SNC·LAVALIN

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Member of the SNC-Lavalin Group

Albany Street Police Station

Assessment of Noise From Air Conditioning Outdoor Unit

MOPAC

18June 2018

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Document history

Revision	Purpose description	Origin-ated	Checked	Reviewed	Author-ised	Date
Rev 1.0	<purpose>	RhWO	AB	IE	IE	18/06/2018

Contents

1. Introduction

1.1. SNC Lavalin Atkins was instructed to assess the noise from a new Daikin type RZQG100L9V1B outdoor unit (part of the air-conditioning system with fans inside) on the lower roof of Albany Street Police Station.

1.2. Following discussion with Mr Camilo Castro-Llach, Noise Officer, London Borough of Camden, the assessment has been made in accordance with Table C “Noise levels applicable to proposed industrial and commercial developments (including plant and machinery)” of Appendix 3 “Noise Thresholds” of the London Borough of Camden “Local Plan Adoption Version”.

1.3. Owing to difficulties of accessing the nearest Existing Noise Sensitive Receptor, the noise survey was made during the night of 29th to 30th May 2018 at a surrogate position on the lower roof of the police station.

1.4. The new Daikin outdoor unit had already been installed but did not operate during the survey.

1.5. An assessment on the basis of the Appendix 3 “Noise Thresholds” has been made on the basis of information provided by Daikin.

1.6. It was found that the requirements of the Local Plan were met.

1.7. A prediction of the noise contribution at the nearest Existing Noise Sensitive Receptor was made on the basis of Daikin’s sound power level data.

2. Noise Criterion

2.1. Following telephone contact with Mr Camilo Castro-Llach, Noise Officer, London Borough of Camden it was determined that the relevant criteria were those given in Appendix 3: Noise Thresholds of the Camden "Local Plan Adopted Version".

2.2. The "Industrial and Commercial Noise Sources" section of Appendix 3 gives "Table C: Noise levels applicable to proposed industrial and commercial developments (including plant and machinery)".

2.3. For dwellings to achieve "Green" (Lowest Observed Adverse Effect Level or LOAEL) under the Camden Local Plan, the "Rating Level" (as defined under British Standard BS4142:2014 "Methods for rating and assessing industrial and commercial sound") of noise from the proposed plant should be 10 dB below background ($L_{A90,T}$) for both day and night. In addition, for the night-time situation, no events should exceed 57 dB L_{Amax}.

2.4. Below "Green" in Table C is "Amber" (Lowest Observed Adverse Effect Level to Significant Observed Adverse Effect Level) where the Rating Level is between 9dB below and 5dB above background level or noise events between 57 dB and 88 dB L_{Amax} occur.

2.5. Below "Amber" is "Red" where the Rating Level is 5dB above background or events exceed 88 dB L_{Amax}.

2.6. The BS4142:2014 assessment method is described in Appendix D.

2.7. The nearest noise sensitive properties were on the upper floors of the nearest residential properties at the rear of the West-side block in Munster Square. Owing to the difficulties of measuring outside these properties it was agreed with Mr Castro-Llach that the measurement of the background would be taken at a surrogate position.

2.8. This position was on the first-floor level roof of the police station and the assessment would be made for that position.

3. Noise Survey

3.1. The noise survey was made on the night of 29th to 30th May 2018.

3.2. The weather conditions were damp with a squall of rain. The measurement in which the squall occurred has been omitted from the assessment while the damp conditions are not thought to have affected the background noise measurement.

3.3. The wind was generally westerly, with slight movement of tree foliage noted, a velocity of 0.4ms^{-1} being measured using an anemometer.

3.4. The microphone of the Norsonic Nor118 meter was set up in a Norsonic Outdoor Microphone Protection Kit 1212 on the lower roof of the police station, the microphone being one metre away from the side of the building immediately east of this roof (see Figures C1 and C2). This gave an effective façade noise measurement position.

3.5. Measurements were taken over 15 minute periods, the survey being terminated shortly after it was noted that birds had started to sing.

3.6. The background noise levels ranged from a lowest value of 44.6 dB L_{A90} to a highest value of 52.3 dB L_{A90}, this latter value being exceptional and attributed to a squall of rain. This value was considered atypical and has been omitted when calculating the mean average background noise level which is 46 dB L_{A90}.

3.7. The noise sources were road traffic and building services, the existing building services in the middle of the lower roof of the police station being noted to be in action. The existing building services noise is considered to be part of the existing background noise.

3.8. At no time during the survey was the new Daikin RZQG100L9V1B machine at the south end of the roof noted to operate.

4. Discussion

4.1. Data for the Daikin RZQG100L9V1B machine were obtained from the manufacturer.

4.2. The sound pressure and sound power level spectra are given below:

Figure 4.1: Sound Pressure Spectrum: Cooling

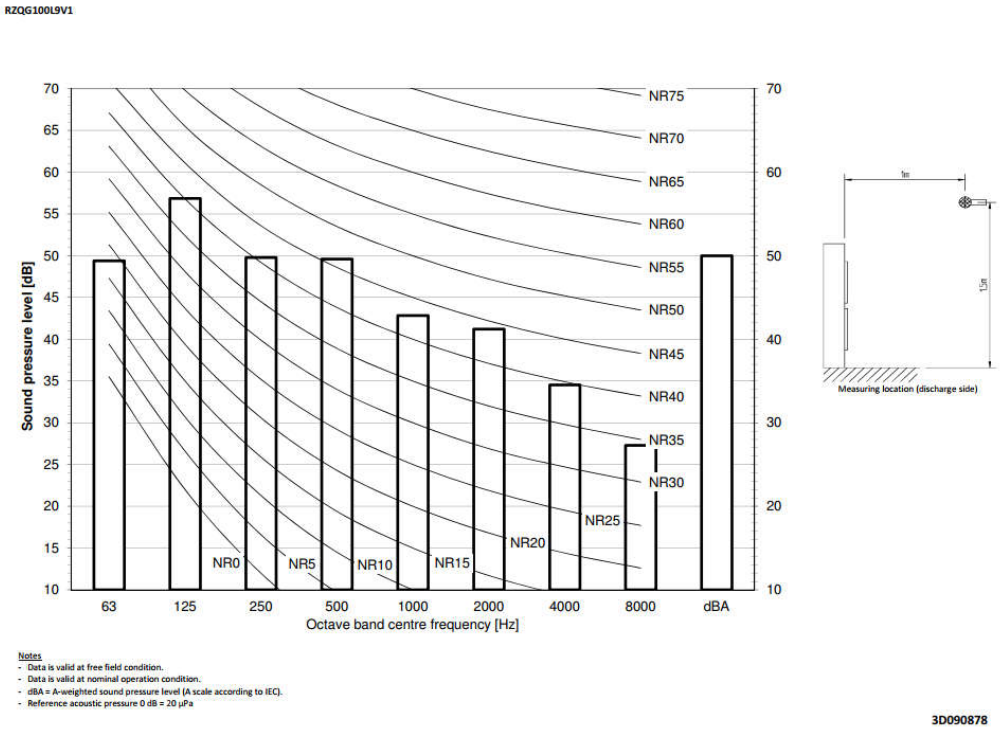


Figure 4.2: Sound Pressure Spectrum: Heating

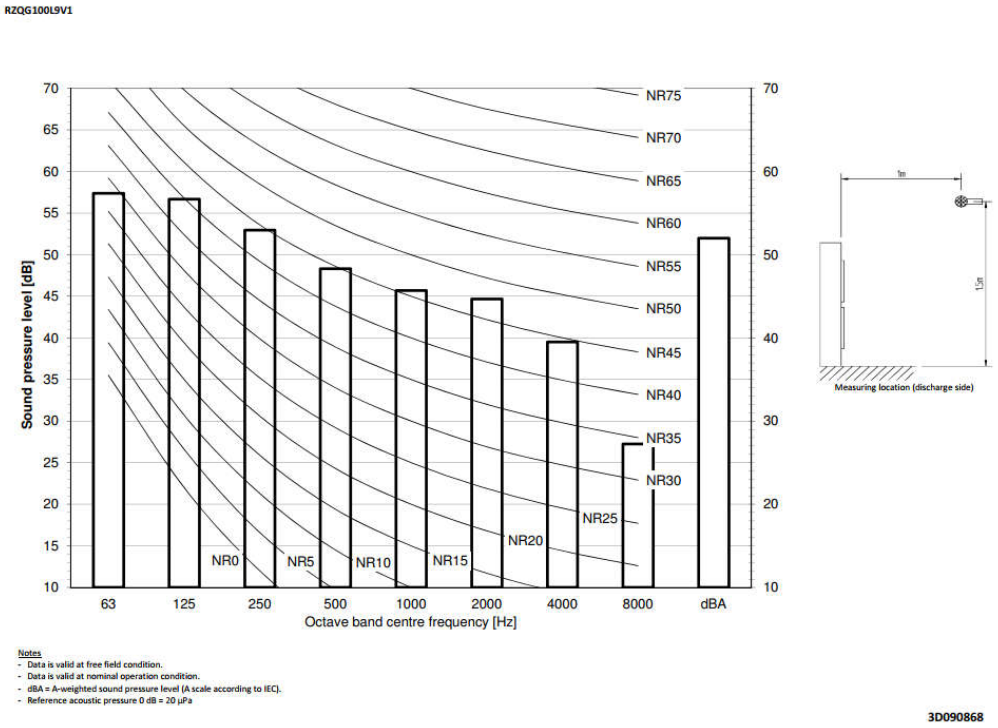


Figure 4.3: Sound Pressure Spectrum: Quiet Mode

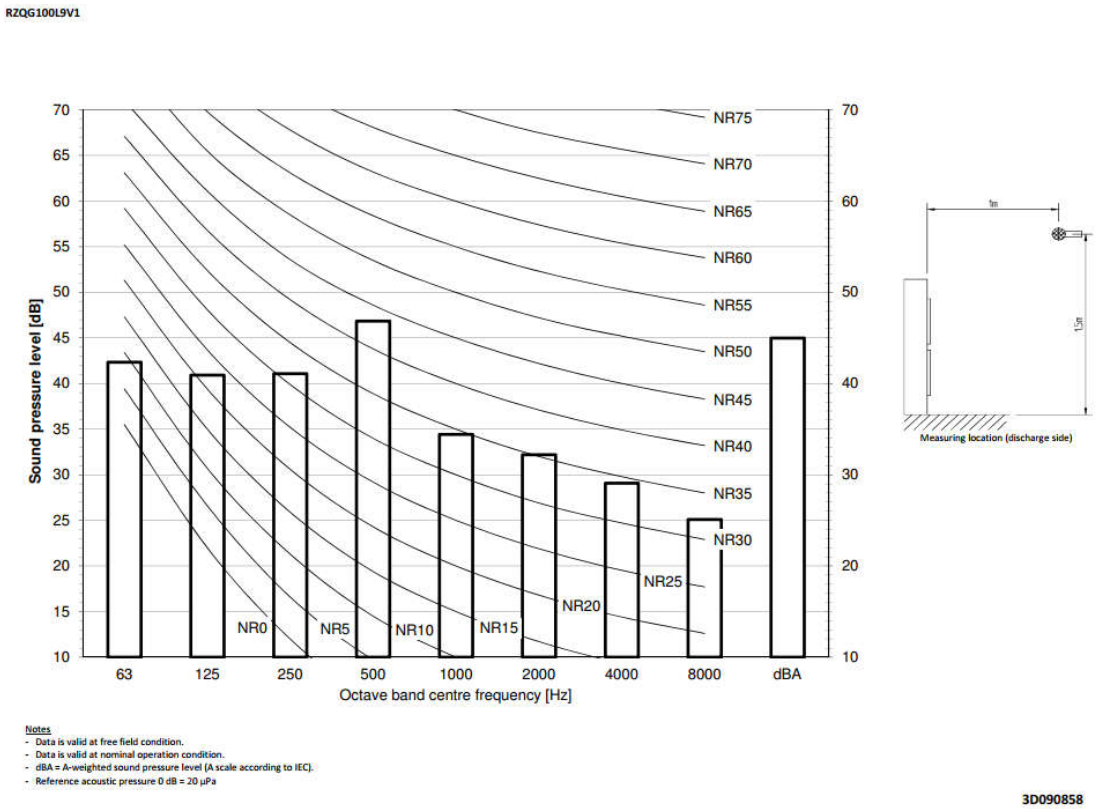
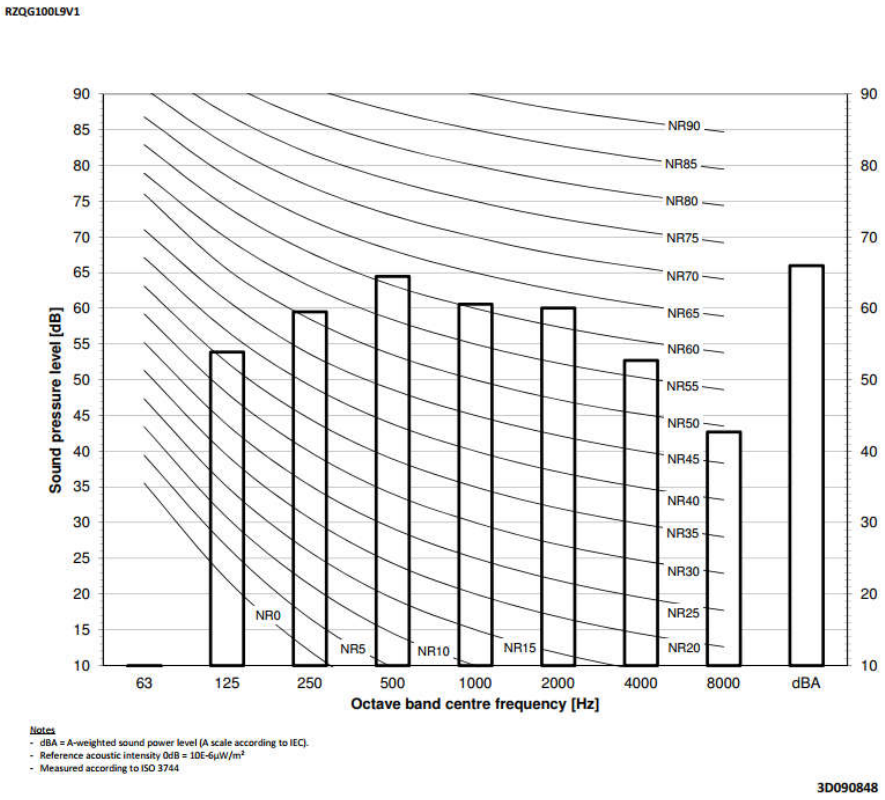


Figure 4.4: Sound Power Spectrum



4.3. It is understood from Daikin that the equipment sound power level measurements are made in accordance with the Standard BS EN ISO 3744:2010 “Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane (ISO 3744:2010)”.

4.4. Paragraph 6.3 of the Standard states that “The noise source to be tested shall be installed with respect to, or driven on, the reflecting plane or planes, as if it were in normal use.”

4.5. The Daikin sound pressure level measurements appear to be taken with the microphone 1m horizontally from the external unit and some 1m above the unit’s centre line. It is assumed that any directivity effects arising from this offset will be the same in the horizontal plane as they are in the vertical plane. In other words, it is considered reasonable to predict the noise level at the survey measurement position on the basis of Daikin’s sound pressure level data.

4.6. Under the assumption that the Daikin microphone measurement position was 1.4m from the centre of the outdoor unit, that the noise propagated in accordance with the point source model and that the distance from the unit to the measurement position was 14m then the following Rating Levels are predicted in accordance with the BS4142 method.

Table 4.1: Assessment for various equipment modes

Equipment Mode	BS4142 Rating Level (dB(A)	Excess over Mean Background Level (dB(A))
Cooling (125Hz tone prominent)	31	-15
Heating	33	-13
Quiet Mode	28	-18

4.7. In the Cooling mode, the 125Hz one-third octave band value is more than 5 dB greater than either of the two adjoining one-third octave bands so that it is assumed that there is an audible tonal element in the noise from the Daikin outdoor unit. Nevertheless, the predicted A weighted sound pressure level contribution of the unit is less than the mean background level by the required 15 dB.

4.8. No “on-time” adjustment has been made but, as noted in Section 3, at no time was the new unit noted to operate. The above Rating Levels have been calculated assuming a 100% on-time whereas it is probable that the time-adjusted weighting level would be much lower.

4.9. Since the Daikin equipment was not heard to start and stop operating it is not known whether it gave rise to a noise level exceeding 57 dB L_{Amax}. However, experience of this type of machine suggests that this is improbable.

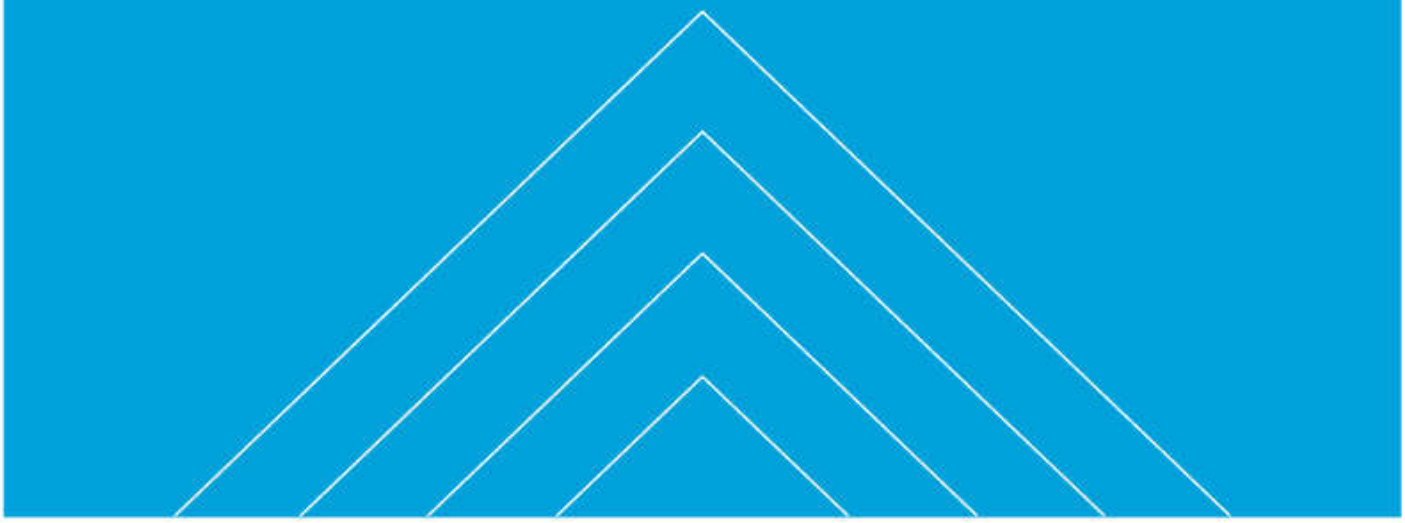
4.10. It may thus be seen that the Council’s requirements are met in all modes.

5. Conclusion

5.1. It is concluded that the new Daikin RZQG100L9V1 Outdoor unit meets the requirements of Table C of Appendix 3 of the London Borough of Camden Local Plan Adoption Version.

5.2. No attenuation measures are required.

Appendices



Appendix A. Site Photographs

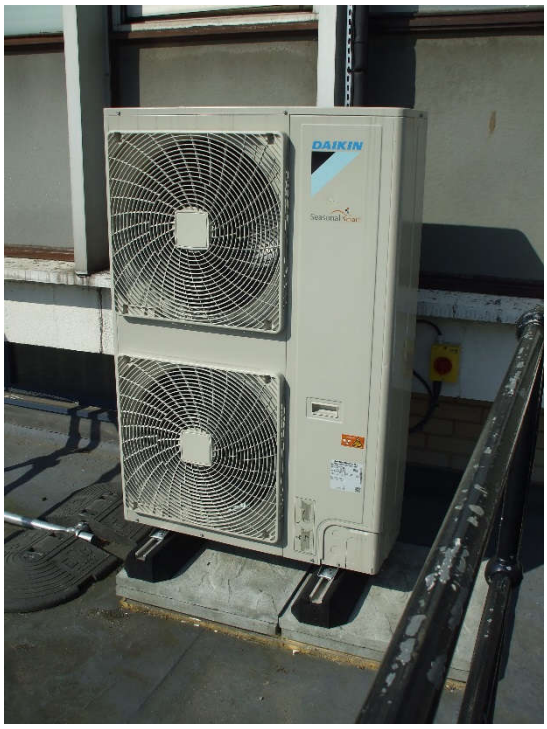


Figure A1: The new item of equipment (Daikin RZQG100L9V1 Outdoor unit)

Figure A2: View of Munster Square properties from the first floor exterior of the police station with courtyard roof in foreground

Appendix B. Aerial View

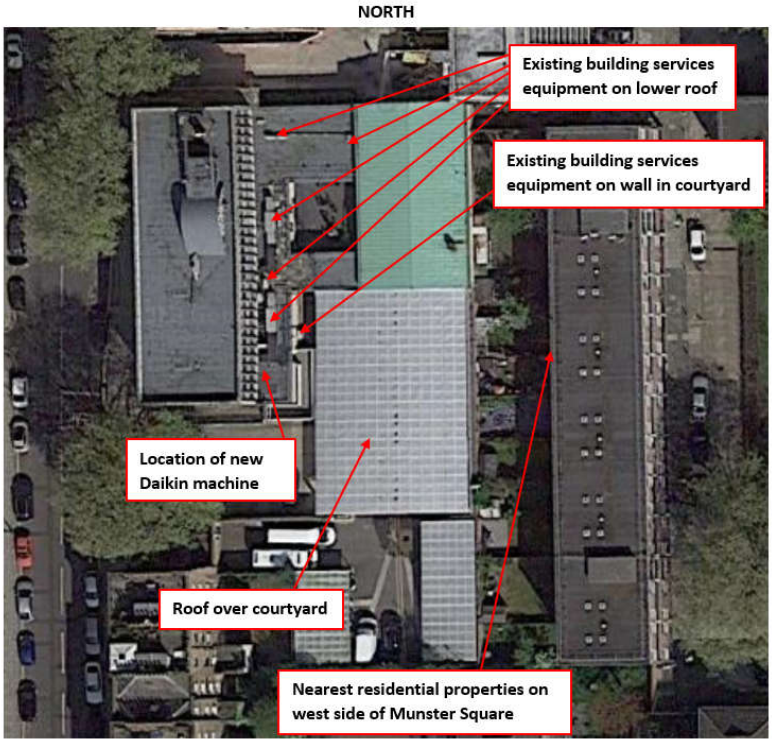


Figure B1: Aerial view of Albany Street Police Station (base image extracted from Google)

Appendix C. Noise Survey

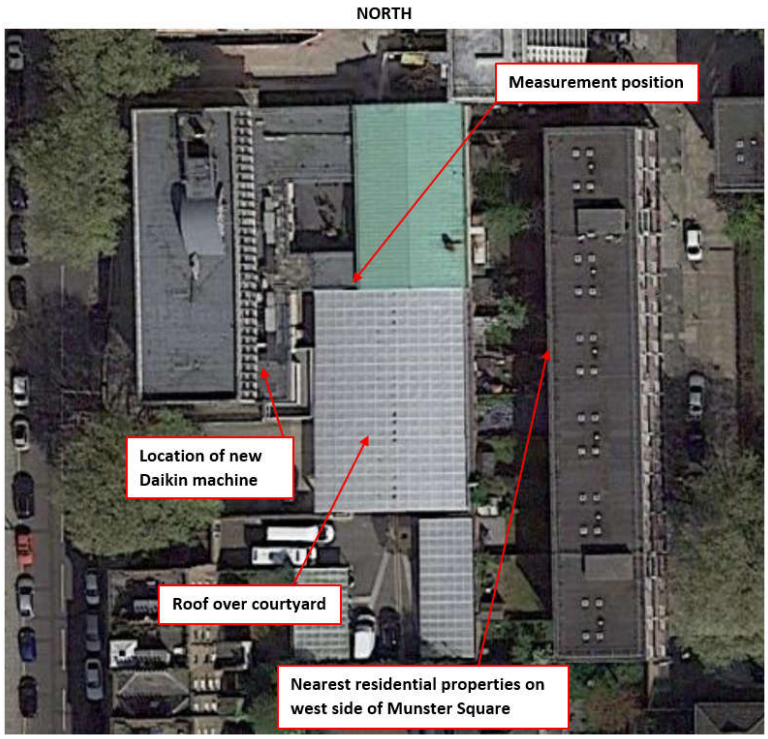


Figure C1: Aerial view of Albany Street Police Station showing measurement position (base image extracted from Google)

Figure C2: Photograph of Measurement Equipment

Table C1: Survey Results

Start Time	L_{Aeq}	L_{AFmax}	L_{AFmin}	L_{A90}
00:37	53.9	69.3	44.1	47.5
00:55	54.5	75.5	43.5	45.8
01:15	52.8	73.8	43.4	45.9
01:30	52.4	62.9	44.8	47.0
01:45	55.0	65.2	47.9	52.3
02:00	54.1	67.1	45.1	47.6
02:15	53.1	69.8	44.5	46.3
02:30	52.6	65.5	44.3	46.8
02:45	51.8	68.5	42.9	45.9
03:00	50.9	63.6	43.2	44.6
03:15	57.1	93.5	43.6	45.5
03:30	51.8	70.6	42.3	45.9

The sound level meter was set up on the lower roof of the police station, the microphone being protected by an outdoor microphone protection kit.

All measurements were of 15 minutes' duration.

The weather conditions were generally satisfactory.

There was some light drizzle with one squall of heavy rain (this is the cause of the higher background level during the measurement that commenced at 01:45).

The wind was generally light (measured at 0.4ms^{-1}), with only slight movement of tree foliage observed. The direction was westerly.

The main noise sources were road traffic and building services. Of the building services on the same roof only the Daikin machines in the middle of the building facade were operating.

Appendix D. BS4142:2014

This assessment has been undertaken with reference to British Standard 4142: 2014 "Methods for rating and assessing industrial and commercial sound" (BS 4142).

BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in the standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

The standard is used to determine the rating levels for sources of sound of an industrial and/or commercial nature and the ambient, background and residual sound levels at outdoor locations. These levels could be used for the purposes of investigating complaints; assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and assessing sound at proposed new dwellings or premises used for residential purposes. However, the determination of noise amounting to a nuisance is beyond the scope of the standard.

The procedure contained in BS 4142 assesses the significance of sound which depends upon the margin by which the rating level of the specific sound sources exceeds the background sound level and the context in which the sound occurs/will occur.

The reference time interval for the specific sound source 'Tr' is 60 minutes during the daytime and 15 minutes during the night. The reduced reference time at night reflects the increased sensitivity to noise during this period.

The assessment method considers the characteristics of the sound, such as tonality, impulsivity and intermittency. Corrections are applied to the specific noise source to account for these characteristics in order to obtain the rating noise level; the corrections account for acoustic features which have the potential to increase disturbances.

An initial estimate of the impact of the sound source is obtained by subtracting the measured background sound level from the rating level and considering the following:

Typically, the greater this difference, the greater the magnitude of the impact.
A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background

sound level, this is an indication of the specific sound source having a low impact, depending on the context.

Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, the standard requires a character correction to be added to the specific sound level to obtain the rating level. Character corrections can be included for tonality, impulsivity, other sound characteristics that make it “readily distinctive”, and intermittency.

Appendix E. Glossary

AIRBORNE SOUND
Sound which is transmitted from the source via the surrounding air, as distinct from transmission through the structure which supports the sound source (cf. structure borne sound).

AMBIENT NOISE
Totally encompassing sound in a given situation at a given time usually composite of sounds from many sources near and far.

ATTENUATION, SOUND
A reduction in the intensity of a sound signal.

A - WEIGHTING dB(A)
The sound pressure level determined when using the frequency-weighting network A. The A-weighting network modifies the electrical response of a sound level meter so that the sensitivity of the meter varies with frequency in approximately the same way that the sensitivity of the human hearing system varies with frequency.

The human ear has a non-linear frequency response; it is less sensitive at low and high frequencies and most sensitive in the range 1 to 4 kHz. The A-weighting is applied to measured or calculated sound pressure levels so that these levels correspond more closely to the response of the human ear. A-weighted sound levels are often denoted as dB(A).

BACKGROUND NOISE LEVEL, L_{A90}, T
The A-weighted sound pressure level of non-specific noise in decibels exceeded for 90% of the given time, T.

CENTRE FREQUENCY
The arithmetic centre of a constant bandwidth filter, or the geometric centre (midpoint on a logarithmic scale) of a constant percentage filter.

DECIBEL (dB)
1. Unit level which denotes the ratio between two quantities that are proportional to power; the number of decibels corresponding to the ratio of two amounts of power is 10 times the logarithm to the base 10 of this ratio.
2. A linear numbering scale used to define a logarithmic amplitude scale, thereby compressing a wide range of amplitude values to a small set of numbers.
3. A unit which indicates that a quantity has a certain LEVEL above some pre-defined reference value.
4. The unit of measurement used for sound pressure levels. The scale is logarithmic rather than linear.

EQUIVALENT CONTINUOUS A-WEIGHTED SOUND PRESSURE LEVEL (L_{Aeq})
1. The hypothetical continuous, A-weighted, sound pressure level which would contain the same amount of acoustic energy a time-varying, A-weighted, sound pressure level when assessed over the same, specified, time period.

2. Value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval T starting at t_1 and ending at t_2 and measured in decibels, has the same mean square sound pressure as the sound under consideration whose level varies with time.

FACADE NOISE LEVEL
A facade noise level is the noise level 1m in front of the most exposed window or door in a building facade. The effect of reflection, is to produce a slightly higher (+2.5 dB) sound level than it would be if the building was not there.

FREE FIELD
1. A free sound field is a field in a homogeneous, isotropic medium free from boundaries. In practice it is a field in which the effects of the boundaries are negligible over the region of interest. The actual pressure impinging on an object (e.g., a microphone) placed in an otherwise free sound field will differ from the pressure which would exist at the point with the object removed, unless the acoustic impedance of the object matches the acoustic impedance of the medium.
2. An environment in which there are no reflective surfaces within the frequency region of interest.
3. A region in which no significant reflections of sound occur.
4. It is considered that free-field environmental noise measurements need to be made at least 3.5m from any reflecting structure.

HERTZ, Hz
This is the unit of frequency representing the number of times a periodic wave repeats itself per second.

LONG TERM AVERAGE SOUND LEVEL, $L_{Aeq,LT}$
The average over the long term time interval of the equivalent A-weighted sound pressure levels for a series of reference time intervals comprised within the long term time interval.

MAXIMUM SOUND LEVEL, $L_{pA,max}$
The highest value of the A-weighted sound pressure level that occurs during a given event or time period. The time-weighting should be specified.

MAXIMUM SOUND PRESSURE LEVEL
The maximum sound pressure for any given cycle of a periodic wave is the maximum absolute value of the instantaneous sound pressure occurring during that cycle. In the case of a sinusoidal sound wave this maximum sound pressure is also called the pressure amplitude.

MEASUREMENT TIME INTERVAL, T_M
The total time over which measurements are taken.

OCTAVE BANDS, OCTAVE BAND SOUND PRESSURE LEVEL
1. A range of frequencies whose upper limit is twice the frequency of the lower limit.
2. The octave-band pressure level of a sound is the band pressure level for a frequency band corresponding to a specified octave. (The location of the octave-

band pressure level on a frequency scale is usually denoted by the geometric mean of the upper and lower frequencies of the octave.) The ISO standard octave centre frequencies are 32, 63, 125, 250, 500, 1k, 2k, 4k, 8k, 16k Hz (etc.).

ONE-THIRD OCTAVE BAND SOUND PRESSURE LEVELS
The ISO standard one-third octave band frequencies are 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3, 8 Hz and decade multiples thereof.

PERCENTILE LEVEL (STATISTICAL SOUND LEVEL INDICES, L_{AN}, L_{A90})
L_{AN} is the dBA level exceeded N% of the time measured on a sound level meter with Fast(F) time weighting, e.g. L_{A90} the dBA level exceeded for 90% of the time, is commonly used to estimate background noise level. LA10, the level exceeded for 10% of the time, is commonly used in the assessment of road traffic noise.

RATING LEVEL, $L_{Ar,T}$
The equivalent continuous A-weighted sound pressure level during a specified time interval, plus specified adjustments for tonal character and impulsiveness of sound.

REFERENCE TIME INTERVAL, T_r
The time interval to which an equivalent continuous A-weighted sound pressure level can be referred. [

SOUND LEVEL
Sound level, in decibels, is the weighted sound pressure level obtained by use of a sound-level meter. The reference pressure is 20 μPa, unless otherwise stated.

SOUND PRESSURE LEVEL (L_p)
1. The level of the pressure of the sound above the internationally accepted reference value of 20 μPa ($2x10^{-5}N/m^2$), which corresponds to the pressure of the quietest sound an average person can hear at the frequency of 1000 Hz. It is a quantity that can be measured, thus the intensity of a sound can be derived from it.
2. The sound pressure level is a measure of a dynamic variation in atmospheric pressure. The pressure at a point in space minus the static pressure at that point.
3. A value equal to 20 times the logarithm to the base 10 of the ratio of the ratio of the root-mean-square pressure of a sound to a reference pressure, which is normally taken to be $2x10^{-5}N/m^3$.

SOUND POWER LEVEL (L_W)
1. The sound power level of a sound source, in decibels, is 10 times the logarithm to the base 10 of the ratio of sound power radiated by the source to a reference power. The reference power is 1 picowatt ($1x10^{-12}$ watt).
2. The sound power level is the fundamental measure of the total sound energy radiated by a source per unit time.
3. A value equal to 10 times the logarithm to the base 10 of the ratio of the total acoustic power emitted by a source to a reference power, which is normally taken to be 10^{-12} watt.

SOUND REDUCTION INDEX, R
A measure of the sound insulating properties of a material or building element.

SPECIFIC NOISE LEVEL, $L_{Aeq,Tr}$

The equivalent continuous A-weighted sound pressure level in decibels at the measurement position produced by the specific noise source over a given reference time interval. The specific noise level is quoted to the nearest whole number of decibels.

SPECIFIC NOISE SOURCE
The noise source under investigation for assessing the likelihood of complaints.

TIME WEIGHTINGS, FAST (F), SLOW (S) AND IMPULSE (I)
Time weighting is used in sound level meters to stabilize the reading. This is achieved by standardizing the speed with which the metering circuit and meter respond. Two different averaging's are used (1) 'FAST', 'F', which has a time constant of 125 ms, and (2) 'SLOW', 'S', which has a time constant of 1000 ms. The impulse (I) characteristic is sometimes used to measure gunshots, punch presses, etc. It has a rise time constant of 35 ms and a decay time constant of 1500 ms.

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