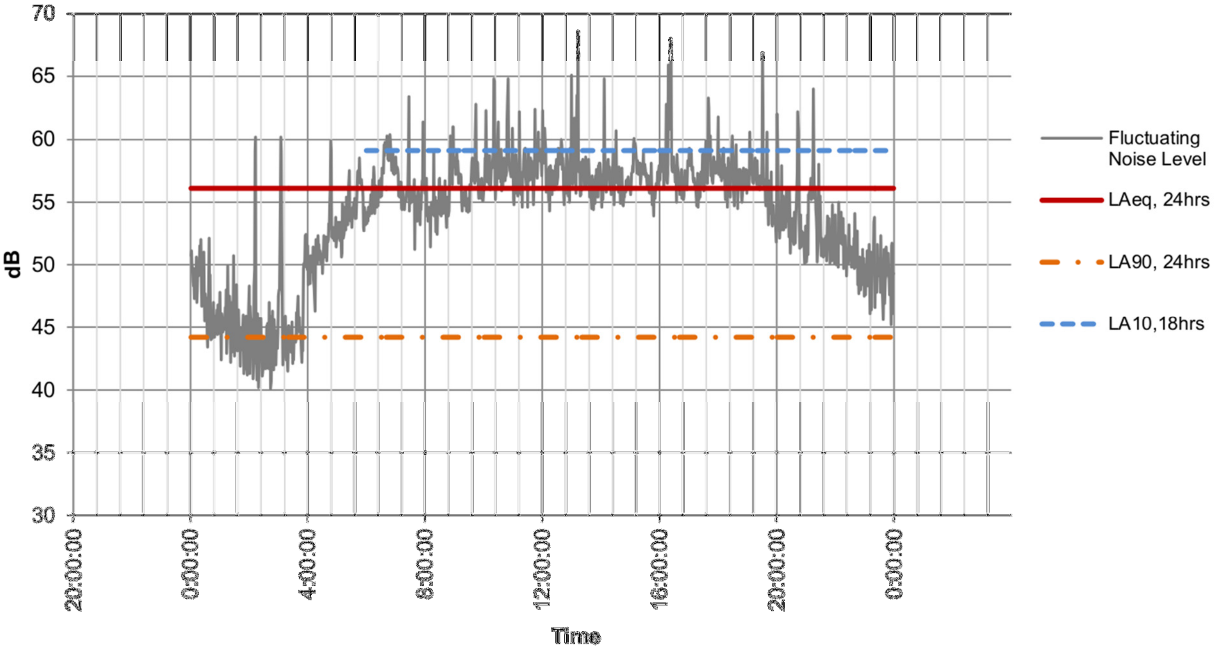
***90 LAeq is a historic value. It is now accepted that progressive loss of hearing due to continuous noise exposure at or above 85 LAeq.**

Noise Descriptors

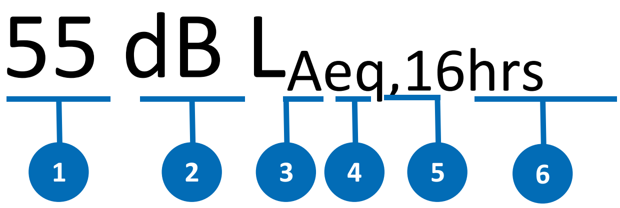
The subjective response to noise is dependent not only upon the sound pressure level and its frequency but also on its duration and the time of day it occurs. Noise levels fluctuate in response to events, for instance with aircraft passing overhead or changes in the quantity and speed of road traffic on nearby roads. For this reason environmental noise is often described in terms of an equivalent continuous sound pressure level, which can be thought of as a constant noise level over a time period (T) that contains the same sound energy as the fluctuating noise level. The notation for this noise descriptor is LAeq,T and this concept is shown graphically in the graph below.

The index adopted in England to assess traffic noise is the A-weighted L10,18hr which is the arithmetic average of the noise levels exceeded for 10 per cent of the time in each of the 18 one-hour periods between 6am and midnight. The A-weighted L10,18hr index has been shown to have a good relationship with annoyance caused by road traffic noise, which can be relatively steady over the course of a day.

The LA90,T statistical noise parameter, which is defined as the level exceeded for 90% of the measurement period (T), is often used to describe background noise levels. This can be thought of as representing the underlying level of noise present during the quieter parts of the measurement.



The nomenclature used to represent statistical acoustic quantities can appear complicated, however once understood it is logical and efficient. Take for instance the upper noise level recommended by BS8233 for balconies and outdoor living areas of 55 $L_{Aeq,16hrs}$:



The above descriptor is comprised as follows:

1. The first part of the statistical descriptor identifies its numeric value. This value is usually given as a whole number or to one decimal place. Where values are given to one decimal place, this is normally required for compliance with a particular standard or convention, but it does not necessarily imply that the values are accurate to one decimal place.

2. The second group of characters indicate that the units of the noise descriptor are decibels.

3. The third grouping (‘L’) indicates that the quantity is a sound pressure level. Other less common quantities are sound intensity level (L_I) and sound power level (L_W).

4. The fourth grouping (‘A’) denotes that the sound pressure level is evaluated using the A-weighted filter network.

> *There are two competing conventions regarding the position of this identifier, either immediately after the ‘L’ as shown in the example above, or alternatively in brackets following the units. Therefore whilst appearing different, 55 LAeq,16hrs and 55(A)Leq,16hrs are equivalent and may be used interchangeably. Which convention is used is a matter of preference; however it is considered good practice to remain consistent within a document for the convenience of the reader.*

5. The fifth grouping of characters identify the statistical index. In this example, the letters indicate that the quantity is in terms of the **eq**uivalent continuous noise level (eq), which has some similarities with the concept of an average noise level. Numerical values are also shown, and these indicate the level exceeded for n per cent of the measurement (e.g. a value of 45 $L_{A90,T}$ indicates that the A-weighted sound pressure level exceeds 45 for 90% of the period T).

6. The sixth and final quantity shown after the statistical index is the duration over which the quantity is evaluated. This is typically represented in minutes or hours, e.g. 15min, 16hrs.

Decibel Addition

If the sound levels from two or more sources have been measured or predicted separately, and the combined sound level is required, the sound levels must be added together. However, due to the fact the decibel is a logarithmic value they cannot be added together using normal arithmetic.

The table below provides a quick guide to adding two sound levels together. First the difference between the higher and lower noise level must be calculated, and then the corresponding amount in the right hand side of the table must be added to the higher of the two noise levels.

Difference between noise levels,	Amount to be added to higher level,
0	3.0
1	2.5
2	2.1
3	1.8
4	1.5
5	1.2
10	0.4
15	0.1

For example, when adding the values of 50.0(A) and 55.0(A) together, the difference between them is 5.0(A) and therefore 1.2(A) should be added to the higher value. The resulting sound level would be 56.2(A).

Human Sensitivity to Change

Generally, a change of 3(A) in fluctuating environmental noise is the minimum change perceptible to a human. However, there is research that suggests with respect to road traffic noise, immediately following a sudden change in traffic flow or road alignment people may find benefits or disbenefits when noise changes are as small as 1 dB(A). A change of 1 dB(A) is equivalent to an increase in traffic flow of 25 per cent or a decrease in traffic flow of 20 per cent. These effects last for a number of years, however, in the longer term, perceived noise nuisance may tend towards the steady state level associated with the new source, which is generally lower.

Free-field and Façade Incident Levels

Due to the effects of reflection, sound pressure levels measured close to large vertical reflecting surfaces such as building façades higher than those that are measured away from reflective surfaces.

Sound pressure levels measured 1m from a large solid, reflecting surface are termed 'façade incident' levels, whilst those measured at least 3m away from any reflective surfaces (other than the ground) are termed 'free-field'. Façade incident levels are typically up to 3 higher than free-field levels and therefore it is important to know the conditions under which a noise measurement or prediction has been undertaken.

Unless stated otherwise, the noise levels presented in this chapter are free-field levels which do not account for the effects of reflection from adjacent building facades.