VENTA ACOUSTICS

Report VA4712.230523.NIA1.1

British Museum Replacement Plant

Noise Impact Assessment

24 May 2023

The British Museum
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Attachments

1. Introduction

It is proposed to install replacement cooling and air handling plant on a flat roof on the southern side of The British Museum, Great Russell Street, London.

Venta Acoustics has been commissioned by The British Museum to undertake an assessment of the potential noise impact of these proposals in support of an application for planning permission.

An environmental noise survey has been undertaken to determine the background noise levels at the most affected noise sensitive receptors. These levels are used to undertake an assessment of the likely impact with reference to the planning requirements of Camden Council.

2. Design Criterion and Assessment Methodology

2.1 Camden Council Requirements

Camden Council's Local Plan (adopted June 2017), Appendix 3, provides the following guidance regarding noise from Industrial and Commercial Noise Sources

> *A relevant standard or guidance document should be referenced when determining values for LOAEL and SOAEL for non-anonymous noise. Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10 dB below background (15dB if tonal components are present) should be considered as the design criterion).*

Existing Noise sensitive receiver	Assessment Location	Design Period	LOAEL (Green)	LOAEL to SOAEL (Amber)	SOAL (Red)
Dwellings**	Garden used for main amenity (free field) and Outside living or dining or bedroom window (façade)	Day	'Rating level' 10dB* below background	'Rating level' between 9dB below and 5dB above background	'Rating level' greater than 5dB above background
Dwellings**	Outside bedroom window (façade)	Night	'Rating level' 10dB* below background and no events exceeding 57dBL_{Amax}	'Rating level' between 9dB below and 5dB above background or noise events between 57dB and 88dB L_{Amax}	'Rating level' greater than 5dB above background and/or events exceeding 88dBL_{Amax}

**10dB should be increased to 15dB if the noise contains audible tonal elements. (day and night). However, if it can be demonstrated that there is no significant difference in the character of the residual background noise and the specific noise from the proposed development then this reduction may not be required.*

In addition, a frequency analysis (to include, the use of Noise Rating (NR) curves or other criteria curves) for the assessment of tonal or low frequency noise may be required.

***levels given are for dwellings, however, levels are use specific and different levels will apply dependent on the use of the premises.*

The periods in Table C correspond to 0700 hours to 2300 hours for the day and 2300 hours to 0700 hours for the night. The Council will take into account the likely times of occupation for types of development and will be amended according to the times of operation of the establishment under consideration.

There are certain smaller pieces of equipment on commercial premises, such as extract ventilation, air conditioning units and condensers, where achievement of the rating levels (ordinarily determined by a BS:4142 assessment) may not afford the necessary protection. In these cases, the Council will generally also require a NR curve specification of NR35 or below, dependant on the room (based upon measured or predicted $L_{eq,5mins}$ *noise levels in octave bands) 1 metre from the façade of affected premises, where the noise sensitive premise is located in a quiet background area.*

3. Site Description

As illustrated on attached site plan VA4712/SP1, the plant area in question is located opposite Montague Street, with houses on the opposite side of Montague Street being those most affected by the proposals.

4. Environmental Noise Survey

4.1 Survey Procedure & Equipment

In order to establish the existing background noise levels at the site, a noise survey was carried out between Thursday 18th and Monday 22nd May 2023 at the external ground floor location shown in site plan VA4712/SP1. This location was chosen to be representative of the background noise level at the most affected noise sensitive receivers.

Continuous 5-minute samples of the L_{Aeq}, L_{Amax}, L_{A10} and L_{A90} sound pressure levels were undertaken at the measurement location.

The weather during the survey period was generally dry with light winds. The background noise data is not considered to have been compromised by these conditions.

Measurements were made generally in accordance with ISO 1996 2:2017 *Acoustics - Description, measurement and assessment of environmental noise – Part 2: Determination of sound pressure levels*.

The following equipment was used in the course of the survey:

Manufacturer	Model Type	Serial No	Calibration	
			Certificate No.	Date
NTi Class 1 Integrating SLM	XL2	A2A-11586-E0	1502936-2	25/7/22
Larson Davis calibrator	CAL200	13069	1502936-1	22/7/22

Table 4.1 – Equipment used for the tests

The calibration of the sound level meter was verified before and after use with no significant calibration drift observed.

4.2 Results

The measured sound levels are shown as time-history plots on the attached charts VA4712/TH1-4.

The background noise climate at the measurement position and most affected receptor is determined by road traffic on the surrounding streets.

The typical background noise levels measured were:

Monitoring Period	Typical[1] $L_{A90,5min}$
07:00 – 23:00 hours	47 dB
23:00 – 07:00 hours	44 dB

Table 4.2 – Typical background noise levels **[dB ref. 20 µPa]**

[1] The typical L_{A90} value is taken as the 10^{th} percentile of all L_{A90} values measured during the relevant period.

4.3 Plant Noise Emission Limits

Tonal noise is not expected to be generated by the proposed plant. As such, and on the basis of the measured noise levels and targeting the LOAEL (as defined by the planning requirements of Camden Council), the following plant sound levels should not be exceeded at 1m outside the most affected noise sensitive receivers:

Monitoring Period	Design Criterion (L_{Aeq})
07:00 – 23:00 hours	37 dB
23:00 – 07:00 hours	34 dB

Table 4.3 – Specific sound pressure levels not to be exceeded at most affected noise sensitive receivers

To ensure a thorough assessment, plant noise emissions should also not exceed $L_{eq,5min}$ NR35 at 1m from the nearest receptor window, as defined in the following table:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
NR35	63	52	45	39	35	35	30	28

Table 4.4 – NR35 curve values

5. Predicted Noise Impact

5.1 Proposed plant

The following plant is proposed for installation at roof level at the general location indicated on site plan VA4712/SP1.

Plant Item	Quantity	Proposed Model	Notes
Condensers	1	Daikin RXYSQ8TY1	
Condensers	1	Daikin RXYSCQ5TV	
AHU	2	Based on Flakt Woods	

Table 5.1 – Indicative plant selections assumed for this assessment.

Consulting the manufacturer's datasheets, the following noise emissions levels are attributed to the proposed plant items:

Plant Item	Octave Band Centre Frequency (Hz) Sound Pressure/Power Level, L_p@1m, L_w (dB)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Daikin RXYSQ8TY1, L_p @1m	60	63	54	52	49	48	42	34	55
Daikin RXYSCQ5TV, L_p @1m	51	53	52	53	46	41	34	27	53
AHU 1+2 Intake, L_w	68	68	67	66	66	63	59	54	70
AHU 1+2 Exhaust, L_w	73	74	72	70	71	68	64	59	75
AHU 1+2 Casing Radiated, L_w	68	62	54	44	36	38	30	30	51

Table 5.2 – Advised plant noise data used for the assessment.

5.2 Recommended Mitigation Measures

The atmospheric side exhaust ductwork of the air handling units will need to be fitted with attenuators providing the minimum insertion losses shown in Table 5.3.

Attenuation Component	Octave Band Centre Frequency (Hz) Minimum Insertion Loss (dB)							
	63	125	250	500	1k	2k	4k	8k
Exhaust attenuators	1	2	7	10	11	9	8	7

Table 5.3 – Minimum attenuator insertion loss

Should the above insertion loss be achieved using multiple silencers, these should be separated from each other by a distance of minimum 3-4 x D, where D is the largest internal dimension of the duct work (e.g. D is 0.5m, so a minimum of 1.5-2m apart) or a bend of at least 90°. Attenuators should be fitted as close to the fan as possible, and attached to the ductwork using flexible connections.

Please note that the above recommendations relate to acoustic issues only. It is recommended that professional advice confirming the suitability of these measures be sought from others with regards to issues such as airflow, structural stability and visual impact.

5.3 Predicted noise levels

The cumulative noise level at the most affected noise sensitive receiver, (29 Montague Street) which is at least 60 meters away, has been calculated on the basis of the above information with reference to the guidelines set out in BS4142:2014 and ISO 9613-2:1996 *Attenuation of sound during propagation outdoors - Part 2: General method of calculation.*

A summary of the calculations are shown in Appendix B.

Description	dB(A)
Plant noise limiting criterion (night-time)	≤ 34 dB
Predicted L_p @ 1m from receiver	32 dB

Table 5.4 – Predicted noise level and limiting design criterion at noise sensitive location

The manufacturer has not published typical maximum noise levels generated by the selected units and so prediction of maxima outside the nearest receptor windows is not possible. However, impulsive noise is not expected to be a feature of the new equipment and therefore generated maxima would not be substantially higher than the published L_{Aeq} levels. As such, plant noise maxima at the receptor are anticipated to be significantly lower than the Camden Council LOAEL limit of L_{Amax} 57 dB outside bedroom windows.

As can been seen from the following comparison in Table 5.5, the predicted noise levels at 1m from the most affected receiver are also comfortably below the NR35 curve.

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
NR35	63	52	45	39	35	35	30	28
Predicted spectrum, $L_{eq,5min}$	34	34	27	24	22	21	17	13

Table 5.5 – Comparison of predicted noise levels against the NR35 criterion

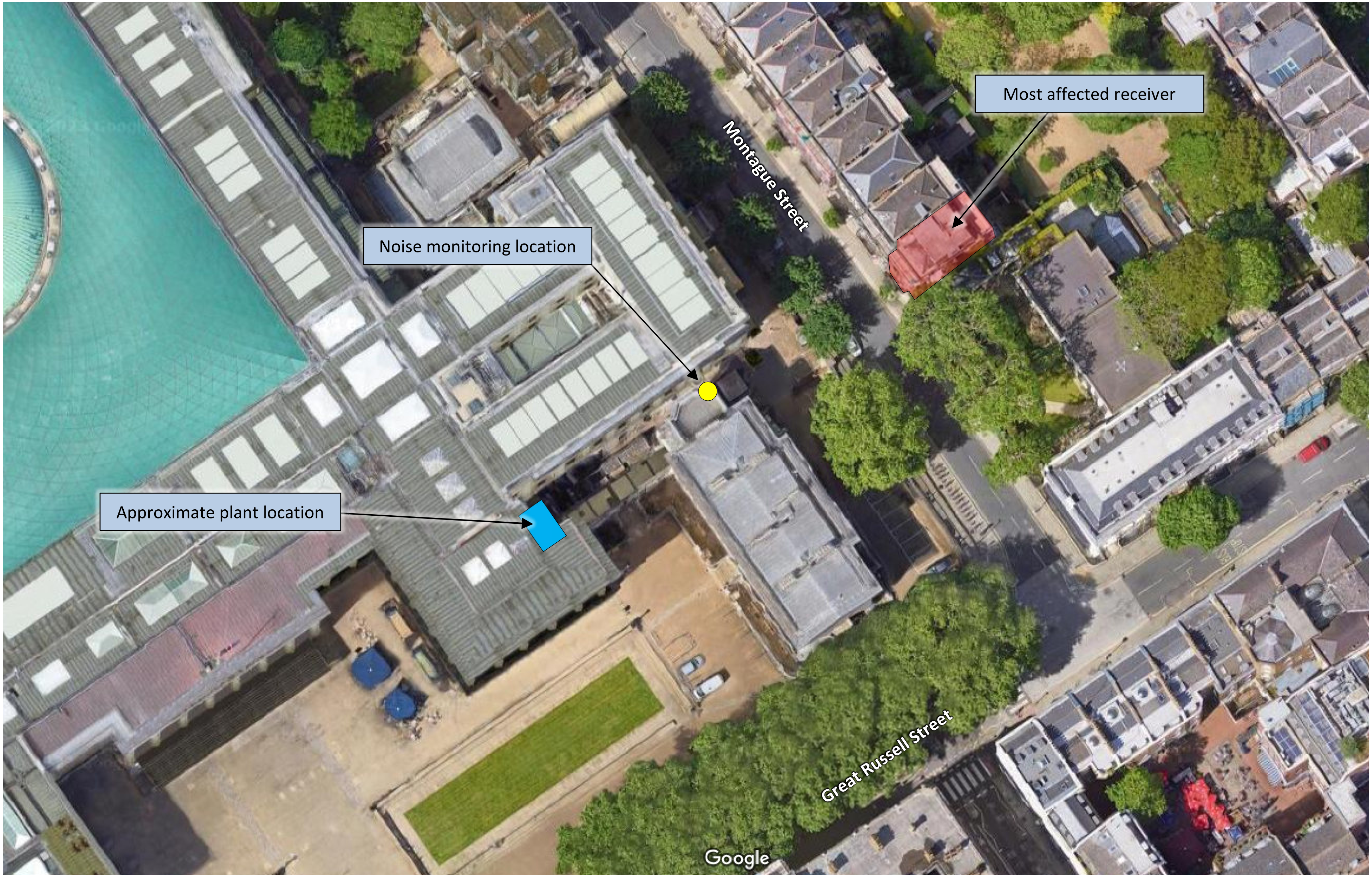
6. Conclusion

A baseline noise survey has been undertaken by Venta Acoustics to establish the background noise climate in the locality of The British Museum, Great Russell Street, London in support of a planning application for the proposed introduction of replacement building services plant.

This has enabled noise emission limits to be set at the most affected noise sensitive receiver such that the proposed installation meets the requirements of Camden Council .

Where the required mitigation is provided, noise emission levels from the proposed plant have been assessed to be compliant with the plant noise emission limits and would result in a low impact.

Ben Alexander MIOA


Most affected receiver
Montague Street
Noise monitoring location
Approximate plant location
Great Russell Street
Google

British Museum Replacement Plant

Environmental Noise Time History: 1

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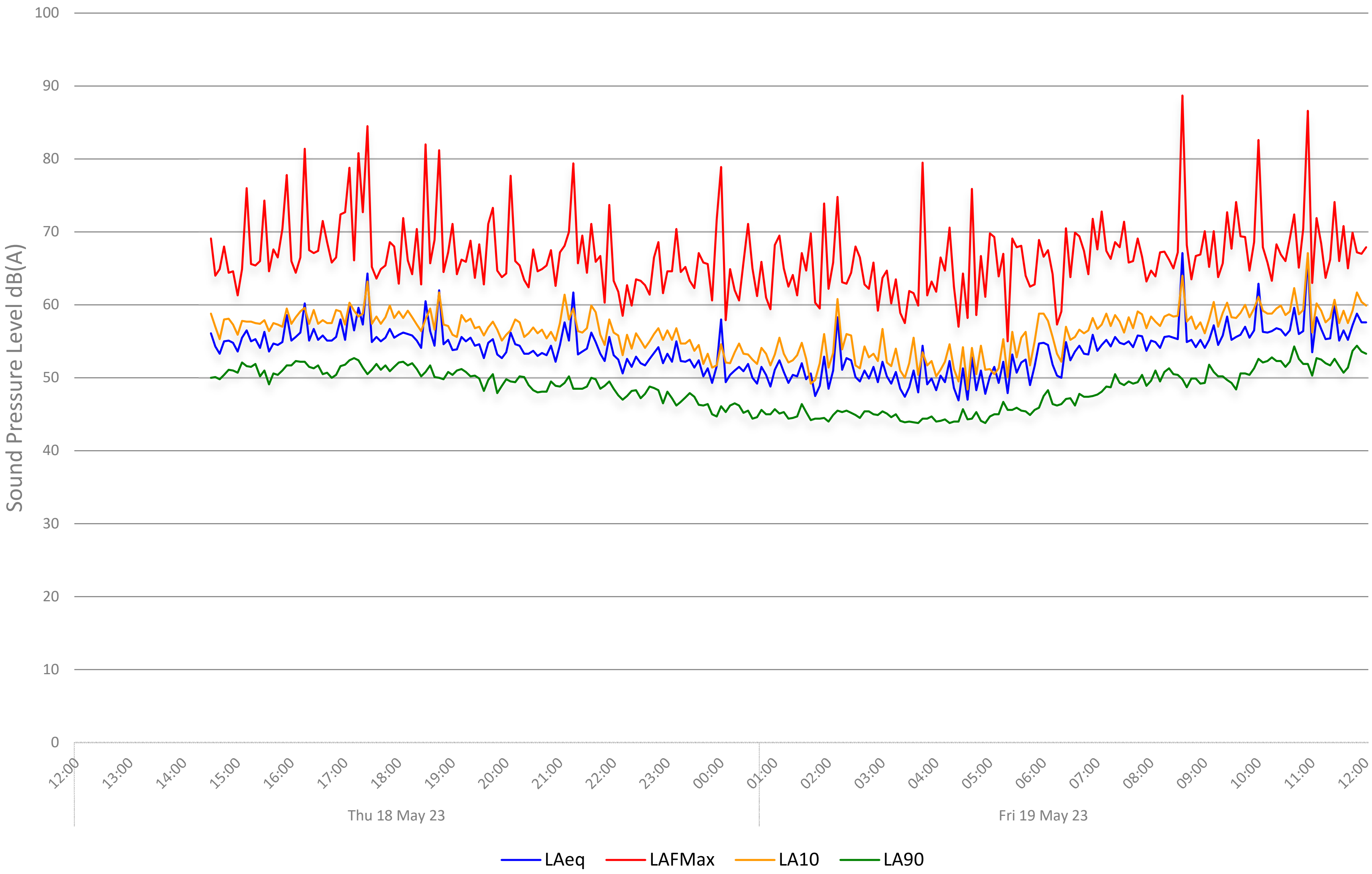
Figure VA4712/TH1



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Environmental Noise Time History: 2

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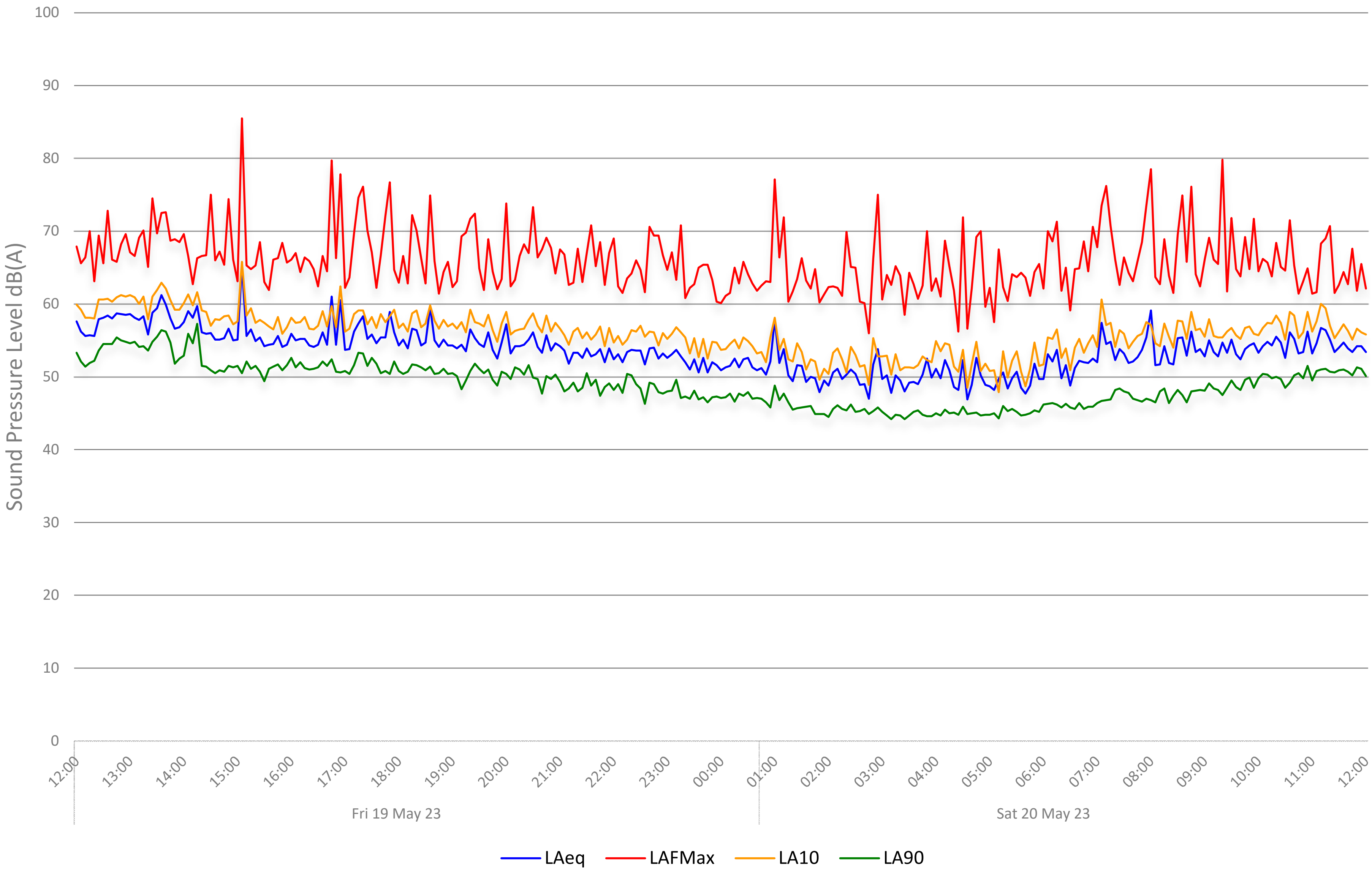
Figure VA4712/TH2



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Environmental Noise Time History: 3

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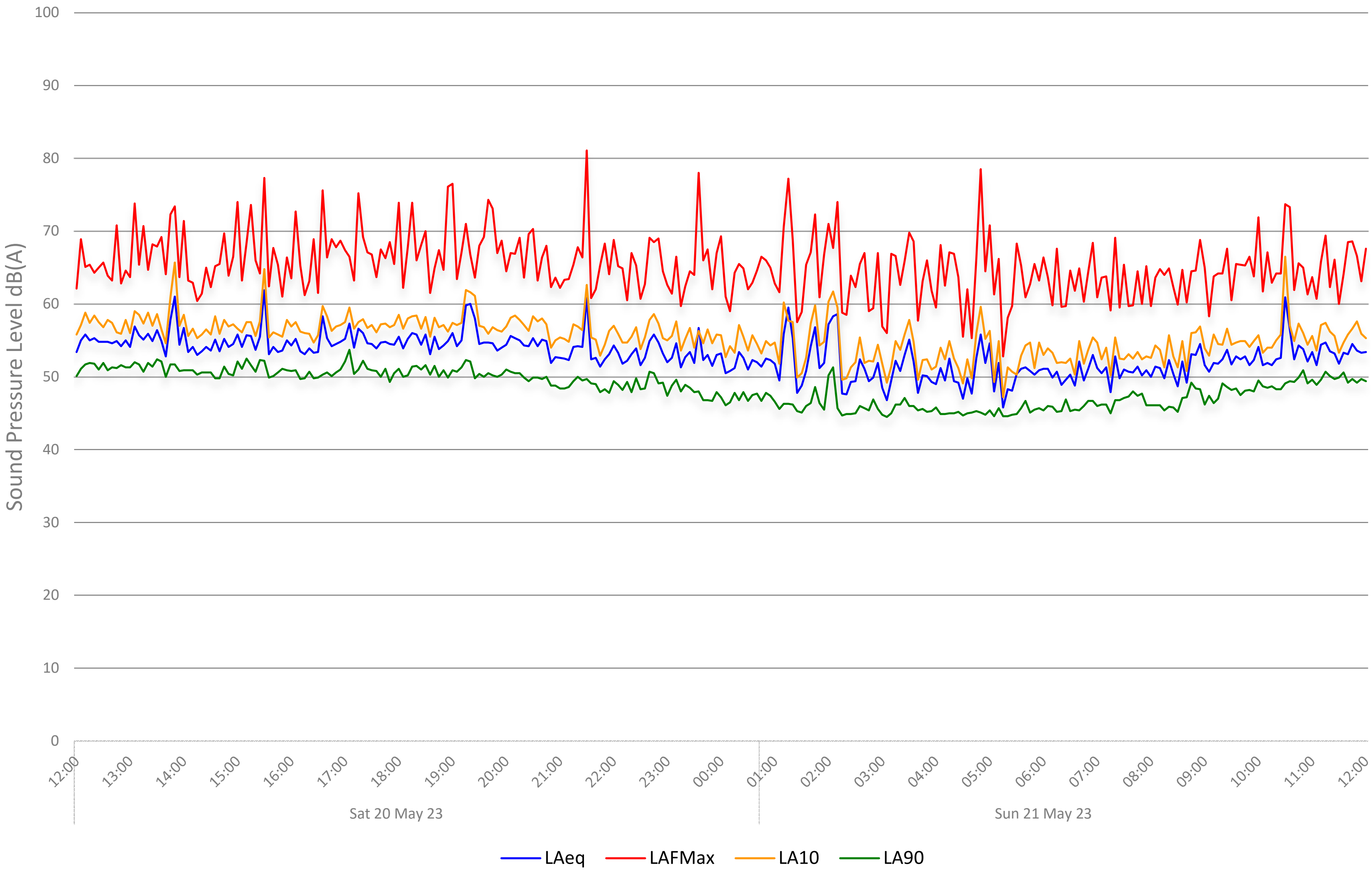
Figure VA4712/TH3



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Environmental Noise Time History: 4

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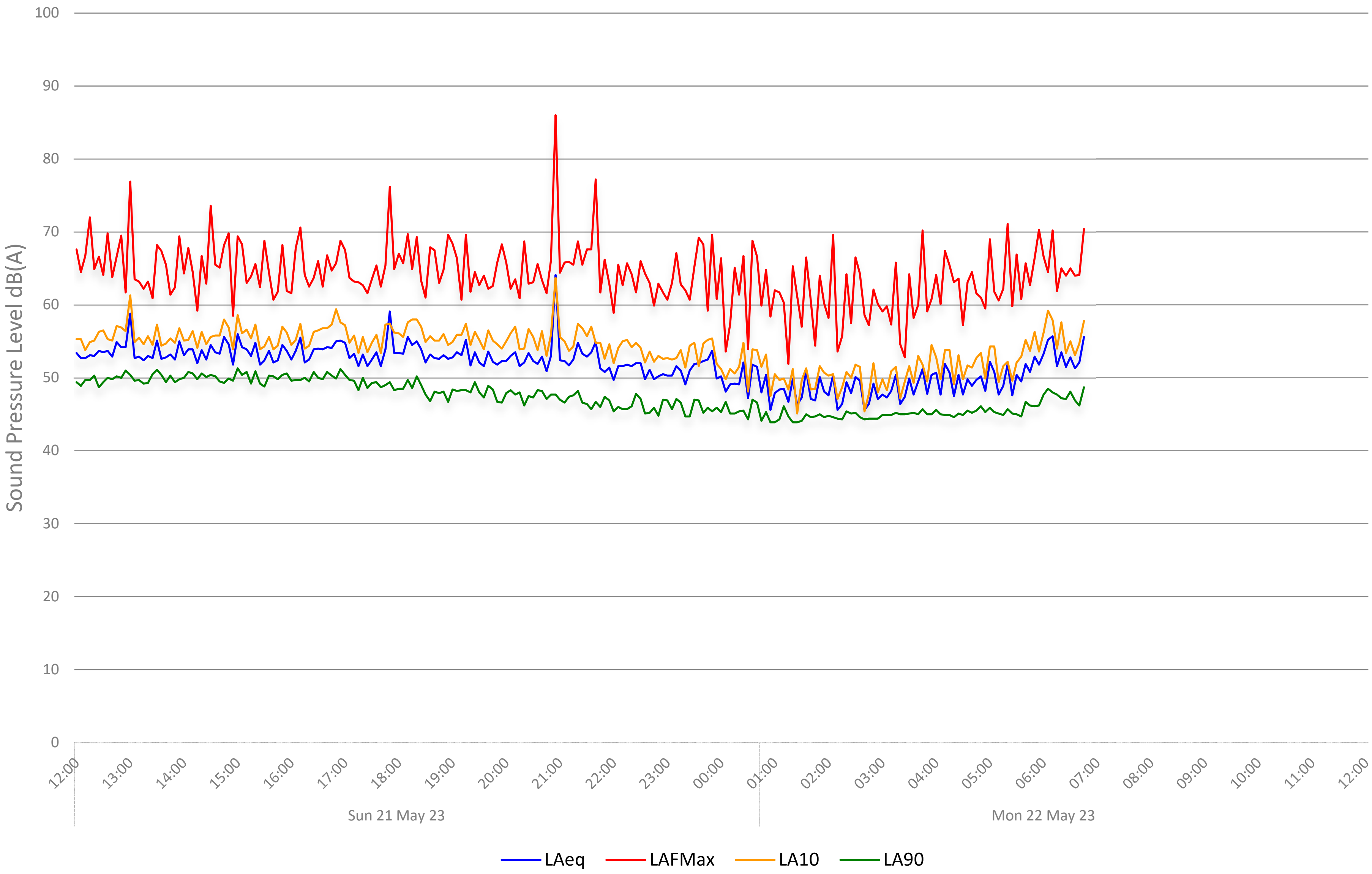
Figure VA4712/TH4



APPENDIX A

Acoustic Terminology & Human Response to Broadband Sound

Frequency	The rate per second of vibration constituting a wave, measured in Hertz (Hz), where 1Hz = 1 vibration cycle per second. The human hearing can generally detect sound having frequencies in the range 20Hz to 20kHz. Frequency corresponds to the perception of 'pitch', with low frequencies producing low 'notes' and higher frequencies producing high 'notes'.
dB(A):	Human hearing is more susceptible to mid-frequency sounds than those at high and low frequencies. To take account of this in measurements and predictions, the 'A' weighting scale is used so that the level of sound corresponds roughly to the level as it is typically discerned by humans. The measured or calculated 'A' weighted sound level is designated as dB(A) or L_A.
L_{eq} :	A notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (e.g. 8 hour, 1 hour, etc). The concept of L_{eq} (equivalent continuous sound level) has primarily been used in assessing noise from industry, although its use is becoming more widespread in defining many other types of sounds, such as from amplified music and environmental sources such as aircraft and construction. Because L_{eq} is effectively a summation of a number of events, it does not in itself limit the magnitude of any individual event, and this is frequently used in conjunction with an absolute sound limit.
L_{10} & L_{90} :	Statistical L_n indices are used to describe the level and the degree of fluctuation of non-steady sound. The term refers to the level exceeded for n% of the time. Hence, L_{10} is the level exceeded for 10% of the time and as such can be regarded as a typical maximum level. Similarly, L_{90} is the typical minimum level and is often used to describe background noise. It is common practice to use the L_{10} index to describe noise from traffic as, being a high average, it takes into account the increased annoyance that results from the non-steady nature of traffic flow.
L_{max} :	The maximum sound pressure level recorded over a given period. L_{max} is sometimes used in assessing environmental noise, where occasional loud events occur which might not be adequately represented by a time-averaged L_{eq} value.

1.1 Octave Band Frequencies

In order to determine the way in which the energy of sound is distributed across the frequency range, the International Standards Organisation has agreed on "preferred" bands of frequency for sound measurement and analysis. The widest and most commonly used band for frequency measurement and analysis is the Octave Band. In these bands, the upper frequency limit is twice the lower frequency limit, with the band being described by its "centre frequency" which is the average (geometric mean) of the upper and lower limits, e.g. 250 Hz octave band extends from 176 Hz to 353 Hz. The most commonly used octave bands are:

Octave Band Centre Frequency Hz	63	125	250	500	1000	2000	4000	8000

1.2 Human Perception of Broadband Noise

Because of the logarithmic nature of the decibel scale, it should be borne in mind that sound levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) sound level is not twice as loud as 50dB(A). It has been found experimentally that changes in the average level of fluctuating sound, such as from traffic, need to be of the order of 3dB before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10dB is perceived by the average listener as a doubling or halving of loudness. Using this information, a guide to the subjective interpretation of changes in environmental sound level can be given.

APPENDIX A

Acoustic Terminology & Human Response to Broadband Sound

Change in Sound Level dB	Subjective Impression	Human Response
0 to 2	Imperceptible change in loudness	Marginal
3 to 5	Perceptible change in loudness	Noticeable
6 to 10	Up to a doubling or halving of loudness	Significant
11 to 15	More than a doubling or halving of loudness	Substantial
16 to 20	Up to a quadrupling or quartering of loudness	Substantial
21 or more	More than a quadrupling or quartering of loudness	Very Substantial

APPENDIX B

VA4715 - 5 St Albans Gardens, Teddington

Noise Impact Assessment

Assessment: to 29 Montague Street

		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Daikin RXYSQ8TY1	Lp @ 1m	60	63	54	52	49	48	42	34	**55**
Distance Loss	To 60m	-36	-36	-36	-36	-36	-36	-36	-36	
Level at receiver		**24**	**27**	**18**	**16**	**13**	**12**	**6**	**-2**	**20**

		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Daikin RXYSCQ5TV	Lp @ 1m	51	53	52	53	46	41	34	27	**53**
Distance Loss	To 60m	-36	-36	-36	-36	-36	-36	-36	-36	
Level at receiver		**15**	**17**	**16**	**17**	**10**	**5**	**-2**	**-9**	**17**

		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Air Handling Units - Intake	Lw	68	68	67	66	66	63	59	54	**70**
Number of Plant	2	3	3	3	3	3	3	3	3	
Radiation geometry		-8	-8	-8	-8	-8	-8	-8	-8	
Distance Loss	To 60m	-36	-36	-36	-36	-36	-36	-36	-36	
Level at receiver		**27**	**27**	**26**	**25**	**25**	**22**	**18**	**13**	**30**

		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Air Handling Units - Exhaust	Lw	73	74	72	70	71	68	64	59	**75**
Indicative attenuator (600mm)	50% F.A	-1	-2	-7	-10	-11	-9	-8	-7	
Number of Plant	2	3	3	3	3	3	3	3	3	
Radiation geometry		-8	-8	-8	-8	-8	-8	-8	-8	
Distance Loss	To 60m	-36	-36	-36	-36	-36	-36	-36	-36	
Level at receiver		**31**	**31**	**24**	**19**	**19**	**18**	**15**	**11**	**26**

		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Air Handling Units - Casing Radiated	Lw	68	62	54	44	36	38	30	30	**51**
Number of Plant	2	3	3	3	3	3	3	3	3	
Radiation geometry		-8	-8	-8	-8	-8	-8	-8	-8	
Distance Loss	To 60m	-36	-36	-36	-36	-36	-36	-36	-36	
Level at receiver		**27**	**21**	**13**	**3**	**-5**	**-3**	**-11**	**-11**	**10**

	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Cumulative level at receiver	**35**	**34**	**29**	**27**	**27**	**24**	**20**	**16**	**32**