330 Grays Inn Road
London

Train Induced Vibration and Assessment Report

26609/VAR1

19/07/2019

For:
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London
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Hann Tucker Associates

Train Induced Vibration and Assessment Report 26609/VAR1

Document Control

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Train Induced Vibration and Assessment Report 26609/VAR1

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1.0 Introduction

A new scheme including noise sensitive residential uses is proposed at 330 Grays Inn road, London. The proposed residential buildings are to be located directly adjacent to the Circle, Hammersmith & City, and Metropolitan tube lines which run overground past the site in addition to Thameslink trains which we understand run in tunnels underground.

Hann Tucker Associates have therefore been commissioned to establish the current incident train induced vibrations and to subsequently use the results of the survey alongside the proposed construction details in order to predict the likely train induced vibration and groundborne noise levels in the development.

2.0 Objectives

To establish, by means of site measurements, the magnitude and frequency distribution of ground borne vibration resulting from the movement of underground and surface trains.

To present suitable train induced vibration and groundborne noise criteria.

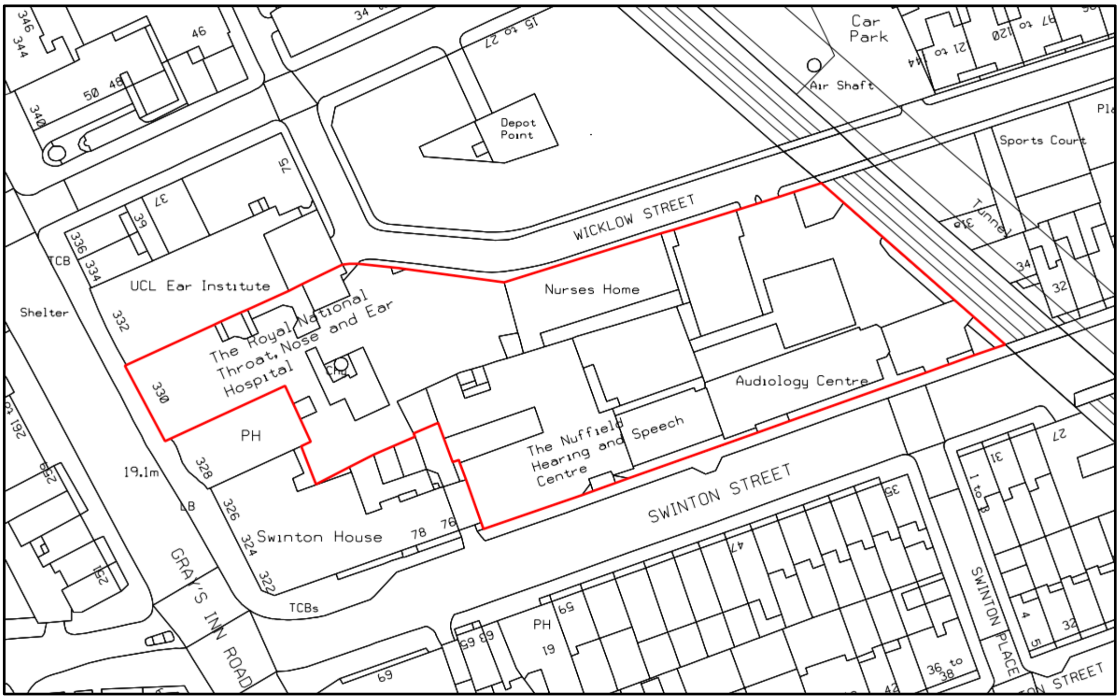
To assess the likely levels of vibration and groundborne noise based on the results of the vibration survey and the proposed substructures and superstructures.

To recommend any potential amelioration measures if deemed necessary.

3.0 Site Description

The site is located at 330 Grays Inn Road, but also incorporates buildings on Wicklow Street and Swinton Street. The site is bounded by Grays Inn Road to the west, and by the train line to the east. The western side of the site is bounded to the north and south by other properties on Grays Inn Road and the eastern side of the site is bounded by Wicklow Street to the north and by Swinton Street to the south.

See Site Plan showing site boundary (in red) below.



Site Plan (Reproduced from Pre App documentation).

4.0 Vibration Survey

4.1 Instrumentation

The following instrumentation was used for the manned survey and subsequent analysis:

- 2No. Dytran Accelerometers
- 01dB –dB4 Hardware Interface
- 01dB – dBTrig Vibration Acquisition Software
- 01dB – dBTrait Vibration Analysis Software
- B&K 2260 Sound Level Meter
- Microsoft Windows Based Laptop Computer

The 01dB hardware and software connects to two accelerometers via a multi-channel unit. The system can record data in real-time to a computer allowing simultaneous analysis in both the time and frequency domains.

The analysis chain was calibrated prior to the measurements to enable subsequent analysis.

The vibration measurements were undertaken with the accelerometers mounted using strong inbuilt magnets attached to large steel washers which were glued to the ground (tarmac/concrete) with Epoxy resin.

The unmanned vibration measurements were undertaken using a Svantek 948 vibration meter and associated SV207a tri-axial accelerometer.

4.2 Procedure

The manned vibration survey was undertaken on 8 July 2019 between approximately 13:00 hours and 15:00 hours, and the unmanned survey was undertaken between approximately 13:00 hours on 8 July and approximately 13:00 hours on 9 July 2019.

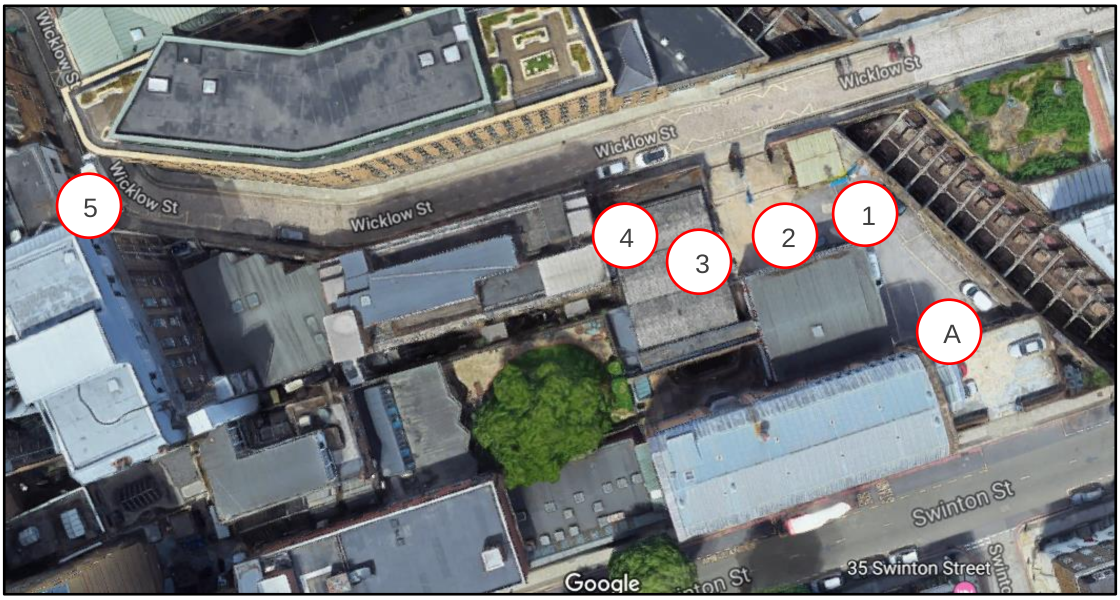
Vibration measurements were undertaken in order to establish the prevailing vibration levels due to train movements.

The unmanned measurement position (Position A) was located in the external courtyard approximately 10m away from the train line.

The manned measurement positions are described in the table below.

Position	Description
1	Located in the external service yard / staff carpark with the accelerometer mounted to the tarmac at a position representative of the closest proposed residential façade to the train line (approximately 5m).
2	Located in the external service yard / staff carpark with the accelerometer mounted to the tarmac approximately 15m from the train line.
3	Located internally in the Carpenters Workshop with the accelerometer mounted to the floor approximately 20m from the train line.
4	Located internally in the Estates Store with the accelerometer mounted to the floor approximately 30m from the train line, representative of the furthest proposed residential apartment from the train line.
5	Located externally on Wicklow Street with the accelerometer mounted to the pavement at a position representative of the closest façade to the train line (approximately 70m)

The above positions are shown in the plan below:



Plan showing measurement positions © Google 2019.

5.0 Criteria

5.1 Vibration

British Standard BS 6472: 2008 "*Guide to Evaluation of Human Exposure to Vibration in Buildings*" advises that intermittent vibration events should not be judged based on perception alone but using the corresponding vibration dose value over a long period.

BS6472:2008 advises that "the VDV defines a relationship that yields a consistent assessment of continuous, intermittent, occasional and impulsive vibration and correlates well with subjective response" and also "the VDV is much more strongly influenced by vibration magnitude than by duration. A doubling of halving of the vibration magnitude is equivalent to an increase or decrease of exposure duration by a factor of sixteen."

The table below details the Vibration Dose Values ($m/s^{1.75}$) above which various degrees of adverse comment may be expected in Residential Buildings.

Time Period	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Daytime (07:00– 23:00)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Night-time(23:00–07:00)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

The table below details the Vibration Dose Values ($m/s^{1.75}$) above which various degrees of adverse comment may be expected in Office Buildings.

Time Period	Low Probability of adverse comment	Adverse comment possible	Adverse comment probable
Daytime (07:00– 23:00)	0.4	0.8	1.6

The perception threshold for continuous whole-body vibration varies widely among individuals. Approximately half a typical population, when standing or seated, can perceive a vertical weighted peak acceleration of 0.015 m/s^2. The weighting used is W_b. A quarter of the population would perceive a vibration of 0.010m/s^2 peak, but the least sensitive quarter would only be able to detect a vibration of 0.020m/s^2 peak or more. Perception thresholds are slightly higher for vibration duration of less than about 1 second.

Please refer to Appendix A for an explanation of the vibration terminology used in this report.

5.1.1 Local Authority Vibration Criteria

The site is under the jurisdiction of Camden Council. The Camden Local Plan 2017 states the following:

Table A: Vibration levels from uses such as railways, roads, leisure and entertainment premises and/or plant or machinery at which planning permission will not normally be granted

Vibration description and location of measurement	Period	Time	Vibration Levels (Vibration Dose Values)
Vibration inside critical areas such as a hospital operating theatre	Day, evening and night	00:00-24:00	0.1 VDV ms-1.75
Vibration inside dwellings	Day and evening	07:00-23:00	0.2 to 0.4 VDV ms-1.75
Vibration inside dwellings	Night	23:00-07:00	0.13 VDV ms-1.75
Vibration inside offices	Day, evening and night	00:00-24:00	0.4 VDV ms-1.75
Vibration inside workshops	Day, evening and night	00:00-24:00	0.8 VDV ms-1.75

5.2 Groundborne Noise

Currently no British Standards exist which recommend a method by which to assess intermittent ground-borne or structure-borne noise, such as that induced by trains.

Whilst there is no widely accepted method of evaluation of groundborne noise, there is some consensus that for levels at and above 50dBA L_{smax} during daytime, there is likely to be significant adverse reaction. For residential situations the L_{smax} noise levels for which there is likely to be very little adverse comment can be taken as around 30dBA during the daytime and around 25dBA during night time.

The Association of Noise Consultants (ANC) - “Measurement and Assessment of Groundborne Noise & Vibration” (Second Edition), presents the following impact classification tables for residential and non-residential receptors, which have been drawn from major railway projects in the UK and Ireland, e.g. Crossrail, the Jubilee Line, Dublin Area Rapid Transit (DART) and HS1.0

<table>
<tr><th colspan="3">Groundborne Noise Impact Criteria for Residential Receptors
presented in ANC “Measurement and Assessment of Groundborne Noise & Vibration”</th></tr>
<tr><th>Impact Classification</th><th colspan="2">Groundborne Noise Level dB L_{smax} (measured indoors, near the centre of any dwelling room on the ground floor)</th></tr>
<tr><td>Negligible</td><td><35</td><td rowspan="2">Not significant</td></tr>
<tr><td>Low</td><td>35-39</td></tr>
<tr><td>Medium</td><td>40-44</td><td rowspan="3">Significant impact</td></tr>
<tr><td>High</td><td>45-49</td></tr>
<tr><td>Very High</td><td>>49</td></tr>
</table>

<table>
<tr><th colspan="2">Groundborne Noise Impact Criteria for Non-Residential Receptors
presented in ANC “Measurement and Assessment of Groundborne Noise & Vibration”</th></tr>
<tr><th>Building</th><th>Significant Impact Threshold dBA L_{smax}</th></tr>
<tr><td>Theatres/large auditoria and concert halls</td><td>25</td></tr>
<tr><td>Sound recording/broadcast studios</td><td>30</td></tr>
<tr><td>Places of meeting for religious worship/courts/lecture theatres/museums/small auditoria or halls</td><td>35</td></tr>
<tr><td>Offices/schools/colleges/hospitals/hotel/libraries</td><td>40</td></tr>
<tr><td>Factories/warehouses</td><td>50</td></tr>
</table>

Groundborne noise is of greatest concern when it is the dominant noise, and also when the source cannot be seen, as in the case of trains in a tunnel. Criteria for groundborne noise are therefore generally intended to apply to sources such as underground trains.

British Council for Offices Guide to Specification 2019 advises as follows:

"Sources of vibration external to the building can transmit to the building structure. Vibration in the building structure can be perceived by humans as either tactile vibration or, more commonly, as re-radiated noise.

Guidance on ground-borne noise and vibration can be found in BS6472-1: 2008 and ANC Guidelines "Measurement and Assessment of Ground-borne Noise & Vibration". In addition, it is suggested that train induced vibration should not result in re-radiated noise levels of more than the following:

Cellular Offices:	*40 dB $L_{Amax(slow)}$*
Meeting Rooms:	*40 dB $L_{Amax(slow)}$*
Open Plan Offices:	*45 dB $L_{Amax(slow)}$*

These levels may be perceptible. Each case must be examined carefully accounting for the occupants' uses and expectations, background masking noise levels, extent and magnitude of levels, together with the number and duration of individual vibration events and - in the case of over-ground trains - any airborne noise intrusion from the same source.

Building vibration isolation can be costly and should have a cost/benefit/risk analysis. Audio simulations of the predicted ground-borne noise levels, together with those of background masking noise, can be extremely worthwhile during the decision-making process, especially where they are near the threshold of acceptability.

Building vibration isolation is normally the only practicable mitigation measure and involves the introduction of resilient bearings between the substructure and superstructure. It is essential that special advice be sought for ground-borne noise at an early stage to identify the structural, cost and programme implications."

In the UK a criterion of 40dBA (L_{smax}) (often used by LUL) is considered unlikely to provoke adverse comment or complaint in a commercial environment. For residential premises we would advise in favour of a criterion of 35dBA (L_{smax}). This equates to train movement being audible but not to an extent likely to cause significant adverse comments.

The table below summarises the proposed assessment criteria:

Environment	Proposed L_{smax} Limit of Train Induced Groundborne Noise Level (dBA)
Cellular Offices	40
Meeting Rooms	40
Open Plan Offices	45
Commercial	40
Residential	35

It is generally accepted however, that people are more tolerant of noise from sources which can also be seen. Furthermore, where sources are visible, airborne noise intrusion through the façade in most cases masks the ground-borne noise which is radiated simultaneously. Therefore, where residential façades are likely to be exposed to relatively high levels of train airborne noise, it could be considered reasonable to relax the criterion to account for this.

The table below summarises the proposed assessment criteria for facades with windows overlooking the train line:

Environment	Proposed L_{smax} Limit of Train Induced Groundborne Noise Level (dBA)
Residential	40

Please refer to Appendix B for an explanation of the acoustic terminology used in this report.

6.0 Train Movements

The following table presents our estimates of the number of train passes for daytime (07:00 hours to 23:00 hours) and night-time (23:00 hours to 07:00 hours) periods. These predictions are based upon measured vibration data from the unmanned survey.

Daytime (07:00 – 23:00)	Night-Time (23:00 – 07:00)
400	110

Note: The Vibration Dose Value parameter is mainly dictated by the magnitude of the individual train pass bys, and is relatively insensitive to the number of train events.

The measured vibration data shows that between the hours of 01:00-05:00 the frequency of trains causing significant vibration events was significantly reduced.

7.0 Survey Results

Typical measured vibration levels at each position for different are presented on Graphs 26609/G1 to 26609/G5 enclosed. The measured vertical peak (Wb weighted) acceleration during the unmanned vibration survey is presented in time history graph 26609/VTH1.

The vertical weighted peak acceleration of vibration events known to be train passbys ranged from 0.004-0.006 (m/s^2, W_b) at the closest position to the trainline. Higher vibration levels were measured at points throughout the unmanned vibration survey, however the survey area was also used for ambulances to park and given the known frequency of the trains, it is likely that these higher levels are the result of hospital personnel/equipment in close proximity to the equipment (for example unloading stretcher beds from the back of an ambulance).

The Vibration Dose Values (VDV) calculated using data from Position A are detailed in the table below.

Period	VDV ($m/s^{1.75}$)
Daytime (07:00 – 23:00)	0.03
Night-Time (23:00 – 07:00)	0.01

A selection of noise levels (dBA, L_{maxs}) were also recorded, and are presented in the table below.

Location	Sound Level (dBA) $L_{max,slow}$
Cupboard B17	37
Cupboard B17	37
Estates Store	34*
Estates Store	34*

*Airborne noise transfer was audible through the roof of the estates store and some airborne contribution may be present.

8.0 Building Response

The building development superstructure will modify the surveyed vibration levels, superstructures often amplifying foundation vibration levels. Our analyses assumes the following:

- Empirically researched floor amplification factors as given within *"A Prediction for Rail Transportation Ground-borne Noise and Vibration"* (Ref 1) and *"Handbook for Urban Noise and Vibration Control"* (Ref 2).
- The typical maximum recorded vibration levels for different train pass-bys shall be used.
- Existing buildings where measurements were made were lightweight commercial type buildings.
- At this stage we have been advised that the proposed building structure is likely to be RC frame with piled foundations for the residential and hotel elements and steel frame with rafted foundations for the office.

9.0 Predicted Levels Of Vibration And Groundborne Noise

9.1 Vibration Levels

Based on the typical maximum recorded vibration levels we have predicted vibration levels within the proposed development at the worst affected noise sensitive floor. Based on the above and measured existing VDVs, the following worst case V.D.V.'s have been predicted.

Period	Location	V.D.V. (m/s$^{1.75}$)
Daytime (07:00 – 23:00)	Closest part of development to train line	0.07
Night-Time (23:00 – 07:00)		0.02

Please note these predicted vibration levels are approximate.

9.2 Groundborne Noise Levels

Based on the typical maximum recorded vibration levels we have calculated the predicted groundborne noise levels within the proposed development at the worst affected noise sensitive floor. Noise levels will decay slightly with height. A reasonable estimate is to subtract 1dB per floor.

Our analysis indicates the following groundborne (L_{smax}) noise levels at first suspended slab level, based on the predicted vibration levels for medium building amplification factors, the typical worst case train pass-bys and the proposed substructure and superstructure constructions.

Location	Level (dB L_{smax})
Position 1 (Residential)	37
Position 2 (Residential)	40
Position 3 (Residential)	35
Position 4 (Office)	34
Position 5 (Hotel)	30

Please note these predicted groundborne noise levels are approximate.

10.0 Discussion Of Results

10.1 Vibration

10.1.1 Surveyed

The magnitude of the vibration of different train pass-bys varied. This was mainly due to the direction of travel and the proximity to Kings Cross St Pancras station; trains traveling the away from the station were observed to be travelling significantly more quickly than trains traveling towards the station. Other factors include speed and weight of trains as well as the condition of the rolling stock (i.e. rough wheels).

With reference to Section 5.1 measured vertical weighted peak acceleration of typical train passbys show that tactile vibration is unlikely to be currently perceivable. This concurs with our engineer's subjective perception whilst on site. Measured VDVs were significantly below the threshold for 'low probability of adverse comment'.

10.1.2 Predicted

Predicted acceleration levels from typical train passbys may be perceivable by some of the population. However, predicted VDVs are still significantly below the threshold for 'low probability of adverse comment' and comply with the Local Authority Criteria.

10.2 Noise

10.2.1 Surveyed

Measured noise levels due to train passbys were slightly higher than our proposed re-radiated noise criterion in cupboard B17, approximately 15m from the train line, and complied with our proposed criterion in the Estates Store, approximately 30m from the train line.

10.2.2 Predicted

Re-radiated noise levels are predicted to be audible but to comply with our proposed re-radiated noise criteria throughout a significant proportion of the development, with the exception of the proposed residential apartments at lower levels (below approximately 5th floor).

Re-radiated noise levels in the worst affected apartments are currently predicted to be approximately 5dB above our proposed re-radiated noise criterion for residential properties but may *just* comply with our proposed relaxed criteria intended to apply to rooms with a direct view of the train line. Therefore the predicted worst-case noise levels may be acceptable in apartments where living areas have windows with view of the train line due to reasons discussed in Section 5.2, however for apartments facing the central courtyard which have no view of the train line and which are screened from airborne train noise, this is likely to be on the borderline of acceptability.

Predicted re-radiated noise levels are approximate, and it should be noted that vibration levels at the closest position to the train line which would typically be expected to be the highest were actually found to be slightly lower than the second closest position. It may be advisable to carry out further measurements to resolve this uncertainty.

11.0 Recommendations

We recommend consideration is given to isolating the residential section of the development. We strongly recommend an audio demonstration of the predicted noise levels in order to aid the decision making process. This can be carried out by our team at your offices as long as a sufficiently quiet room is available (comparable to a bedroom at night).

12.0 Building Isolation

Vibration isolation of a building structure is a relatively complex – and therefore costly – process which fundamentally involves the introduction of resilient bearings between the substructure and superstructure. Mitigation measures should be based on the use of elastomeric resilient bearings, operating with a natural frequency of not greater than 8Hz. It is probably sensible to position these beneath the first residential level.

The alternative method often used to isolate low frequency vibrations is to install an arrangement of steel springs. However, elastomeric bearings for acoustic isolation of low frequency vibrations provide a more cost-effective and superior acoustic isolation over the long term compared with other alternatives such as steel springs.

- Elastomeric bearings contain inherent material damping that limits vibration amplification at the system's natural frequency. Steel springs inherently lose vibration isolation at their internal resonance and often require supplementary damping systems.
- More corrosion resistant compared with steel springs.
- Less mechanical complexity compared with steel springs.

- History of good long-term durability indicates an effective life in excess of 50 years. Resistance to degradation is superior to steel and concrete.

Additionally, bearings can be supplied either pre-compressed or uncompressed. They are specially designed with increased stability and increased lateral restraint.

For a building to be isolated, it has to be effectively free to “float”. The gradual loading of the building will also cause the isolated superstructure to move downwards as the bearings deflect. Details therefore need to be developed for (but not limited to) the following areas:

- Services – movement joints need to be incorporated where services cross the isolation line.
- Perimeter detailing – isolated structures may need to be buffered from the ground along the perimeter of a building. This is normally achieved with a resilient material such as Plastazote.
- Internal partitioning – isolating at ground floor level may require the introduction of soft joints at partition bases at the interface with the non-isolated structure.

13.0 Conclusions

A vibration survey has been undertaken to establish the existing levels of train induced vibration.

The survey results have subsequently been used to predict the likely levels of train induced noise and vibration, based upon our understanding of the proposed scheme.

The results of our assessment indicate that train induced vibration might be perceptible by some of the population in the parts of the development closest to the train line, but should be below the suggested criteria and should be therefore deemed acceptable.

Groundborne re-radiated noise levels are predicted to be audible but to comply with our proposed re-radiated noise criteria throughout a significant proportion of the development, with the exception of the proposed residential apartments at lower levels (below approximately 5th floor).

Re-radiated noise levels in worst case apartments during train passbys are currently predicted to be approximately 5dB above our proposed re-radiated noise criterion for residential properties. This may be acceptable in apartments where living areas have windows with view of the train line, however for apartments facing the central courtyard which have no view of the train line and which are screened from airborne train noise, this is likely to be on the borderline of acceptability.

We therefore recommend consideration is given to isolating the residential section of the development. We strongly recommend an audio demonstration of the predicted noise levels in order to aid the decision making process.

Generally, we would recommend that measures are taken to minimise amplification of vibration levels by the use of heavy, stiff constructions. We would advise against the use of lightweight wide span constructions as these are inherently prone to significant vibration amplification.

330 Grays Inn Road

References

"A Prediction Procedure for Rail Transportation Ground-borne Noise and Vibration" James Turner Nelson and High Saurenman Transportation Research Record 1143.

"Handbook of Urban Rail Noise and Vibration Control" Saurenman, Nelson, Wilson US Department of Commerce National Technical Information Services – February 1982.

"Measurement and Assessment of Groundborne Noise and Vibration" (Second Edition), The Association of Noise Consultants. ISBN 978-0-9572543-0-5

Appendix A

Vibration Units

The vibratory motion of a surface can be described by either:

(a) displacement (m),

(b) velocity (m/s), or

(c) acceleration (m/s^2).

Furthermore the vibration magnitude can be quantified in several ways:

peak to peak : This value gives the total excursion of the oscillation about the zero datum. The unit is often used where the vibratory displacement of a component is critical for maximum stress or mechanical clearance calculations.

peak : This value gives the maximum excursion of the oscillation above or below the zero datum. This value is useful for indicating the level of short duration shocks.

r.m.s : This value gives the root mean square of the time history over a specific time interval (time constant). This value is useful for indicating the energy content of the vibration.

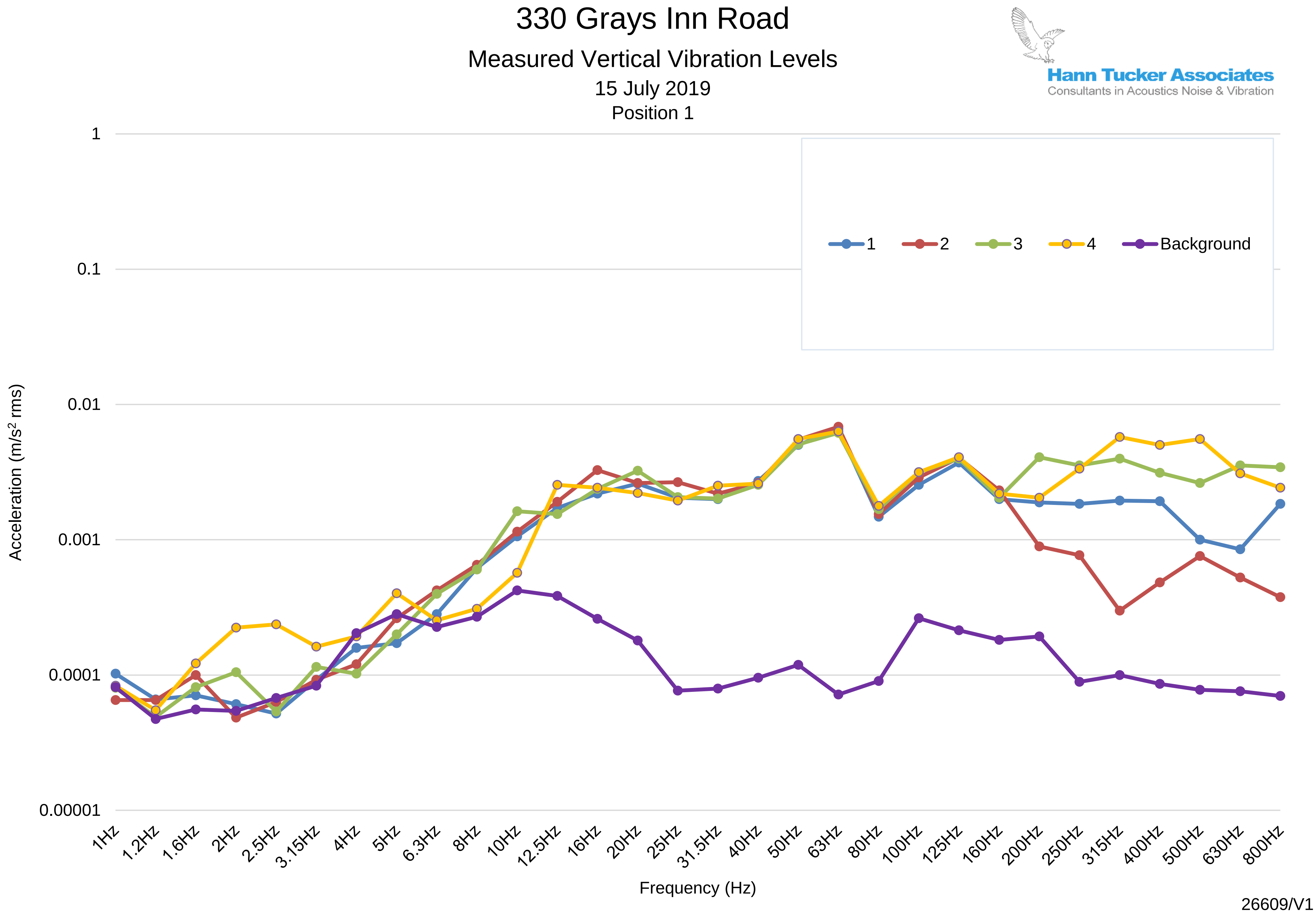
dB : Decibel quantities are often encountered. A reference level of 10^{-6} m/s^2 r.m.s is typically used for acceleration.

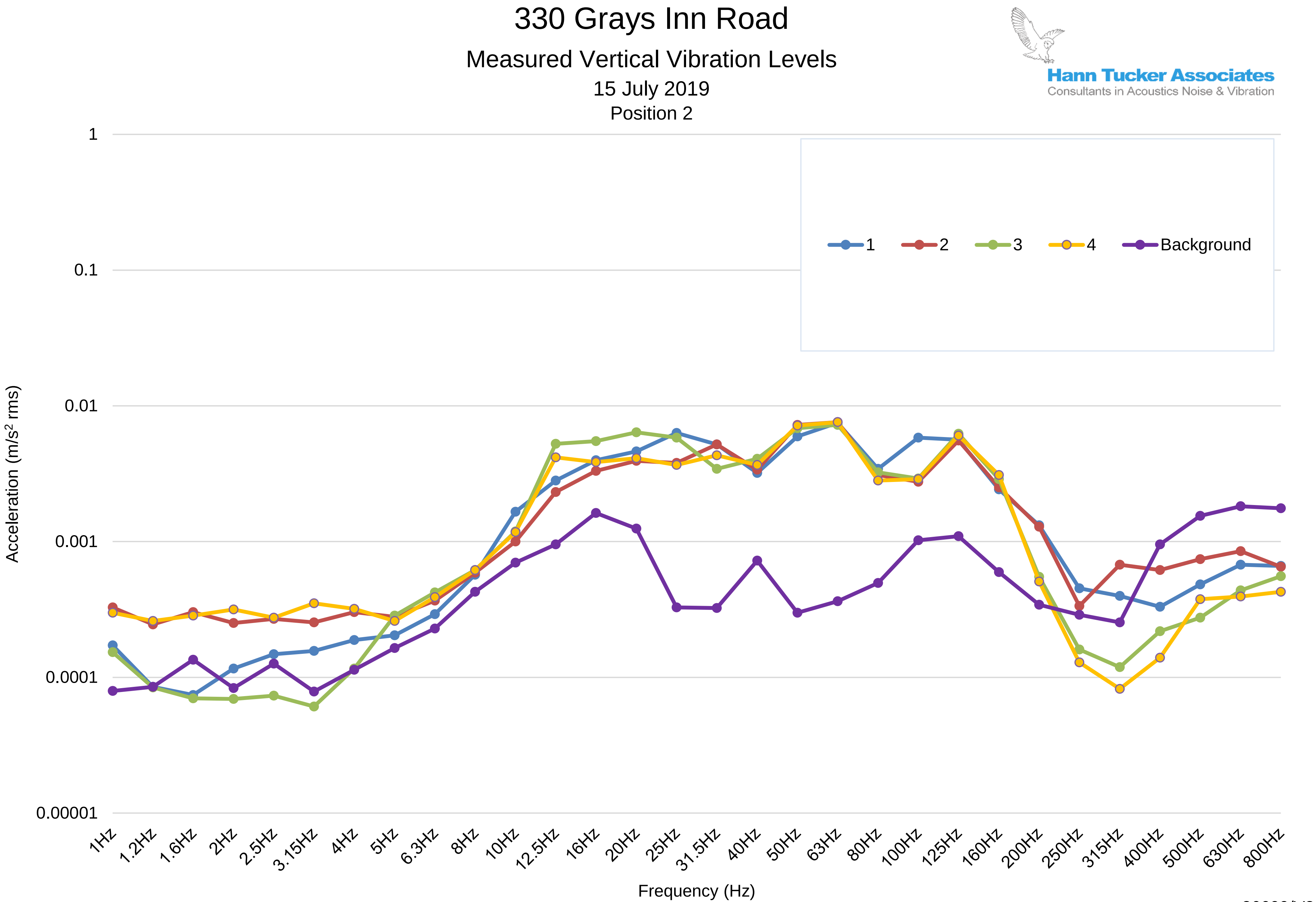
Vibration Dose Value (V.D.V) (m/s$^{1.75}$)

This value assesses both the magnitude of vibration and its duration. Where possible the vibration dose value should be determined over the full exposure to vibration. It is often estimated from the frequency weighted r.m.s value of the acceleration and its duration and is then referred to as e.V.D.V.

Appendix B

dB	:	Decibel - Used as a measurement of sound pressure level. It is the logarithmic ratio of the noise being assessed to a standard reference level.
dBA	:	The human ear is more susceptible to mid-frequency noise than the high and low frequencies. To take account of this when measuring noise, the 'A' weighting scale is used so that the measured noise corresponds roughly to the overall level of noise that is discerned by the average human. It is also possible to calculate the 'A' weighted noise level by applying certain corrections to an un-weighted spectrum. The measured or calculated 'A' weighted noise level is known as the dBA level. Because of being a logarithmic scale noise levels in dBA do not have a linear relationship to each other. For similar noises, a change in noise level of 10dBA represents a doubling or halving of subjective loudness. A change of 3dBA is just perceptible.
L_{max}	:	L_{max} is the maximum sound pressure level recorded over the period stated. L_{max} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the L_{eq} noise level.
L_{smax}	:	L_{smax} is the maximum sound pressure level recorded over the period stated where the meter has a slow response (1 second) as opposed to a fast response which is usually set to 0.125 seconds.


330 Grays Inn Road
Measured Vertical Vibration Levels
15 July 2019
Position 1
Hann Tucker Associates
Consultants in Acoustics Noise & Vibration
1
0.1
0.01
0.001
0.0001
0.00001
Acceleration (m/s² rms)
1
2
3
4
Background
1Hz
1.2Hz
1.6Hz
2Hz
2.5Hz
3.15Hz
4Hz
5Hz
6.3Hz
8Hz
10Hz
12.5Hz
16Hz
20Hz
25Hz
31.5Hz
40Hz
50Hz
63Hz
80Hz
100Hz
125Hz
160Hz
200Hz
250Hz
315Hz
400Hz
500Hz
630Hz
800Hz
Frequency (Hz)
26609/V1



330 Grays Inn Road
Measured Vertical Vibration Levels
15 July 2019
Position 2
Hann Tucker Associates
Consultants in Acoustics Noise & Vibration
1
0.1
0.01
0.001
0.0001
0.00001
Acceleration (m/s² rms)
1
2
3
4
Background
1Hz
1.2Hz
1.6Hz
2Hz
2.5Hz
3.15Hz
4Hz
5Hz
6.3Hz
8Hz
10Hz
12.5Hz
16Hz
20Hz
25Hz
31.5Hz
40Hz
50Hz
63Hz
80Hz
100Hz
125Hz
160Hz
200Hz
250Hz
315Hz
400Hz
500Hz
630Hz
800Hz
Frequency (Hz)

26609/V2

330 Grays Inn Road

Measured Vertical Vibration Levels

15 July 2019

Position 3

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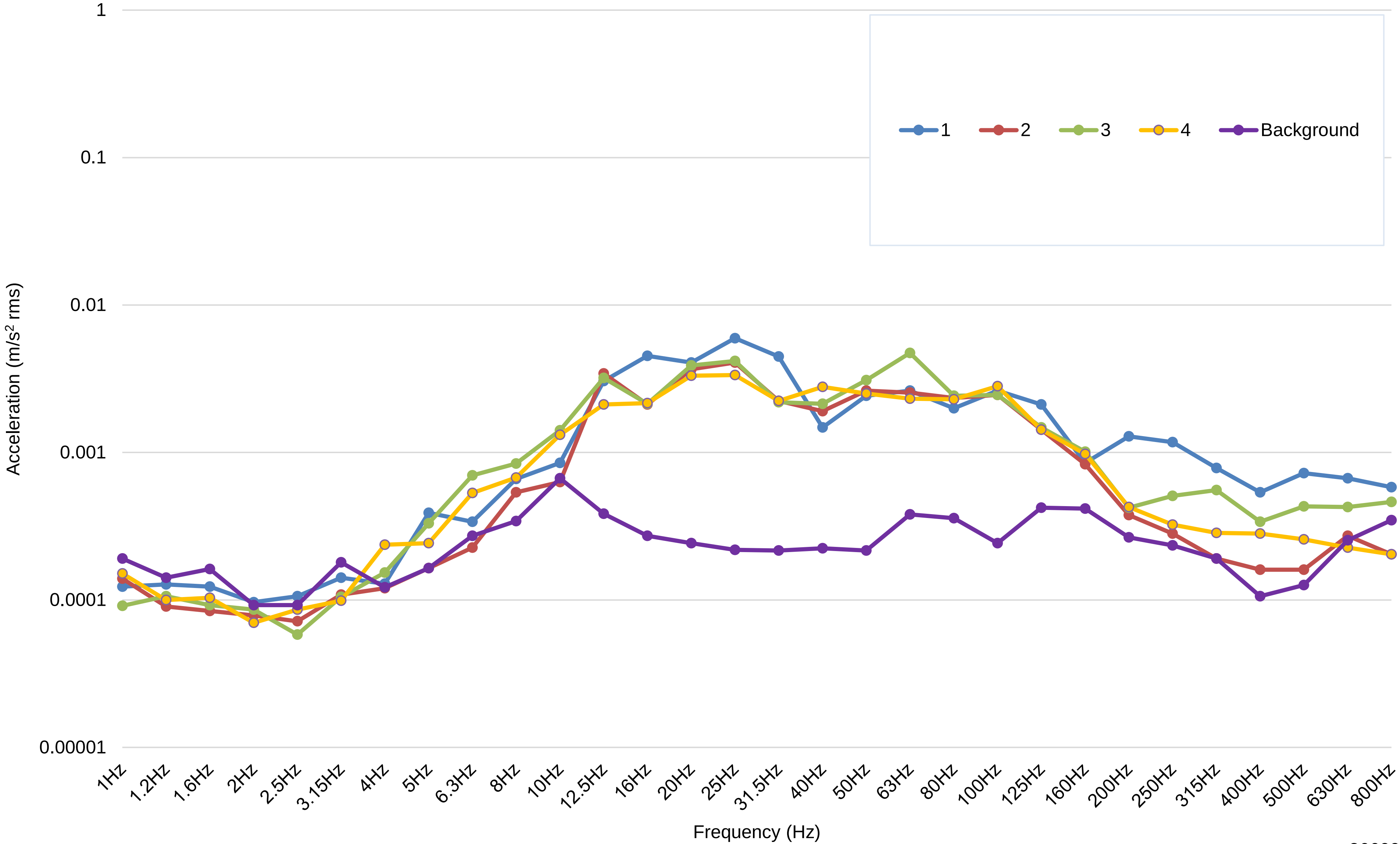

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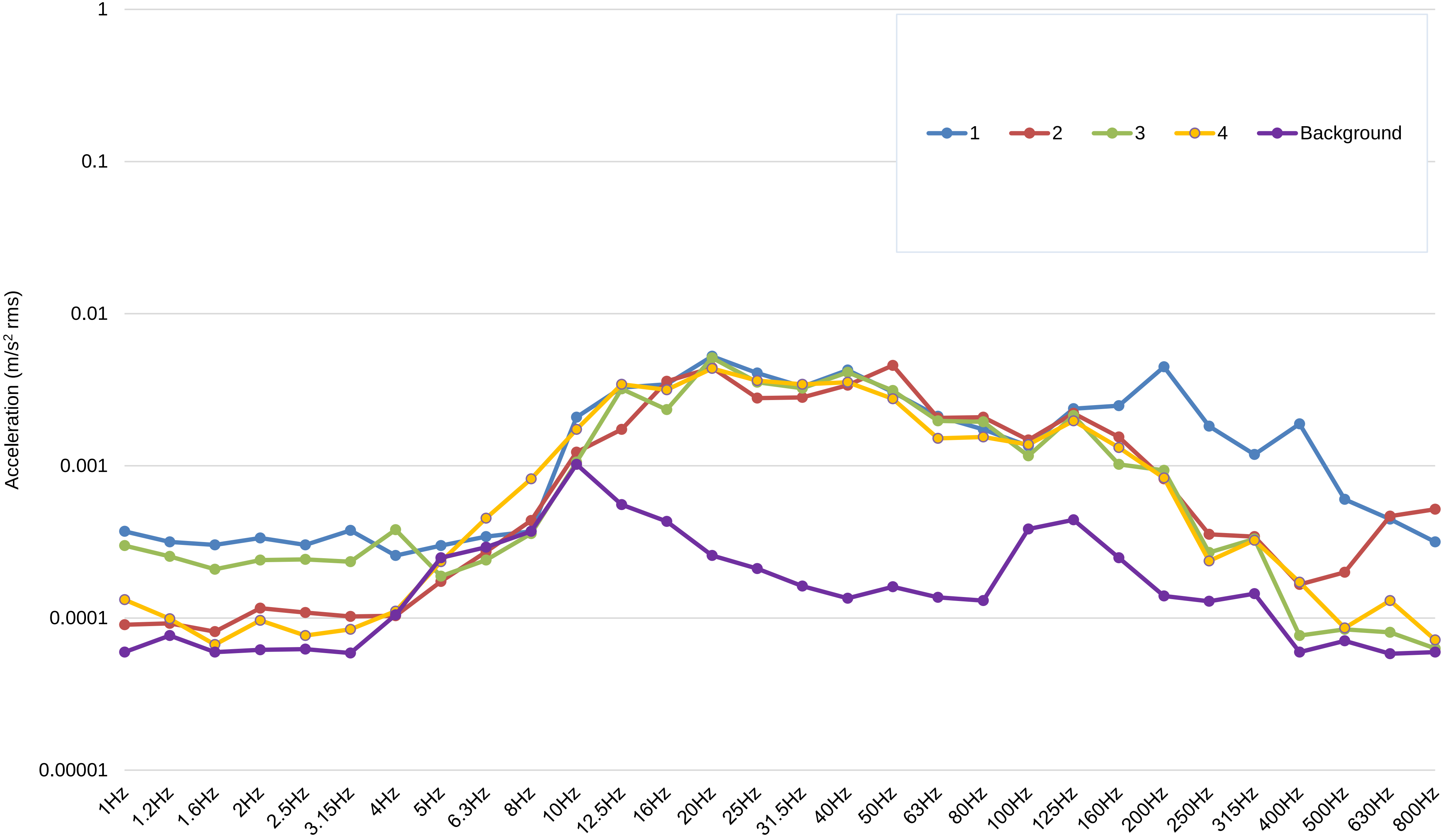
330 Grays Inn Road

Measured Vertical Vibration Levels

15 July 2019

Position 4



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26609/V4

330 Grays Inn Road

Measured Vertical Vibration Levels

15 July 2019

Position 5

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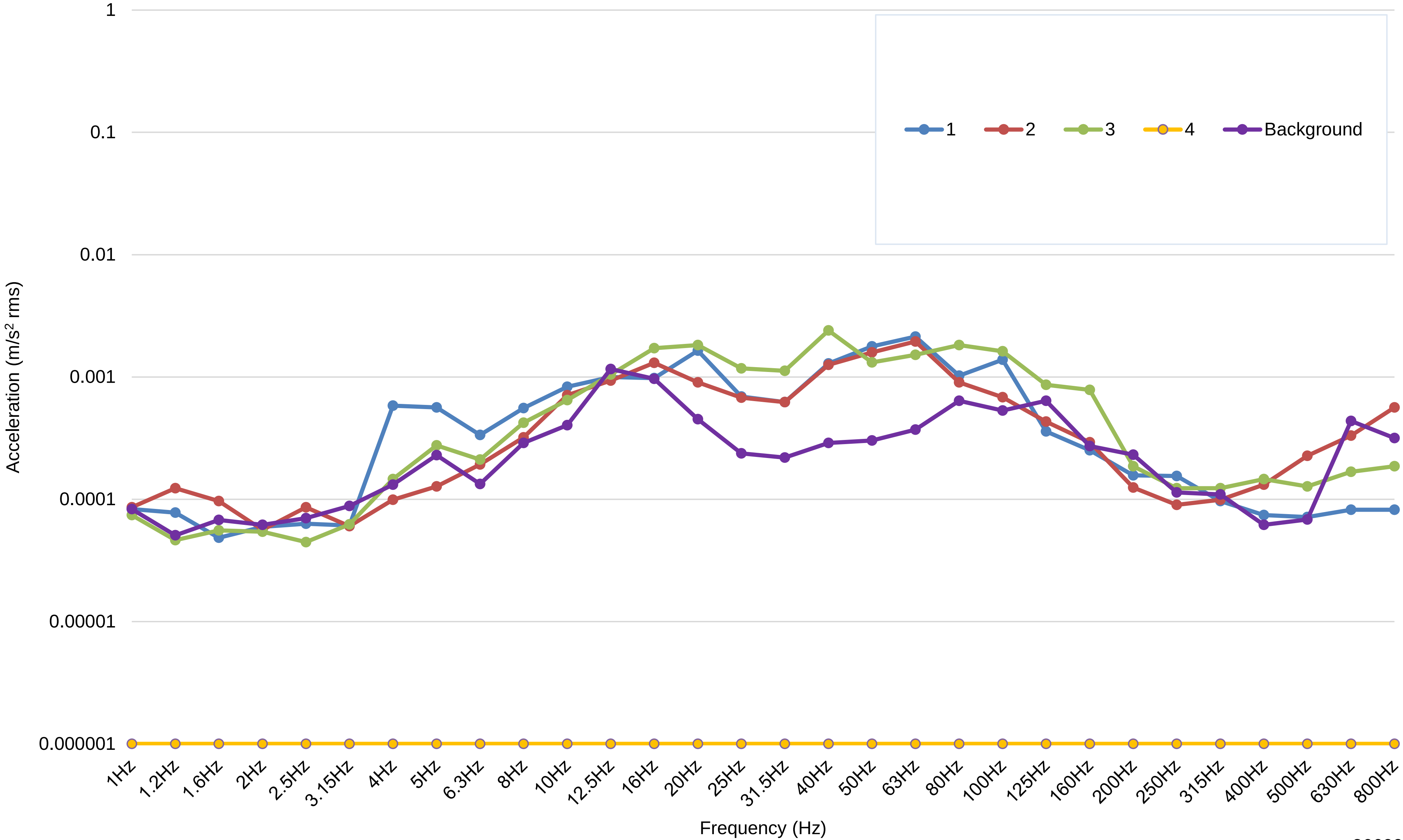
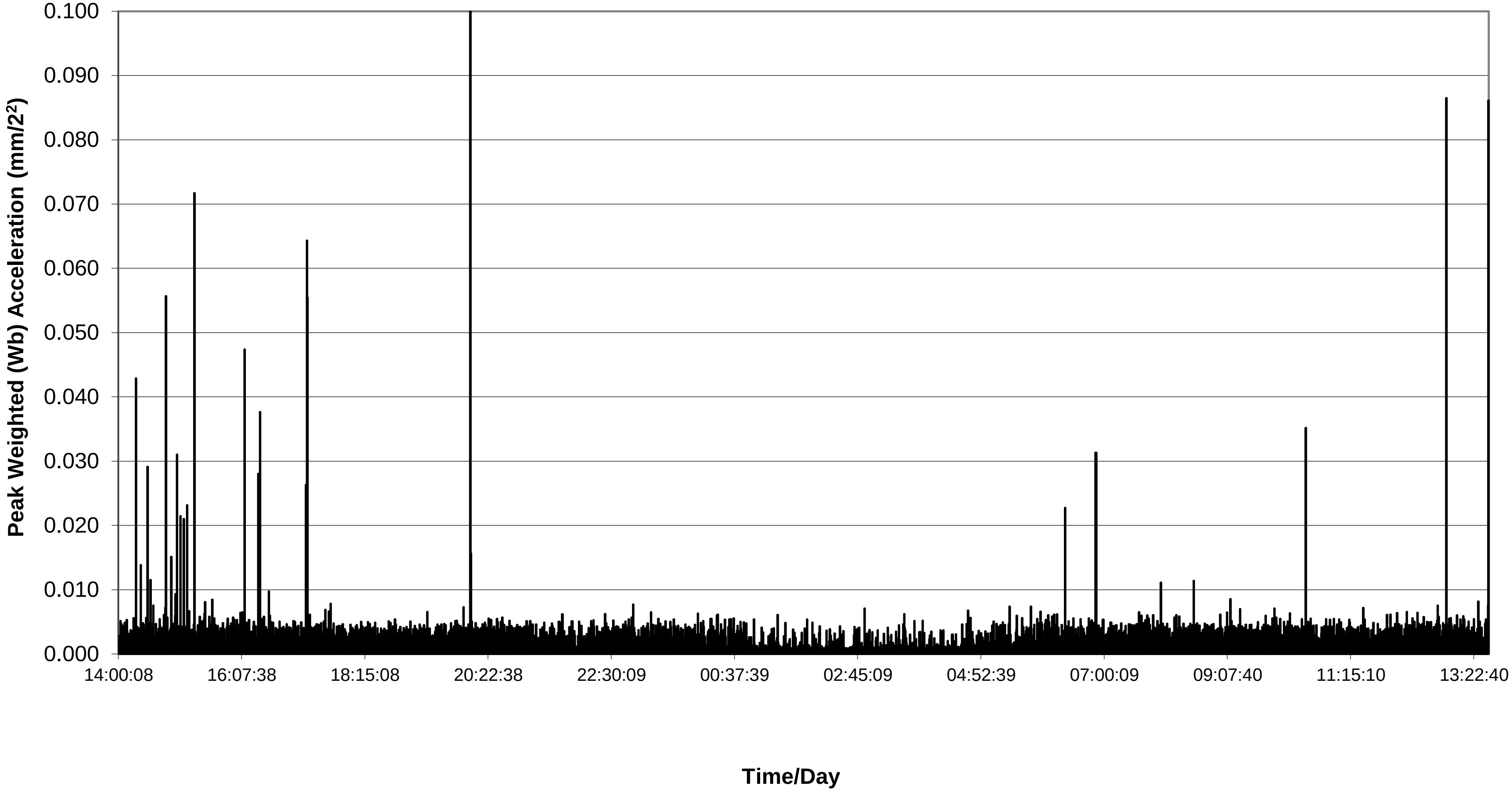


26609/V5

330 Grays Inn Road
Unmanned Vibration Survey
Peak Weighted (Wb) Acceleration
08/07/2019 - 09/07/2019



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