University College London

UCL Alexandra House

Noise Impact Assessment

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1 Introduction

1.1 Proposals are in place to refurbish both the Basement Level and Fifth Floor within UCL's Alexandra House building located on Queen Square, London. As part of these works it is understood that two new external plant items will be installed to locations within the front lightwell and rear external courtyard of the building.

1.2 An external noise survey has previously been undertaken at the site by AECOM to establish the prevailing ambient and background noise levels. Based on these measured noise levels, along with guidance provided by the Local Authority, the London Borough of Camden, noise emission limits have been determined for the site.

1.3 To demonstrate that the noise emission limits will be attained, calculations to predict the noise level 1 m from the window of the nearest noise sensitive premises have been performed based upon the proposed plant details.

1.4 A glossary of acoustic terminology used in this report is presented in Appendix A.

2 Noise Emission Assessment

2.1 Site Description

2.1.1 Alexandra House (17 – 19 Queen Square) is located on the north west corner of Queen Square, within the London Borough of Camden.

2.1.2 Unattended noise measurements were made previously by AECOM (report ref: *60236694/Rp1v1*) between 13:15 on Thursday 7th and 13:30 on Friday 8th May 2015 at a location to the rear of Alexandra House.

2.1.3 Additional measurements were also made to the front of the building, at street level, between 13:30 and 14:00 on Thursday 7th and Friday 8th May 2015.

2.1.4 The nearest noise sensitive premises (NNSP) to the site is considered to be the neighbouring residential property at 15 Queen Square. The measurement locations and location of the NNSP are shown in Figure 2.1 below:

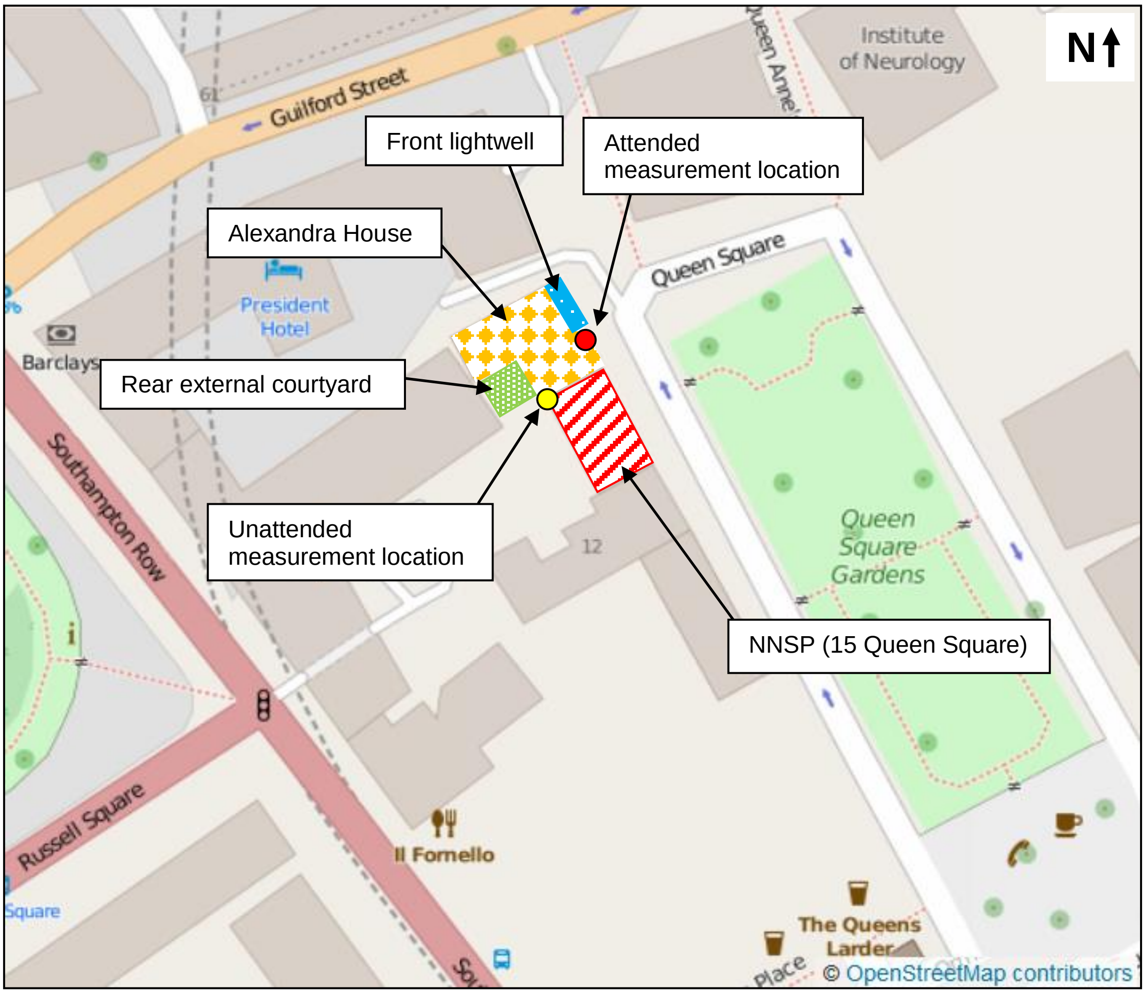

Figure 2.1 Site Plan Showing Measurement Locations and Location of NNSP

2.2 Noise Emission Limits – Rear External Courtyard

2.2.1 Based on the background noise levels measured at the unattended measurement location and subsequent Local Authority guidance, the following noise emission limits are to be achieved (initial noise emission limits proposed were based upon achieving a level of 5 dB below the existing background sound level). These are to be achieved at 1 m from the façade of the nearest noise sensitive premises and are based on achieving a level of 10 dB below the existing background sound level.

Location	Time Period	Noise Emission Limit at 1 m from the Façade of the Nearest Noise Sensitive Premises (dB $L_{Ar,Tr}$)
Rear External Courtyard	Daytime (07:00 – 23:00)	47
	Night-time (23:00 – 07:00)	47

All values are sound pressure levels in dB re 20 µPa

Table 2.1: Noise Emission Limits – Rear External Courtyard

2.2.2 The above limits should be met with all plant operating simultaneously. In line with guidance contained within BS 4142:2014 where noise from plant contains certain acoustic features (impulses, tones etc.) this should be accounted for by applying a penalty correction to the 'specific sound level' of the item, as defined in BS 4142, in order to determine its rating level, $L_{Ar,Tr}$.

2.3 Noise Emission Limits – Front Lightwell

2.3.1 Where plant is proposed to be installed to the front of the building, within the lightwell, the noise emission limits have been informed by the previous attended measurements made at this location. It is considered that these measurements are applicable as it is understood that plant at this location will only be in operation during office hours (07:00 – 19:00).

2.3.2 Background noise levels measured at this location during this period ranged from **50 – 53 dB $L_{A90, 15mins}$**. It is considered that designing the plant to achieve a level of **≤ 40 dB $L_{Ar,Tr}$** (10 dB below the representative background level) at the window of the nearest NNSP would be acceptable to the Local Authority.

Location	Time Period	Noise Emission Limit @ 1 m from the Façade of the Nearest Noise Sensitive Premises (dB $L_{Ar,Tr}$)
Front Lightwell	Daytime (07:00 – 23:00)	40
	Night-time (23:00 – 07:00)	n/a – plant only operational during typical office hours (07:00 – 19:00)

All values are sound pressure levels in dB re 20 µPa

Table 2.2: Noise Emission Limits – Front Lightwell

2.4 Proposed Plant Items

2.4.1 External plant items are detailed in Table 2.3. Acoustic data has been taken from the manufacturer's data sheets for the units, assumed to be correct at the time of writing.

Location	Plant Item	Free-Field Sound Pressure Level at 1 m from item (dB L_A)
Rear external courtyard	Daikin RYYQ8T Condenser	58
Front lightwell	Daikin RXS50L Condenser	48

Sound pressure levels are in dB re 20 µPa

Table 2.3: External Plant Details

2.5 Noise Impact Assessment – Rear External Courtyard

2.5.1 The proposed location of the external plant item to be installed to the courtyard at the rear of Alexandra House and location of the most affected residential window in relation to this are shown in Figure 2.2 below. A plan and section drawing showing the location of this item is also shown in Figure 2.3.

Figure 2.2: Rear External Courtyard – Proposed Plant Location

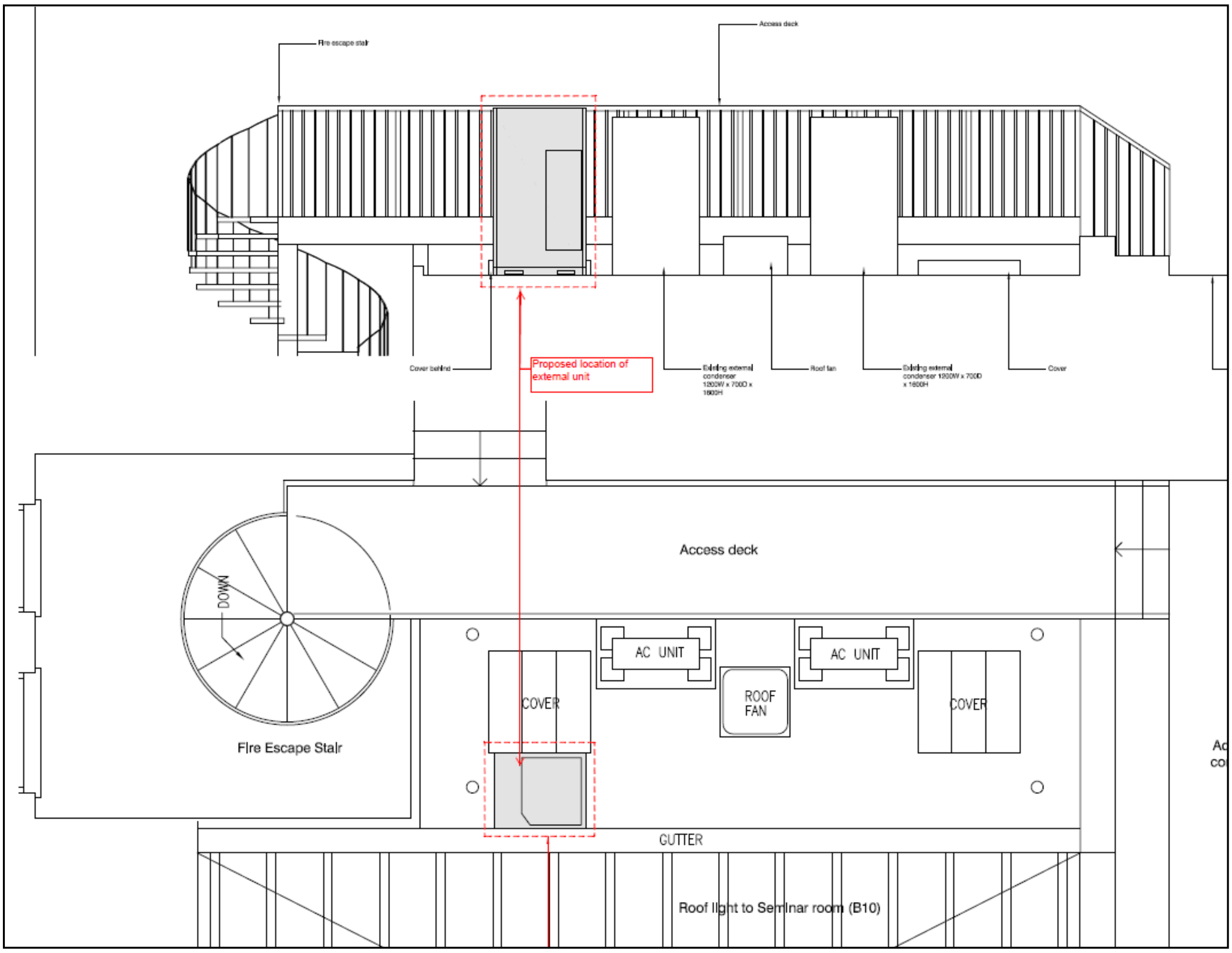

Figure 2.3: Elevation and plan drawing showing proposed plant location at Rear External Courtyard and distance to most affected residential window

2.5.2 The external condensing unit located at the rear of Alexandra House is overlooked by residential windows of 15 Queen Square. The nearest, most affected of these windows has been measured to be 7 m (rounded up) away from the proposed unit. The predicted amount of distance attenuation, assuming point source noise propagation, has been calculated to be 17 dB.

2.5.3 No attenuation owing to screening has been included, as the unit is directly overlooked by the NNSP.

2.5.4 As the proposed plant item is to be located in proximity to 2 reflecting surfaces (the floor it is positioned on and 45° pitched roof to the rear of the unit) a directivity factor (Q) of 4 has been applied, in order to provide a worst case assessment. An additional 6 dB has been added to the free-field sound pressure level accordingly.

2.5.5 The results of the noise impact assessment are summarised later in Section 2.7 of this document.

2.6 Noise Impact Assessment – Front Lightwell

2.6.1 The location of the external plant item to be installed to the front lightwell of Alexandra House, serving the seminar room, is shown in Figure 2.4 below. An elevation drawing showing the location of this item is also shown in Figure 2.5.

Figure 2.4: Front Lightwell – Proposed Plant Location

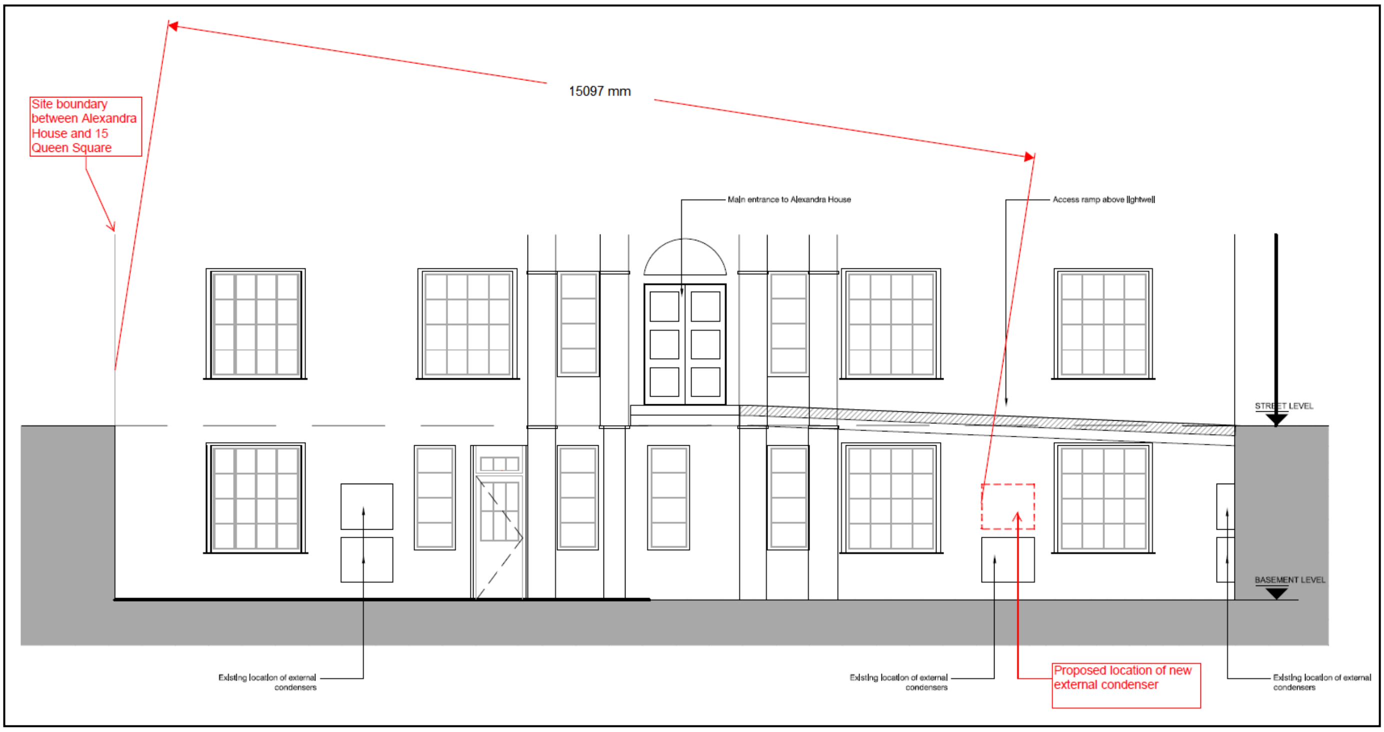

Figure 2.5: Section and plan showing proposed plant location within Front Lightwell and distance to most affected residential window

2.6.1 The external condensing unit is proposed to be installed in the front lightwell of the building, beneath the access ramp. The nearest noise sensitive premises to this item is 15 Queen Square, some 15 m away from the proposed plant location. The predicted amount of distance attenuation, assuming point source noise prorogation, has been calculated to be 24 dB.

2.6.2 No attenuation owing to screening effects of the access ramp has been included, in order to provide a conservative assessment of the resultant noise level at the NNSP.

2.6.3 The proposed plant item is to be located in proximity to 1 reflecting surface (the wall the unit is installed to) however in order to account for the potential build-up of reverberant noise within the plant well, a directivity factor (Q) of 4 has been chosen to be applied. An additional 6 dB has been added to the free-field sound pressure level accordingly.

2.7 Noise Impact Assessment – Summary

2.7.1 Based on the plant noise levels shown in Table 2.3, and commentary in Sections 2.5 and 2.6, the level of noise emission from the two proposed plant items is predicted to be below the limits at the NNSP, during both the daytime and night-time periods where applicable. This is summarised in Table 2.4 below:

Location	Time Period	Sound Pressure Level @ 1 m from Proposed Plant Item (dB L_A)	Attenuation Owing to Distance	Directivity Factor (Q)	Resultant Noise Level at NNSR (dB L_A)	Noise Emission Limit at 1 m from the Façade of the NNSP (dB $L_{Ar,Tr}$)	Compliant
Rear external courtyard	Daytime (07:00 – 23:00)	58	– 17 dB	Q = 4 + 6 dB	47	47	✓
	Night-time (23:00 – 07:00)					47	✓
Front lightwell	Daytime (07:00 – 23:00)	48	– 24 dB	Q = 4 + 6 dB	30	40	✓
	Night-time (23:00 – 07:00)	n/a: Plant only operational during office hours (07:00 – 19:00)					

Sound pressure levels are in dB re 20 µPa

Table 2.4: Predicted Noise Level at 1 m from the NNSP

2.7.2 Based on the calculations presented above, the noise level at the NNSP, as a result of the proposed plant items, is predicted to be compliant with our advised noise emission limits based on findings of an external noise survey. It is therefore considered that compliance with the Local Authority's requirements has been demonstrated.

3 Conclusions

3.1 New items of external plant are proposed to be installed to two locations at the UCL building Alexandra House.

3.2 In order to satisfy the requirements of the Local Authority, the London Borough of Camden, a noise emission assessment has been undertaken to predict the levels of noise emission at the nearest noise sensitive premises (NNSP), 15 Queen Square.

3.3 Based on the current plant proposals as shown in Table 2.3, the commentary and summary presented in Sections 2.5 – 2.7, the resultant noise levels at the NNSP are predicted to be below the advised noise emission limits. It is therefore considered that compliance with the Local Authority requirements has been demonstrated.

Appendix A: Acoustic Terminology

This appendix provides a layperson's explanation of the acoustics terms that commonly appear in reports. It is not intended to give full scientific definitions and explanations or go into detail on how and why things are as they are. Some obsolete terms and abbreviations have been included as they still appear in documents from time to time.

Many words have more specific meanings when used in acoustics than in every-day language.	
sound	is used to describe the physical phenomenon of the transmission of energy through gaseous or liquid media via rapid fluctuations in pressure.
level	used solely to describe values measured in decibels
loudness	is the human perception of the level of sound
noise	has no strict definition and is often used interchangeably with sound however it is usually taken to mean unwanted sound
index	a value based on the mathematical processing of raw data
indicator	a value used to indicate the likelihood of a particular response of effect eg. $L_{10,18hr}$ is an index based on statistical processing of sound pressure data that is used as an indicator for road traffic noise response.
weighted	values modified to reflect sensitivities at particular frequencies.
apparent	measured in situ
standardised	a generalised value based on an in-situ measurement with a correction based on a space with standard reverberation
normalised	a generalised value based on an in-situ measurement with a correction based on space with standard absorption area
insulation	resistance to the passage of airborne sound
attenuation	amount by which sound or vibration is reduced when passing through a structure or system

decibels dB	The decibel is not a true measurement unit nor is it exclusive to acoustics. The decibel is a logarithmic ratio of two values of a variable. Decibels are used because they can represent very wide ranges of ratios (from trillionths and billionths to billions and trillions) with a small range of decibel values. Decibels can be used to represent measured values by using a known reference value in the ratio. When using decibels to measure something it is therefore important to specify what variable is actually being measured and what reference level has been used. This is done by adding a reference value statement in the form “dB re x units”, where the units indicate the variable being measured and x is the reference value. Decibels are used in acoustics because the human ear responds to sound in a logarithmic way and the quantities measured in acoustics vary over wide ranges. However, decibels are used in acoustics to measure several different things which it is important not to confuse with each other. To avoid confusion there is a notation system that identifies what a decibel value is for. The notations take the form of an italic capital letter and some subscript characters. The capital identifies the general type of value and the subscripts give specific details of what is being represented. L_{xxx} denotes a level (ie a value measured in dB by comparison with a reference value); D_{xxx} denotes a difference between two levels; R_{xxx} denotes a rating (or index), which is measure of the generalised acoustic performance of a material or construction based on a difference between two levels; C_{xxx} denotes a correction (or constant) Of these only those with *L* notations require a reference value statement. Those with *D* or *R* notations are effectively ratios of two measured values not one measured value and a reference value and those with *C* notations are not based on reference values at all. A reference value statement therefore has no meaning when describing *D*, *R* and *C* decibels. Because decibels are logarithmic they have to be added, subtracted, multiplied, divided and averaged using different techniques from normal numbers.
Sound Pressure Level L_p obsolete – SPL	This is the basic measure of how much sound there is at a given location. It is a measure of the size of the pressure fluctuations in the air that we perceive as sound. Sound Pressure Level is expressed in decibels with a reference level of 20 μPa (L_p in dB re 20 μPa)

Pitch, frequency tonal sound broadband sound impulsive sound frequency analysis	The sound we perceive can have different characteristics. These can range from low-pitched hums to high-pitched squeals and impulsive sounds. In engineering acoustics the word frequency rather than pitch tends to be used when describing the characteristics of a sound. The unit of frequency is the Hertz (Hz), which is the number of pressure fluctuations per second. Any sound can be defined by its frequency content. Some sounds comprise just one discrete frequency (tonal sounds). Others are distributed over wide frequency ranges (broad band sound). Impulsive sounds are made up short pulses of high frequency components. Sources often produce all of these types of sound at the same time. There are different ways of analysing and displaying the frequency content of a sound: Octave Band Analysis – is the simplest method. The audible range of frequencies is divided into 10 bands. Third-Octave Band Analysis – more detailed with 30 bands Narrow Band Analysis – 12^{th} Octave (120 bands), 24^{th} Octave (240), Fast Fourier (FFT) Analysis – a high resolution technique that can give extremely detailed information on frequency content
   A-weighting L_A or L_{pA}, L_{WA}, obsolete – dBA, dBA similar – C-weighting L_C or L_{pC}, L_{WC}	The human ear does not sense all frequencies of sound equally. Our sensitivity is at a maximum at around 2 kHz and steadily decreases above and below. Below 20 Hz and above about 20 kHz we can't hear at all. Within its operating limits a precision measurement microphone measures all frequencies the same so the output it produces does not reflect what we would actually hear. The A-weighting is an electronic filter that matches the response of a sound level meter to that of the human ear. When A-weighted the Sound Pressure Level L_p becomes L_{pA} (or L_A) and the Sound Power Level L_W becomes L_{WA}. It used to be common to identify that a level was A-weighted by writing dBA or dBA instead of dB. These terms are now obsolete and should not be used as they conflict with other, non-acoustic, uses of decibels The response of the human ear varies depending on how loud the sound is. A-weighting matches the response of a sound level meter to human hearing at low levels (~ 40-90 dB). For higher levels there are other weightings the most common of which is the C-weighting.

Different types of decibels commonly used in acoustics

L_p L_{pA} (or L_A) L_{AF}, L_{AS}	*The instantaneous sound pressure level* (L_p) *The A-weighted instantaneous sound pressure level* (L_{pA} or L_A) This is the root mean square size of the pressure fluctuations in the air. This level can fluctuate wildly even for seemingly steady sounds. To make sound level meters easier to read the values on the display are smoothed or damped out. This is effectively done by taking a rolling average of the previous 0.125 s (FAST time constant) or the previous 1 s (SLOW time constant). The letters F or S are added to the subscripts in the notation to indicate when the FAST or SLOW time constant has been used. These are often omitted but it is good practice to include them.

L_{max} L_{Amax} L_{AFmax} L_{min} , L_{Fmin}	*The maximum instantaneous sound pressure level* (L_{max}), *The A-weighted maximum instantaneous sound pressure level* (L_{Amax}) *The A-weighted maximum instantaneous sound pressure level with a FAST time constant* (L_{AFmax}). This is the highest instantaneous sound pressure level reached during a measurement period. The opposite of the L_{max} is the *minimum instantaneous sound pressure level* or L_{min} etc. It is good practice to include the letter which identifies the time constant used as this can make a significant difference to the value.
$L_{N,T}$ $L_{AN,T}$ $L_{AFN,T}$ $_N$ = %age value, 0-100 $_T$ = measurement time eg. L_{A90}, L_{A10}, $L_{AF90, 5 min}$	*The percentage exceedence sound pressure level* ($L_{N,T}$), *The A-weighted percentage exceedence sound pressure level* ($L_{AN,T}$), *the A-weighted percentage exceedence sound pressure level with a FAST time constant* ($L_{AFN,T}$). This is the sound pressure level exceeded for *N*% of time period *T*. eg. If an A-weighted level of x dB is exceeded for a total of 6 minutes within one hour, the level will have been above x dB for 10% of the measurement period. This is written as $L_{A10,1hr}$ = x dB. L_{A0} (the level exceeded for 0 % of the time) is equivalent to the L_{Amax} and L_{A100} (the level exceeded for 100 % of the time) is equivalent to the L_{Amin}. It is good practice to include the letter which identifies the time constant used as this can make a significant difference to the value.
$L_{eq,T}$ $L_{Aeq,T}$ $_T$ = measurement time eg. $L_{Aeq,5min}$	The *equivalent continuous sound pressure level over period T* ($L_{eq,T}$), *The A-weighted equivalent continuous sound pressure level over period T* ($L_{Aeq,T}$). This is effectively the average sound pressure level over a given period. As the decibel is a logarithmic quantity the L_{eq} is not a simple arithmetic mean value. The L_{eq} is calculated from the raw sound pressure data. It is not appropriate to include a reference to the FAST and SLOW time constants in the notation