

Technical Services – Noise & Vibration
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Technical Report

Reference: N&V – R3354

PLU – NOISE & VIBRATION ASSESSMENT FOR NEW ELECTRICAL SUB-STATION AT TURNPIKE LANE (COLINA ROAD)

Issue Date: 26th June 2024

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CONDITIONS OF ISSUE OF REPORT

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QUERIES OR FURTHER INFORMATION

ANY QUERIES OR REQUESTS FOR ADDITIONAL INFORMATION ON THE SUBJECT OF THIS REPORT SHOULD BE ADDRESSED TO THE AUTHOR WHO MAY BE CONTACTED AT THE ADDRESS GIVEN ON THE TITLE PAGE.

1. BACKGROUND

London Underground (LU) are in the process of purchasing new rolling stock for the Piccadilly line and new electrical sub-stations need to be built to ensure that the line has sufficient electrical capacity for the new rolling stock. New electrical sub-stations are planned for Jermyn Street (near Piccadilly Circus), Isledon Road (near Finsbury Park), Colina Road (near Turnpike Lane) and the Hounslow West area. Technical Services have been requested to conduct environmental surveys at the first three of these sites so that the planned facilities can be designed in such a way as to mitigate any noise impact from the operation of these facilities. This report deals with the measurements conducted at Colina Road.

The expectation of many local authorities in London is that any new plant equipment possesses a rating level 10dB below the pre-existing background sound or lower, when measured 1 metre outside the nearest noise sensitive receptor. This is so that any noise from the equipment is masked by already present noise sources and is inaudible. G1323 – Noise & Vibration Asset Design, Table 1 defines this level as the No Observable Effect Level, in recognition of this preference, and designers should use reasonable endeavours to meet this requirement where it is practicable and feasible. However, where this is not possible, new assets should be designed such that the Low Observable Adverse Effect Level is not exceeded (i.e. the rating level should be no more than 5dB above the pre-existing background sound level).

2. MEASUREMENT DETAILS

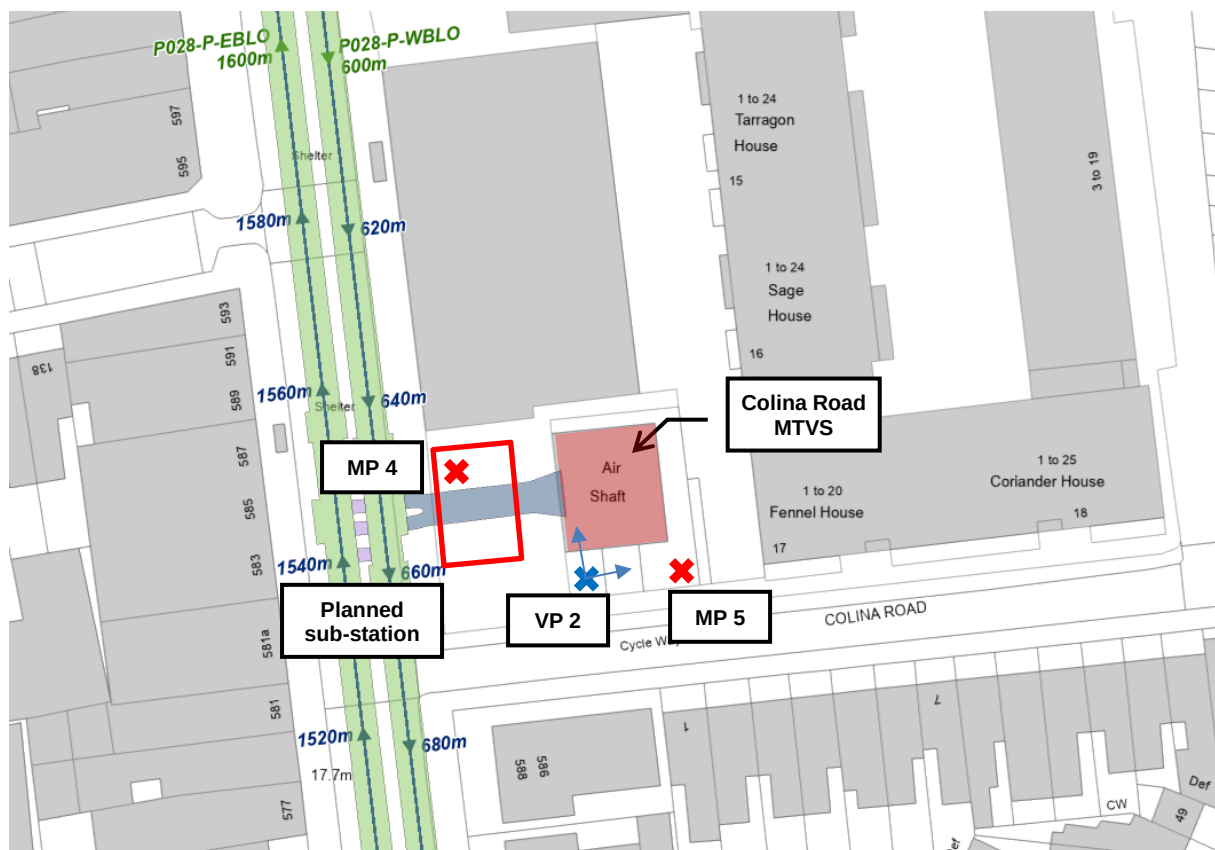


Figure 3 – Map showing the planned location of the new sub-station

The sub-station at this site is planned to be constructed as a new structure on LU land surrounding the Colina Road Mid-Tunnel Ventilation Shaft (MTVS). The principal noise & vibration risk from this structure is airborne noise from the ventilation system which will keep the transformers cool. The site is intersected by a sewer which has the potential of carrying ground borne vibration into properties served by the sewer,

introducing the risk of ground borne noise in the surrounding properties. Immediately to the east of the proposed site is the Colina Road MTVS behind which is a new apartment building. All the other properties surrounding the site are mixed use commercial and residential properties.

Noise measurements were conducted in general accordance with BS 4142:2014+A1:2019 (The British Standards Institution, 2019). Microphones were setup in the free-field, away from reflective surfaces, adjacent to Green Lanes (MP4) and Colina Road (MP5) and are considered to be representative of the noise exposure for properties on the respective roads. The microphones were setup 1.55m above ground level.

The sound level meters were field checked for calibration before and after the measurement and no significant variation in level was observed. Open-source weather data was used as an indication of the weather conditions throughout the measurement period. The weather data indicates that there were prolonged periods of high winds (above 5ms^{-1}) which have been excluded from the results.

The accelerometer was mounted on soft earth and fixed in place with four 350mm ground spikes. The axes of the vibration meter were arranged orthogonal to the MTVS building. Vibration measurements were unaffected by the weather conditions.

Table 3 – Survey details

Date/time of measurements	18/04/2024 – 22/04/2024
Measurement location	Colina Road MTVS & grounds
Equipment used	MP4: 01dB Duo Class 1 Sound Level Monitor s/n 10534 MP5: 01dB Fusion Class 1 Sound Level Meter s/n 10758 VP2: 01dB Orion Vibration Meter s/n 10631 Larson Davis CAL200 Acoustic Calibrator s/n 20977

3. RESULTS OF MEASUREMENTS

Table 8 – Acoustic measurement results

Date	Period	Duration, T (Hours)	Ambient Sound Level ($L_{Aeq, T}$ (dB))		Background Sound Level ($L_{A90, 15 \text{ mins}}$ (dB))					
					Min		Max		Avg	
			MP4	MP5	MP4	MP5	MP4	MP5	MP4	MP5
18/04/2024	Day*	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Night*	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19/04/2024	Day*	8.5	63	63	55	52	58	55	56	54
	Night	8	61	60	47	44	57	53	52	49
20/04/2024	Day	16	62	62	54	52	57	55	55	53
	Night	8	61	60	45	45	56	54	51	49
21/04/2024	Day	16	61	61	50	46	56	55	54	53
	Night	8	60	59	38	41	57	55	49	47
22/04/2024	Day	4.75	63	63	54	52	60	55	58	54

*Levels affected by strong winds.

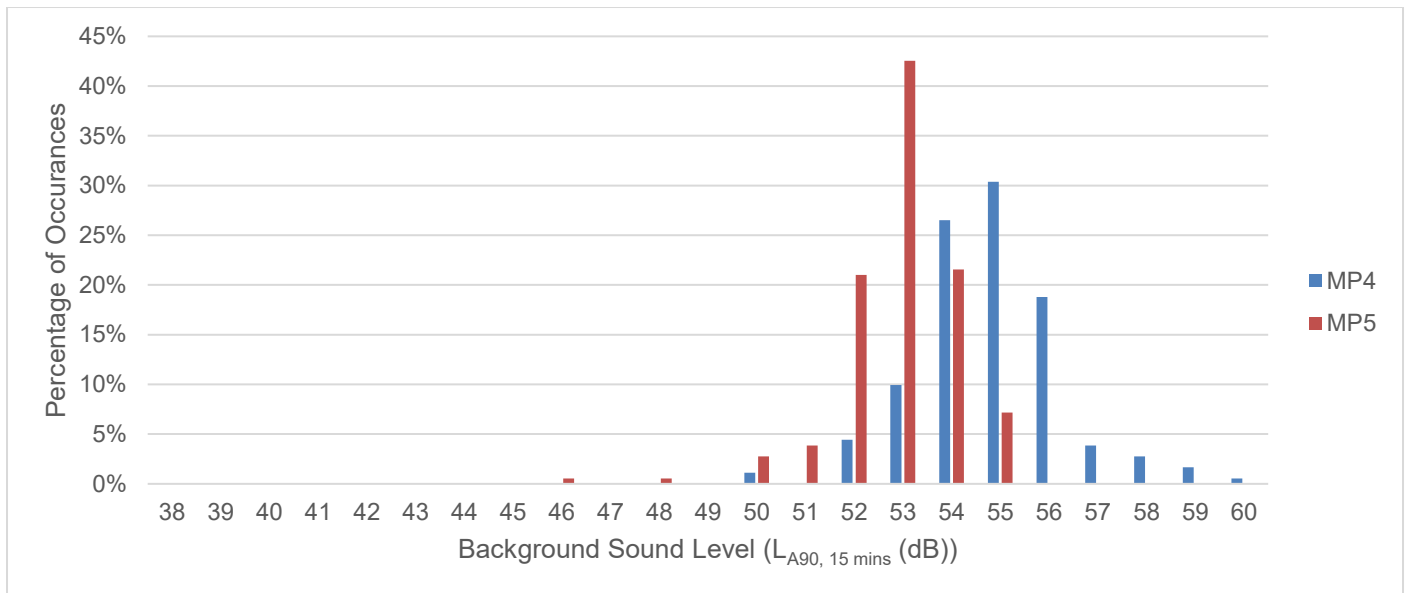


Figure 6 – Statistical distribution of background noise levels during the daytime

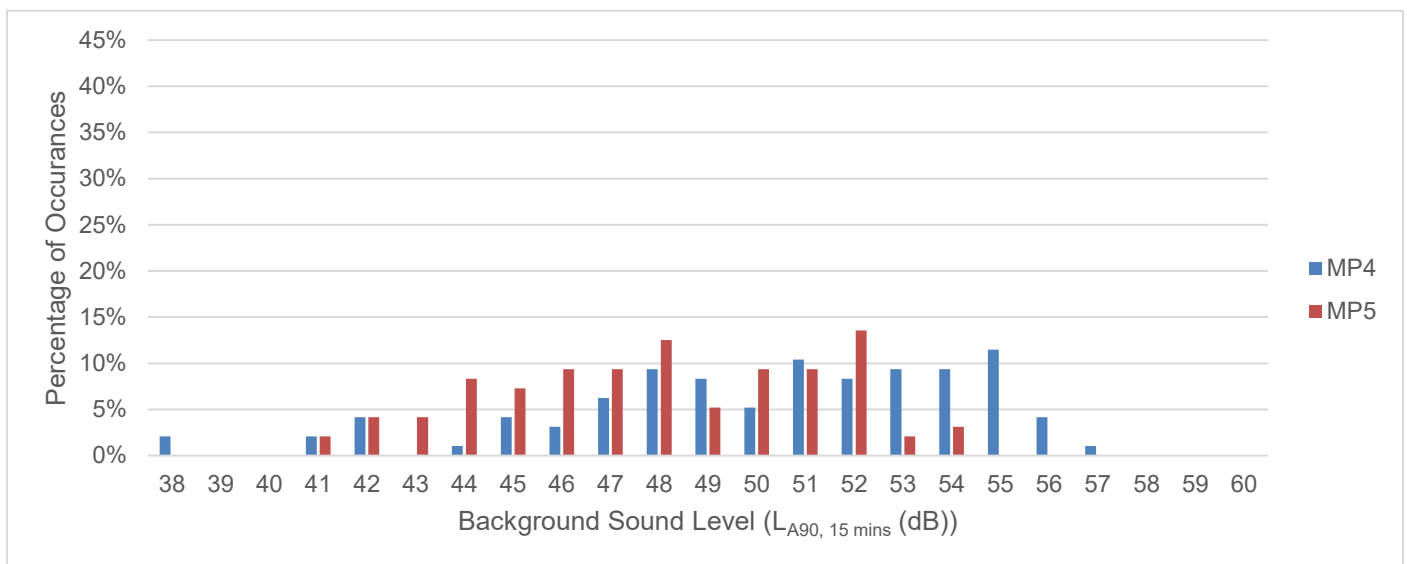


Figure 7 – Statistical distribution of background noise levels during the night-time

Table 9 – Vibration measurement results

Date	Period	Duration, T (Hours)	No. of Transient Events	Axis	Period VDV _T (ms ^{-1.75})	Transient MTVV (mms ⁻²)		
						Min	Max	Avg
18/04/2024	Day	6.75	213	X	Not Applicable	11.8	249.7	109.4
				Y		17.0	379.3	123.7
				Z		4.0	107.1	34.6
	Night	8	53	X	0.0184	39.7	216.9	115.6
				Y	0.0203	53.8	235.3	115.8
				Z	0.0573	13.5	76.0	35.6
19/04/2024	Day	16	463	X	0.0184	14.6	271.6	105.9
				Y	0.0203	16.2	265.0	109.7
				Z	0.0573	4.7	82.4	32.8
	Night	8	68	X	0.0200	41.9	205.8	119.6
				Y	0.0208	44.3	222.6	114.4
				Z	0.0612	12.7	70.1	36.7
20/04/2024	Day	16	407	X	0.0305	7.7	266.9	109.7
				Y	0.0346	18.4	335.8	115.4
				Z	0.0909	2.8	83.4	33.5
	Night	8	67	X	0.0204	44.8	239.3	127.3
				Y	0.0212	44.9	230.9	122.6
				Z	0.0621	13.7	75.6	39.6
21/04/2024	Day	16	376	X	0.0301	8.1	262.4	106.6
				Y	0.0340	16.6	303.5	114.9
				Z	0.0889	5.4	88.6	32.7
	Night	8	37	X	0.0184	56.1	237.4	128.7
				Y	0.0184	53.4	240.7	126.4
				Z	0.0531	13.3	84.2	38.8
22/04/2024	Day	5	143	X	Not Applicable	7.2	232.9	104.5
				Y		21.7	234.9	106.4
				Z		4.7	76.3	33.3

4. OBSERVATIONS

At position MP4 High levels of road traffic were observed on Green Lanes when the equipment was being setup on the afternoon of Thursday 18th April and audio recordings indicate that the road was busy at all hours, including with large vehicles such as buses or Heavy Goods Vehicles. During the day the noise is mainly combustion noise from vehicles stuck in congestion while at night traffic flows more freely and the combustion noise from idling vehicles is replaced by tyre noise. There is a large bus station located at Turnpike Lane and there are two bus routes serving Green Lane during the day and one at night.

The London bus fleet is moving away from using vehicles with internal combustion (IC) engines and towards quiet running vehicles (hybrid, hydrogen & battery electric). The expansion of the ULEZ to cover all of London, will encourage private vehicle owners to also move away from vehicles with IC engines and towards quiet running vehicles.

Colina Road is a one-way street feeding on to Green Lanes, producing much more variable volumes of traffic than Green Lanes, during both the day and night. Position MP5 still experiences the traffic noise from Green Lanes but to a lesser degree as it is further away than MP4.

There was occasional noise from overflying aircraft during the day which would have affected both measurement positions.

The Vibration Dose Value (VDV) is the cumulative vibration exposure over each period of time. The values for the first and last periods have been excluded as these periods are incomplete. The frequency response of the acquisition system is equivalent to the Wd curve for the horizontal axes (X & Y) and Wb curve for the vertical axis (Z), providing a generally flat response between 0.1 and 10Hz but suppressing vibration outside of this range.

1,827 transient vibration events were identified as producing significant levels of vibration above the ambient during the measurements period, with 1,602 events during the day and 225 events during the night. Based upon the timing of these events they are most likely the result of train movements on the Piccadilly Line as they stop between midnight and 1am on Thursday and Sunday nights but continue throughout the night on Friday and Saturday night, as a result of night tube operations.

5. RECOMMENDATIONS

In order to minimise the risk of disturbance from ventilation noise, it is recommended that ventilation fans be positioned facing away for noise sensitive receptors such as private homes. To reduce the risk of turbulent air noise produced by the operation of the fan it is recommended that large fans which can be run at low speeds be used.

It is recommended that the transformers be stood on isolating mounts to mitigate the risk of any vibration from their operation entering the ground and being transmitted into adjacent structures.

APPENDIX A – SITE PHOTOS



Figure A.1 – Microphone at position MP4



Figure A.2 – Microphone at position MP5



Figure A.3 – Acquisition system and batter for MP5



Figure A.4 – Vibration meter at position VP2



Figure A.5 - Vibration meter at position VP2

APPENDIX B – CALIBRATION CERTIFICATES



Brand of ACOEM

CERTIFICAT D'ETALONNAGE CALIBRATION CERTIFICATE

N° CE-DTE-L-24-PVE-85912

DELIVRE PAR :
ISSUED BY

ACOEM
Service Métrologie
85 route de Marcilly

69380 LISSIEU
France

INSTRUMENT ETALONNE
CALIBRATED INSTRUMENT

Désignation : Vibromètre
Designation : Vibration meter

Constructeur :
Manufacturer : 01dB

Type :
Type : ORION

N° de serie :
Serial number : 10631

N° d'identification :
Identification number

Date d'émission : 30/01/2024

Ce certificat comprend 6 pages
This certificate includes pages

LE RESPONSABLE PRODUCTION
MANUFACTURING MANAGER
Jérôme PIA

LA REPRODUCTION DE CE CERTIFICAT N'EST AUTORISEE QUE SOUS LA FORME DE
FAC-SIMILE PHOTOGRAPHIQUE INTEGRAL

THIS CERTIFICATE MAY NOT BE REPRODUCED OTHER THAN IN FULL
BY PHOTOGRAPHIC PROCESS

CE CERTIFICAT EST CONFORME AU FASCICULE DE DOCUMENTATION FD X 07-
012

THIS CERTIFICATE IS CONFORM TO THE STANDARD FD X 07-012

Certificate of Calibration

Issued By CoMech Metrology Limited

Date of issue 04-Mar-2024

Certificate number C430429-01

CoMech*

1 Pride Park View

Victoria Way

Pride Park

Derby

DE24 8AN

Tel: 01332 867700

Email: sales@comech.co.uk

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Authorised Signatory:
Traver Gombé

Client : LONDON UNDERGROUND - LILLIE BRIDGE
Lillie Bridge Depot,, 7 Beaumont Avenue, Greater London, W14 9UY, UK

Order No : 3500088942

Manufacturer/Model No : 01dB Fusion SLM
Description : Sound and vibration analyzer
Identification : 10758

Serial No : 10758

Date Received : 05-Feb-2024

Date of test : 28-Feb-2024

Basis of test : This instrument was sub-contracted by CoMech to an approved or requested safety critical supplier for calibration.

Calibration Results

We certify that the above product was calibrated and found to be within manufacturers performance specification prior to dispatch.
Measurements are traceable to national standards.

Tests were carried out in environmental conditions appropriate to the instruments specification.
CoMech Metrology Ltd record the calibration measurements for this unit and details of all tests.

Number of pages attached: 6

Comments:

All equipment used has calibration certification traceable to national standards.
Instrument was sub-contracted by CoMech

Ancillaries: in black case

This certificate may not be reproduced other than in full, except with prior written approval of the issuing laboratory.

Certificate of Calibration

Issued By CoMech Metrology Limited

Date of issue 06-Dec-2022

Certificate number C394415-01

CoMech

1 Pride Park View
Victoria Way
Pride Park
Derby
DE24 8AN
Tel: 01332 867700
Email: sales@comech.co.uk

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Client : LONDON UNDERGROUND - LILLIE BRIDGE
Lillie Bridge Depot,, 7 Beaumont Avenue, Greater London, W14 9UY, UK

Order No : 3101277969

Manufacturer/Model No : DUO

Description : Sound Level Meter

Identification : 10534A

Serial No : 10534A

Date Received : 05-Dec-2022

Date of test : 06-Dec-2022

Basis of test : Examined using an Acoustic Calibrator at an ambient temperature of 20°C $\pm$ 5°C to OEM Manufacturer's specification and the measured values reported. All equipment used has calibration certification traceable to national standards.

Calibration Results

Sound Level Meter

<u>Input @ 1 kHz</u>	<u>UUT reading @ 1 kHz</u>	<u>Error</u>
94 dB	94.07 dB	0.1
104 dB	103.34 dB	-0.7

Comments

* Denotes not to specification

Instrument conforms to manufacturer's specification $\pm$ 1 dB

No adjustments made

Test equipment used: **HP018**

Ancillaries: -

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Certificate of Calibration

Issued By **CoMech Metrology Limited**

Date of issue 26-Mar-2024

Certificate number C434525-01

CoMech®

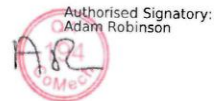
Calibration House
1 Pride Park View, Victoria Way
Derby DE24 8AN

Tel: 01332 867700

Fax: 01332 867707

Email: metrology@comech.co.uk

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Client : London Underground - Lillie Bridge (JNP)
Track Workshops, Lillie Bridge Depot, Lillie Road, London, SW6 1TP, UK
Order No : 3500088990

Manufacturer / Model No : LARSON DAVIES CAL 200
Description : Sound Meter
Identification : 20977

Serial No : 20977

Date received : 25-Mar-2024

Date of test : 26-Mar-2024

Basis of test :

Examined and tested using equipment HP570 at an ambient temperature of 20°C +/- 5°C to Manufacturer's specification and the measured values reported.

Test Report

Prior To Adjustment

Sound Level Meter

<u>Input @ 1 KHz</u>	<u>UUT reading @ 1 KHz</u>	<u>Error</u>
94 dB	94.3 dB	0.3
114 dB	114.3 dB	0.3

Comments

All equipment used has calibration certification traceable to National Standards.
Instrument conforms to manufacturers specification.
CEL-120/2: 114dB +/- 0.35dB
Equipment used: **HP570**

This certificate may not be reproduced other than in full, except with prior written approval of the issuing laboratory.

APPENDIX C – DEFINITIONS

A-weighting – a frequency weighting of measured values over the full frequency range and comparable with the loudness response of the human ear at lower sound amplitudes.

$L_{A90, T}$ – The sound level just exceeded for 90% of the measurement period and calculated by statistical analysis, for time-period T, A-weighted.

$L_{Aeq, T}$ – The equivalent continuous sound level or average sound level of the measurement period, for time-period T, A-weighted.

Ambient sound level $L_a = L_{Aeq, 30 \text{ sec}}$ – equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, usually from many sources near and far, at the assessment location over a reference time interval of 30 seconds.

Background sound level, $L_{A90, 15 \text{ min}}$ – A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a 15-minute time interval, measured using time weighting, F.

Residual sound level, $L_r = L_{Aeq, 15 \text{ min}}$ – ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound.

Specific sound level, $L_s = L_{Aeq, 30 \text{ sec}}$ – equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a reference time interval of 30 seconds.

Vibration Dosage Value (VDV_T) = a parameter that combines the magnitude of vibration and the time for which it occurs. When assessing intermittent vibration it is necessary to use the vibration dose value, a cumulative measurement of the vibration level received over an 8-hour or 16-hour period.

Maximum Transient Vibration Value (MTVV) = the highest maximum vibration level during a measurement period recorded in 1 second intervals to account for transient motion and short acceleration peaks.

APPENDIX D – STANDARDS AND GUIDANCE

National Planning Policy

National Planning Policy Framework

The National Planning Policy Framework (NPPF) (Ministry of Housing, Communities & Local Government, 2021) sets out the government's planning policies for England and how these are expected to be applied. It was revised in 2018 following a review of the 2012 document and was updated in July 2021.

The revised NPPF comments on noise in the following ways:

Paragraph 174: *Planning policies and decisions should contribute to and enhance the natural and local environment by:*

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability.

Paragraph 185: *Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so, they should:*

a) mitigate, and reduce to a minimum, potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life; and

b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

Noise Policy Statement for England

The Noise Policy Statement for England (NPSE) (Department for Environment, Food and Rural Affairs, March 2010) seeks to clarify the underlying principles and aims in existing policy documents, legislation and guidance that relate to noise. The statement applies to all forms of noise, including environmental noise, neighbour noise and neighbourhood noise.

The statement sets out the long-term vision of the government's noise policy, which is to "promote good health and a good quality of life through the effective management of noise within the context of policy on sustainable development".

The guidance promotes the effective management and control of noise, within the context of Government policy on sustainable development and thereby aims to:

- Avoid significant adverse impacts on health and quality of life;
- Mitigate and minimise adverse impacts on health and quality of life; and
- Where possible, contribute to the improvements of health and quality of life.

The statement adopts established concepts from toxicology that are currently being applied to noise impacts. The concept details noise levels, at which the effects of an

exposure may be classified into a specific category. The classification categories as detailed within NPSE are as follows:

- No Observed Effect Level (NOEL) - the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established;
- Lowest Observed Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected; and
- Significant Observed Adverse Effect Level (SOAEL) - the level above which significant adverse effects on health and quality of life occur.

It is recognised that SOAEL does not have a single objective noise-based level that is applicable to all sources of noise in all situations and therefore the SOAEL is likely to be different for different sources, receptors and at different times of the day.

Planning Practice Guidance

The National Planning Practice Guidance (NPPG) (Ministry of Housing, Communities & Local Government, 2019) expands on the use of SOAEL:

“If the exposure is above this level the planning process should be used to avoid this effect occurring, by use of appropriate mitigation such as by altering the design and layout. Such decisions must be made taking account of the economic and social benefit of the activity causing the noise, but it is undesirable for such exposure to be caused.”

The NPPG also goes on to identify unacceptable noise exposure:

“At the highest extreme, noise exposure would cause extensive and sustained changes in behaviour without an ability to mitigate the effect of noise. The impacts on health and quality of life are such that regardless of the benefits of the activity causing the noise, this situation should be prevented from occurring.”

Regional and Local Policy

The London Plan

The Spatial Development Strategy (SDS), otherwise known as The London Plan (LP) (Greater London Authority, 2021), was adopted in March 2021 and looks to “serve as a blueprint for the future development and sustainable, inclusive growth of our city.”

The applicable policies to this assessment are taken from The LP and reproduced below:

Policy D13 Agent of Change

- A) *The Agent of Change principle places the responsibility for mitigating impacts from existing noise and other nuisance-generating activities or uses on the proposed new noise-sensitive development. Boroughs should ensure that Development Plans and planning decisions reflect the Agent of Change principle and take account of existing noise and other nuisance-generating uses in a sensitive manner when new development is proposed nearby.*
- C) *New noise and other nuisance-generating development proposed close to residential and other noise-sensitive uses should put in place measures to*

mitigate and manage any noise impacts for neighbouring residents and businesses.

Policy D14 Noise

A) In order to reduce, manage and mitigate noise to improve health and quality of life, residential and other non-aviation development proposals should manage noise by:

- 1) avoiding significant adverse noise impacts on health and quality of life;*
- 2) reflecting the Agent of Change principle as set out in Policy D13 Agent of Change;*
- 3) mitigating and minimising the existing and potential adverse impacts of noise on, from, within, as a result of, or in the vicinity of new development without placing unreasonable restrictions on existing noise-generating uses;*
- 4) improving and enhancing the acoustic environment and promoting appropriate soundscapes (including Quiet Areas and spaces of relative tranquillity);*
- 6) where it is not possible to achieve separation of noise-sensitive development and noise sources without undue impact on other sustainable development objectives, then any potential adverse effects should be controlled and mitigated through applying good acoustic design principles;*
- 7) promoting new technologies and improved practices to reduce noise at source, and on the transmission path from source to receiver.*

Standards and Guidance

British Standard 7445

British Standard 7445 Part 1 (British Standard Institution, 2003) defines the basic quantities to be used for the description of noise in community environments and describes basic procedures for the determination of these quantities.

The methods and procedures described in this British Standard are intended to be applicable to sounds from all sources, individually and in combination, which contribute to the total noise at a site.

British Standard 7445 Part 2 (British Standards Institution, 1991) describes methods for the acquisition of data which provide descriptors that enable:

- a) a description of the environmental noise in a specified area of land to be made in a uniform way; and
- b) the compatibility of any land use activity or projected activity to be assessed with respect to existing or predicted noise.

Using the data as a basis, authorities may establish a system for selecting the appropriate land use, as far as levels of noise are concerned, for a specified area, or the sources of noise - existing or planned - which are acceptable with respect to land use, existing or planned.

British Standard 4142

British Standard 4142:2014+A1:2019 (BS 4142) (British Standards Institution, 2019) describes methods for rating and assessing sound of an industrial and/or commercial nature. The method uses 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 method is suitable for the purpose of assessing sound at proposed new dwellings or premises used for residential purposes.

The standard distinguishes between the uses of the words “sound” and “noise”. Sound can be measured by a sound level meter or other measurement system. Noise is related to a human response and is routinely described as unwanted sound, or sound that is considered undesirable or disruptive.

The standard requires determination of the following:

- Rating level – L_{Aeq,T_r} sound level produced by the specific sound source at the assessment location with any adjustment for the characteristic features of the sound which could be added to the specific sound level if tones, impulsivity or other characteristics occur, or are expected to be present. T_r is the reference time interval over which the specific sound level is determined; 1 hour for daytime (07:00-23:00hr) and 15 minutes for night-time (23:00-07:00hr).
- Background sound level – $L_{A90,T}$ – A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T , measured using time weighting F (fast) and quoted to the nearest whole number in decibels.

The assessment methodology considers the Specific Sound Level, as measured or calculated at a potential noise sensitive receptor, due to the sound under investigation. A correction factor is added to this level to account for the acoustic character of the sound as follows:

- Tonality – A correction of up to 6 dB depending on the prominence of tones;
- Impulsivity – A correction of up to 9 dB depending on the prominence of impulsivity;
- Other sound characteristics – A 3 dB correction may be applied where a distinctive acoustic character is present that is neither tonal nor impulsive;
- Intermittency – A 3 dB correction may be applied where the specific sound has identifiable on-off conditions.

An estimate of the impact of the specific sound generated can be obtained by subtracting the measured background sound level from the rating level, and the following is considered:

- a) Typically, the greater this difference, the greater the magnitude of the impact.
- b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- d) 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.

All pertinent factors should be taken into consideration when assessing the impact, including the following:

- Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.
- The character and level of the residual sound compared to the character and level of the specific sound.
- The sensitivity of the receptor.