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PREPARED: Friday, 04 August 2023

BRUNSWICK CENTRE, LONDON;
ACOUSTIC PLANNING REPORT

CONTENTS

LIST OF ATTACHMENTS

Project Ref:	AS12664	**Title:**	Brunswick Centre, London
Report Ref:	AS12664.230517.NIA revB	**Title:**	Acoustic Planning Report
Client Name:	Lazari Investments Limited		
Project Manager:	Ian MacArthur		
Report Author:	Ian MacArthur		
Clarke Saunders Acoustics Winchester SO22 5BE		This report has been prepared in response to the instructions of our client. It is not intended for and should not be relied upon by any other party or for any other purpose.	

1.0 EXECUTIVE SUMMARY

1.1 This report has been prepared to support the application for Full Planning Permission and Listed Building Consent for redevelopment of part of the basement and lower basement levels of the Brunswick Centre, Bloomsbury, London to form a Hub by Premier Inn Hotel, setting out the acoustic planning objectives against the Local Planning Authority requirements, and where relevant to planning, the operator requirements.

1.2 Current design strategies adopted in the scheme design to suitably mitigate noise and vibration impacts are outlined

1.3 Clarke Saunders Acoustics has undertaken a survey of environmental noise levels externally at rooftop level, and a survey of noise and vibration levels from underground trains within lower basement level

1.4 Environmental survey data has been used to establish new plant noise emissions criteria following the London Borough of Camden noise standards.

1.5 Calculations show that noise emissions from the proposed rooftop plant, with allocated attenuation measures, will be compliant with these standards.

1.6 Data from noise and vibration surveys within the basement has confirmed that vibration levels from underground trains are below tactile thresholds and would satisfy Camden and Premier Inn requirements.

1.7 Re-radiated noise levels from underground trains are expected to be in excess of the required Premier Inn performance standard. Initial design has, therefore, included provision for proposed hotel guestrooms to be constructed on an isolated concrete slab, with internal walls and ceilings isolated from the core building structure.

1.8 Noise breakout from the cinema demise due to film soundtracks was inaudible during the surveys. The current design incorporates full isolation of guestrooms from the building structure and suitable buffer zones to minimise risk. Detailed design will target compliance with the hotel operator's range of internal noise level requirements which are in line with, or more stringent than, the London Borough of Camden requirements.

2.0 INTRODUCTION

2.1 Part of the Upper and Lower Basement level of the Brunswick Centre, Bloomsbury, London WC1N (the Site) is proposed to be redeveloped into a hotel, operated as a Hub by Premier Inn. The Site is currently subject to noise and vibration from train pass-bys on the nearby London Underground Piccadilly Line and is neighboured by the existing retail areas of the centre.

2.2 Installation of external plant items is proposed to serve the proposed development.

2.3 Clarke Saunders Acoustics (CSA) has undertaken noise and vibration surveys at the Site to inform the initial concept design and initial assessments against Premier Inn acoustic requirements.

3.0 SITE DESCRIPTION AND PROPOSALS

3.1 The site is located close to Russell Square London Underground (LUL) station in the London Borough of Camden. The Piccadilly Line tunnels are aligned in relatively close proximity parallel to the Site and, as such, trains are audible as re-radiated groundborne noise within the basement levels. The location of the of the nearby Piccadilly Line tunnels is indicated in the figure below, sourced from a LUL alignment drawing.

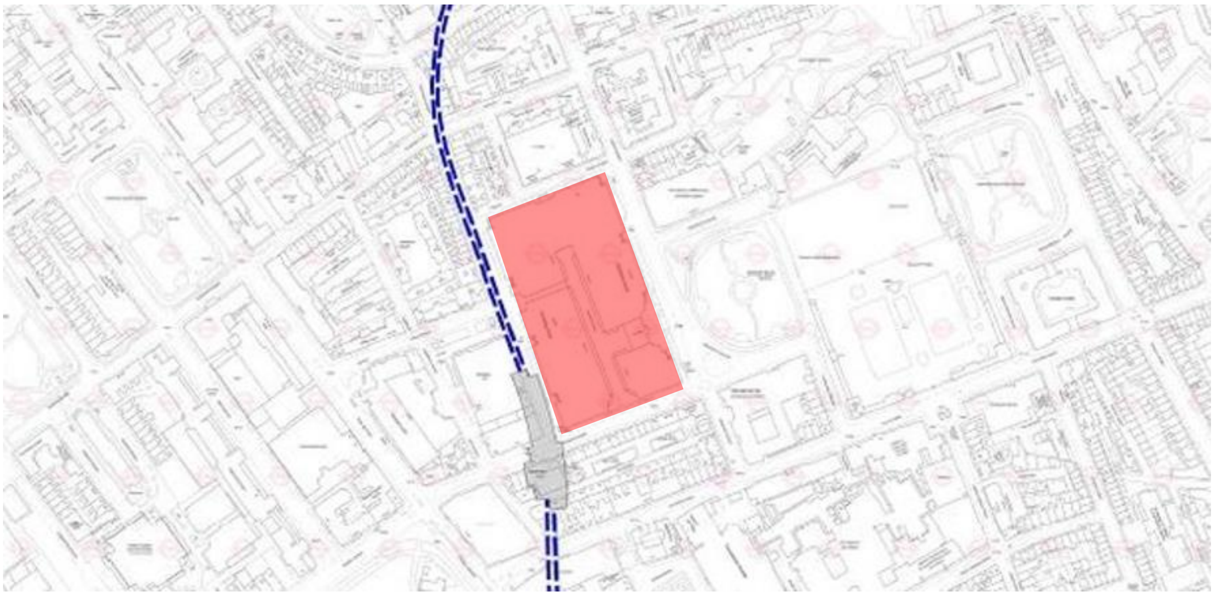


Figure 1 – Plan showing site and LUL alignment

3.2 The current proposals involve severing the upper basement level floor slab and lowering it in sections to form a new slab above the lower basement upon which the proposed hotel internal structure will be built.

3.3 Rooftop plant is proposed to be installed within a louvre screened plant enclosure in line with the existing ventilation towers on each 'block'. The proposed plant areas are shown highlighted orange in the overlaid satellite image below.

Figure 2 – Plan showing proposed roof plant areas and background noise monitoring location LT1

3.4 The existing car park ventilation system utilises the ventilation towers. The hotel mechanical scheme proposes to make use of these towers and atmospheric louvres for fresh air supply and exhaust air.

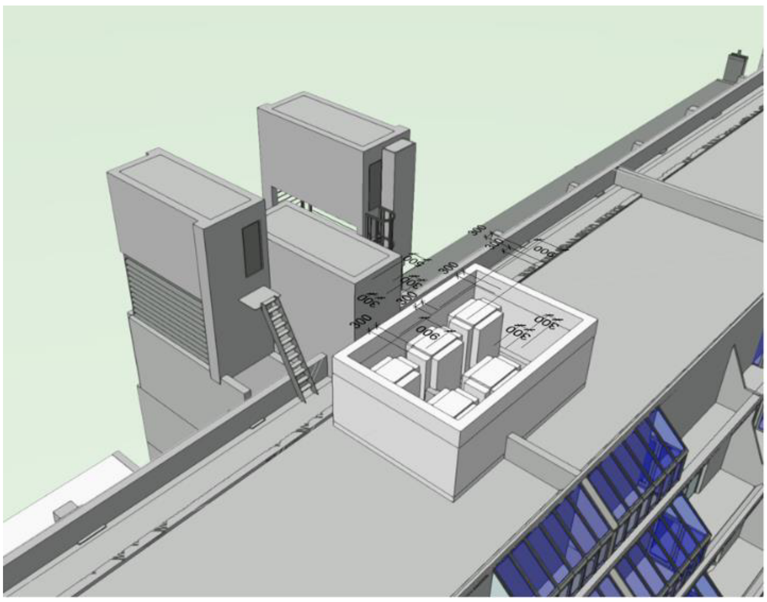


Figure 3 – showing indicative proposed plant enclosure, existing ventilation towers and residential balconies

4.0 LOCAL PLANNING POLICY - NOISE

4.1 Pre-application advice and consultation with Camden's environmental team confirmed that the application should aim to comply with their noise standards (Policy A4).

4.2 The current Local Plan was adopted on 3rd July 2017. Policy A4 *Noise and Vibration* states:

The Council will seek to ensure that noise and vibration is controlled and managed. Development should have regard to Camden's Noise and Vibration Thresholds (Appendix 3). We will not grant planning permission for:

a. development likely to generate unacceptable noise and vibration impacts; or

b. development sensitive to noise in locations which experience high levels of noise, unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses.

4.3 Appendix 3 of the 2017 Local Plan provides "*noise thresholds*" for noise and vibration levels incident on development, as well as emissions from the development. These thresholds are based on evaluating noise impact in terms of the NPPF and Planning Practice Guidance.

4.4 Appendix 3: Table A details vibration thresholds for various spaces, above which "*planning permission would not normally be granted*". For dwellings, day and evening limits are specified as Vibration Dose Values 0.2-0.4 $ms^{-1.75}$ VDV, and night-time thresholds of 0.13 $ms^{-1.75}$ VDV. These align with the evaluation criteria related a *'low probability of adverse comment'* as detailed in Table 5.1 below.

4.5 Appendix 3: Table B details a matrix of noise levels applicable to noise sensitive development proposed in areas of existing noise. The proposed Brunswick development design targets (see Table 5.2 below) are consistent with the lower range identified in Table B for inside residential bedrooms.

4.6 Appendix 3: Table C provides thresholds for noise emissions to noise sensitive receptors from industrial and commercial developments (including plant and machinery). Table 3 is reproduced as Table 4.1 below:

EXISTING RECEPTOR	ASSESSMENT LOCATION	DESIGN PERIOD	LOAEL (GREEN)	LOAEL TO SOAEL (AMBER)	SOAEL (RED)
Dwellings	Garden used for main amenity (free field) and Outside living or dining or bedroom window(façade)	Day (07:00 – 23:00)	'Rating level' 10 dB* below background	'Rating level' between 9 dB below and 5 dB above background	'Rating level' greater than 5 dB above background
	Outside bedroom window (façade)	Night (23:00 - 07:00)	'Rating level' 10 dB* below background and no events exceeding 57 dB L_{Amax}	'Rating level' between 9 dB below and 5 dB above background or noise events between 57 dB and 88 dB L_{Amax}	'Rating level' 5dB above background and/or events exceeding 88 dB L_{Amax}

Table 4.1: Table C from London Borough of Camden's Local Plan Appendix 3 (July 2017)

**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.*

4.7 The nearest noise sensitive receptors to the proposed plant locations are the flats on the top floor of the Brunswick Centre, with the relevant assessment point for both daytime and night-time being the external balcony onto which bedroom windows face.

5.0 PROJECT DESIGN TARGETS

5.1 Hub by Premier Inn developments are subject to a series of pre-defined performance standards. The relevant performance standards are detailed below, taken from *'Bloomsbury, Brunswick Centre Specification for a Turnkey Development 18 February 2022 – Edition Rev H'*. The relevant supplementary guidance cited by the Hub by Premier Inn performance standards are also detailed.

5.2 HUB BY PREMIER INN PERFORMANCE STANDARDS (2022 Edition Rev H)

5.2.1 Vibration – *"Vibration within guest bedrooms shall be imperceptible. Guidance on levels of vibration considered being imperceptible to seated standing and resting persons can be found in BS6472."*

5.2.2 Groundborne (re-radiated) Noise - *"Internal noise levels in bedrooms from underground railway train movements and re-radiated noise from railway trains not visible from the bedroom window when measured at the bedhead shall not exceed 30dB L_{AFmax}."*

5.2.3 Background Noise Levels – External Sources – *"The noise level in any hotel bedroom with windows closed due to all external sources including road, rail and air traffic and noise from activities outside the hotel and any adjacent premises shall not exceed the average and maximum noise levels in [Table 5.1]"*

PERIOD	NOISE LEVEL
Daytime (07:00 to 23:00 hrs)	$L_{Aeq,1hour}$ = 35 dB
Night-time (23:00 to 07:00 hrs)	$L_{Aeq,1hour}$ = 30 dB L_{AFmax} = 42 dB (*)

Table 5.1: Proposed Hotel Internal background noise level requirements

"(*) The maximum criterion applies to all vehicle and railway train passbys and all aircraft flyovers. It also applies to the noise from all street activities including those associated with patrons attending and leaving adjacent, neighbouring or connected entertainment venues; noise associated with commercial and industrial neighbouring premises including delivery activities and process equipment; seagulls and church bells. Genuinely infrequent and unpredictable sources of noise such as car alarms occurring no more than twice a night are excluded."

5.2.4 The requirement for gyms, bars and nightclub noise is as follows

"Music and patron noise intrusion from inside or outside any adjacent, neighbouring or connected gym, bar/restaurant or nightclub demises, into the guest bedrooms shall be controlled such that this source of noise intrusion is inaudible"

5.3 BS6472-1:2008 GUIDE TO EVALUATION OF HUMAN EXPOSURE TO VIBRATION IN BUILDINGS

5.3.1 BS6472-1:2008 *Guide to evaluation of human exposure to vibration in buildings* suggests that building vibration with respect to human response is measured and assessed in the form of a vibration dose value (VDV). The VDV defines a relationship that yields a consistent assessment of continuous, intermittent, occasional, and impulsive vibration and correlates well with subjective response. The vibration is to be evaluated for the axis in which the magnitude of weighted acceleration is greatest, against the values in the table below.

TIME	LOW PROBABILITY OF ADVERSE COMMENT	ADVERSE COMMENT POSSIBLE	ADVERSE COMMENT PROBABLE
16hr day (07:00 to 23:00)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
8hr day (23:00 to 07:00)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Table 5.2: VDV ranges resulting in risk level of adverse comment [values ref. $m/s^{1.75}$]

5.3.2 BS6472 also provides guidance on the thresholds of human perception of structure-borne vibration. This is an indication of the levels of vibration that correspond to thresholds of perception and is not a measure of the likelihood of annoyance. The standards states that:

"approximately half of the population, when standing or seated, can perceive a vertical weighted peak acceleration of 0.015m·s^2. A quarter of the people would perceive a vibration of 0.01 m·s^2 peak, but the least sensitive quarter would only be able to detect a vibration of 0.02 m·s^2 peak or more."

6.0 SURVEY METHODOLOGY

ENVIRONMENTAL NOISE (EXTERNAL)

6.1 Automated measurements of ambient and background noise levels were undertaken at roof level between 13:50h on 1st February and 12:00h on 6th February 2023. The following equipment was used for the survey:

- 1no. Svantek sound level meter type 971;
- 1 no. Norsonic sound level calibrator type 1251.

6.2 The microphone was located at the position shown in Figure 2, mounted off the edge of the roof parapet facing into the middle of the Brunswick Centre. Data obtained from this location was considered to be fully representative of the ambient and background noise levels at the upper level residential balconies.

6.3 The calibration of the sound level meter was verified before and after the survey. No significant calibration drift was detected.

6.4 The weather conditions were generally dry with light winds. Conditions were, therefore, suitable for measurement of environmental noise levels.

6.5 Measurements were made following procedures in BS 7445:1991 (ISO1996-2:1987) *Description and measurement of environmental noise Part 2- Acquisition of data pertinent to land use* and BS4142:2014 + A.1:2019 *Methods for rating and assessing industrial and commercial sound,* where appropriate.

BASEMENT NOISE AND VIBRATION (INTERNAL)

6.6 Automated measurements of noise and vibration at the Site were undertaken between 15:00h on 25th August and 23:00h on 29th August 2022. The following equipment was used for the survey:

- 1no. Svantek noise and vibration data logger type 958 with triaxial accelerometer type SV84 and microphone type MK255;
- 1 no. Norsonic sound level calibrator type 1251.

6.7 Additional attended vibration measurements were simultaneously undertaken on 30th August 2022 at various positions across the basement slab. The approximate locations of each test position are indicated on the attached site plan AS12664/SP1.

6.8 The triaxial accelerometer was attached to a heavy metal tripod base plate to ensure optimal contact with the slab which, at all positions, comprised of concrete.

6.9 The microphone for the automated measurements was attached to a tripod at a height of approximately 1.2m above the floor surface.

6.10 The automated monitoring location was within a service corridor on the south west side of the basement. This location was selected to provide the quietest possible monitoring location in relation to existing background car park activity, and to represent the closest development area of the site to the Piccadilly Line.

6.11 Measurement of re-radiated train noise levels over the entire Site area was not possible owing to the high existing background noise from ventilation systems and car park activity. Potential reductions in train noise level at increasing separation can, however, be estimated from the differential measurements of vibration across the basement slab.

7.0 RESULTS

ENVIRONMENTAL NOISE RESULTS (EXTERNAL)

7.1 Figures AS12664/TH1-5, attached, show the L_{Aeq}, L_{Amax}, L_{A10} and L_{A90} sound pressure levels as time histories at monitoring position LT1.

7.2 The background noise climate was largely determined by general city traffic contributions from the surrounding road network and surrounding plant noise.

7.3 The measured typical lowest background and average noise levels from the monitoring position is presented in the following table.

POSITION	MONITORING PERIOD	TYPICAL BACKGROUND $L_{A90, 5MINS}$	AVERAGE $L_{Aeq, T}$
LT1	07:00 - 23:00 hours	47 dB	53 dB
	23:00 - 07:00 hours	44 dB	48 dB

Table 7.1: Measured background and average noise levels **[dB ref. 20 µPa]**
*Typical lowest determined from 10th Percentile L_{A90} dataset.

7.4 The following design criterion should be targeted for plant noise emissions on the basis of achieving LOAEL, as per Camden's Local Plan:

DAYTIME (07:00 - 23:00 HOURS)	NIGHT-TIME (23:00 - 07:00 HOURS)
L_{Aeq} ≤37 dB	L_{Aeq} ≤34 dB

Table 7.2: Plant noise design criteria at residential dwellings **[dB ref. 20 µPa]**

7.5 Measurements of the existing ventilation tower louvres at a distance of 1m demonstrated that emitted noise levels did not currently fall below 52dB(A).

BASEMENT NOISE AND VIBRATION RESULTS (INTERNAL)

7.6 A summary of the noise and vibration levels measured during the survey is presented in Table 7.3 below. These show the levels of vibration in terms of vibration dose value (VDV) and weighted peak acceleration to assess against perceptibility criteria.

7.7 In addition to groundborne noise from underground train pass-bys, the current basement area was noted to be subject to noise from other sources, including vehicular activity within the active car parks and delivery access routes, ventilation systems and noise transfer from the commercial basement areas directly adjacent to the measurement location. It is noted that noise from existing car park activity will not be present at the completion of the development, whilst noise from the adjacent commercial basement areas and retained parking provision will be the subject of detailed design review for new separating structures.

7.8 A time-history of the overall noise and vibration levels measured during the survey is shown in attached figure AS12664/NV1. This clearly shows the night-time periods where underground train activity stops (corresponding to Thursday and Sunday Night).

7.9 In order to provide an assessment of groundborne noise alone, a survey period has been selected which captured noise from the underground train movements with minimal influence from background sources. The period selected for specific analysis was 02:00h to 04:00h of 28th August 2022, as shown in greater detail in the attached time history AS12664/NV2.

PERIOD	VDV ($m/s^{1.75}$)	TYPICAL MAXIMUM PEAK ACCELERATION (m/s^2)	AVERAGE NOISE LEVEL ($L_{AEQ,T}$)	TYPICAL MAXIMUM GROUNDBORNE NOISE LEVEL ($L_{AF,max}$)
Daytime (07:00 to 23:00)	0.0080	0.0052	36 dB*	39 dB†
Night-time (23:00 to 07:00)	0.0055	0.0047	31 dB*	

Table 7.1: Summary of noise and vibration measurements [dB ref. 20µPa]
* Highest daily average noise level from full measurement period
† Derived from period between 02:00 to 04:00 of 28 August 2022

7.10 Maximum noise levels from other external sources have been excluded from this summary on the basis that there is a high degree of uncertainty over their origin. It is expected that, with the proposed change in layout and change/removal of car park ventilation fans, viable sound insulation specifications between the guest rooms and the adjacent commercial basement areas and parking allocation can be set to suitably control noise intrusion from such sources. As such, the performance standards for average and maximum noise levels from external sources (see Table 5.1) are expected to be achieved through design.

7.11 Weighted peak vibration levels measured throughout the survey period remained below the threshold of human perception, as cited in section 4.3.2. Recorded VDV is below the range typically associated with a '*low probability of adverse comment*' as presented in Table 5.2. This is supported by subjective observations on site by the survey engineers, that vibration from trains was not tactile.

7.12 Figures AS12664/N1 and AS12664/V1 show the frequency spectra of ground-borne noise and vibration from train pass-bys during the specific night-time period analysed, showing maximum unweighted sound pressure level and unweighted vertical RMS acceleration, respectively. The datasets indicate the differential in spectral characteristics between northbound and southbound train movements, i.e. leaving and approaching Russell Square station.

7.13 These charts show southbound trains to have a higher level of energy both at 31.5Hz (low frequency, associated with wheel/track rolling noise) and notably at 500Hz (mid frequency, associated with track junctions/points). It is currently understood that the southbound track is within the closer tunnel.

7.14 Both directions of travel appear to result in similar overall maximum noise levels, typically between 37 and 39 $dBL_{AF,max.}$

7.15 A summary of the vibration levels measured during the attended survey is presented below. This shows the levels of vibration in terms of Wb-weighted RMS acceleration for a pass-by event with reference to synchronised measured levels at the automated survey position. The locations of each of these positions is indicated in the attached site plan, AS12664/SP1.

POSITION	MAXIMUM MEASURED RMS DURING TRAIN PASS-BY (mm/s²)	SYNCHRONOUS LEVEL AT L1 (mm/s²)
S1	0.4	0.4
S2	0.3	0.5
S3	0.5	0.4
S4	0.5	0.5
S5	0.3	0.6
S6	0.2	0.5
S7	0.2	0.5

Table 7.4: Results of attended measurements with reference to automated measurements, showing acceleration during specific train pass-by events.

7.16 These measurements suggest that vibration levels do not reduce significantly or consistently toward the middle of the basement slab. The greatest difference is seen at the east side (S6 & S7), indicating a 40-50% reduction in RMS acceleration. In terms of groundborne noise, this reduction in vibration would equate to around a 3dB decrease in re-radiated levels.

7.17 DISCUSSION

7.17.1 The typical highest groundborne noise level from underground train movements measured within the basement area was 39dB $L_{AFmax.}$ This exceeds the Premier Inn performance standard by 9dB. It is noted that the Premier Inn standard is relatively onerous, being 5dB lower than would more typically be applied to underground train noise within residential settings.

7.17.2 The measured vibration levels suggest that the VDV is below the threshold likely to result in a low probability of adverse comment and weighted peak acceleration is unlikely to be tactile (perceptible). The measured levels are within Camden' thresholds.

7.17.3 The results of the attended measurements suggest that the level of vibration reduces across the floorplate. The resultant decrease in re-radiated noise would, however, mean that the Premier Inn standard would be exceeded in all areas of the proposed development without appropriate mitigation.

8.0 PLANT NOISE ASSESSMENT

8.1 PROPOSED PLANT

8.1.1 The preliminary roof top plant selections are as follows:

East Roof

- 2no. Mitsubishi PURY-P300 YNW-A2
- 3no. Mitsubishi PURY-P400 YNW-A2

West Roof

- 1no. Mitsubishi PUHY-P700 YSNW-A1
- 4no. Mitsubishi PURY-P400 YNW-A2
- 3no. Mitsubishi ECODAN CAHV P500T-HPB

8.1.2 The highest sound pressure levels generated by the plant at 1 metre (heating mode at full duty) have been confirmed by the manufacturer and are presented in table below:

TYPE	63	125	250	500	1K	2K	4K	8K	dB(A)
PURY-P300 YNW-A2	74.5	70	68.5	65.5	60.5	56.5	52	48	66.9
PURY-P400 YNW-A2	81	69.5	69.5	68	62	59	54	48.5	68.9
PUHY-P700 YSNW-A1	75	73.5	67	65	60	57	54.5	51	66.9
ECODAN CAHV-P500TB-HPB	70	65	60	56	52	47	49	45	58.9

Table 8.1 Manufacturers sound pressure levels at 1m (Heating Mode)

8.1.3 Plant noise emissions in cooling mode or at reduced duty is shown to be up to 15dB lower.

8.1.4 In order to ensure plant noise emissions can be controlled to the noise emissions criteria, allowance has been made for individual plant acoustic attenuation kits[1], as well as an acoustic louvre surrounding each plant area.

TYPE	63	125	250	500	1K	2K	4K	8K
Ambient Acoustics Full Module Kit	-4	-5	-7	-8	-12	-12	-10	-7
Acoustic Louvre (i.e. 150mm Slimshield)	-6	-6	-8	-10	-14	-18	-16	-15

Table 8.2 Manufacturer's attenuation data (Insertion Loss, dB)

8.2 PREDICTED NOISE LEVELS

8.2.1 Based on the manufacturer's noise data and attenuation provision, taking into account distance loss and acoustic screening afforded by the roof parapet and edge, the calculated specific plant noise level at the closest top floor residential balcony area is as follows. Full calculations are shown in Appendix B.

LOCATION	PREDICTED LEVEL	CRITERIA (NIGHT-TIME)
Nearest Balcony (West Roof Plant)	29 dB	34 dB
Nearest Balcony (East Roof Plant)	27 dB	

Table 8.3 Predicted Noise Levels

8.2.2 Compliance with Camden's requirements is shown with the specific attenuation measures in place.

8.2.3 Air handling plant feeding into the ventilation towers will be designed and suitably attenuated such that noise levels from the ventilation tower louvres do not exceed 50dB(A) at 1m. This level is commensurate, or lower than, existing noise emissions, and would ensure compliance with the overall plant noise emissions criteria when assessed at the residential balconies.

8.3 FURTHER NOISE ATTENUATION CONSIDERATIONS

8.3.1 Due to the rooftop location above existing residential dwellings, spatial allowance has been incorporated into the design to site the plant items on a fully isolated plant deck. This will serve to minimise risk of structural noise transmission (i.e. through potential vibration) and enhance the sound insulation of the roof construction. Allowance has been made to incorporate a 100mm thick concrete isolated plant base, with an additional zone for structural strengthening, if required.

8.3.2 Based on current assumptions regarding the existing roof slab, the above measures would be sufficient to control the worst case airborne noise transfer through the roof to below NR15 (all proposed plant operating at full duty), representing a very low level of noise within the apartment, verging on inaudibility.

[1] https://www.ambientacoustics.co.uk/downloads/YNW_Kit_PI.pdf

9.0 DEVELOPMENT ACOUSTIC DESIGN PRINCIPLES

GROUNDBORNE NOISE

9.1 As detailed in Sections 4 and 5, the project design targets are equivalent to, or more onerous than, those required by London Borough of Camden.

9.2 To reduce groundborne noise levels from underground trains in line with the Premier Inn requirements, the proposed guest room structures (floor, walls and ceilings) will require isolation from the basement shell structures.

9.3 In order to target the low frequency element of the train noise, and achieve reduction by the required 10dB, the isolation solution will require a natural frequency of 10 to 12Hz, or lower.

9.4 The current proposed method of achieving this will be to isolate the newly formed basement slab utilising springs or high-performance elastomeric bearings. All guestroom structures are being developed such that they are independent, or isolated, from the structural elements (i.e. columns, core walls etc.).

9.5 Ceilings will be necessarily suspended from the ground floor slab using isolated mounts or hangers. Details and specifications for these solutions will be developed as the detailed design progresses.

INTERNAL SOUND INSULATION

9.6 With the exception of the Cinema, there are no adjacent retail uses that would be expected to generate significant levels of noise or vibration (i.e. gymnasia, nightclubs etc.). Internal sound insulation design of the proposed hotel will include full isolation from the building structure, supplemented by the existing sound insulation provided by the concrete shell structure. Where there are no significant 'buffer' zones or existing structural separation, sound insulation between sensitive hotel areas and adjacent retail and/or car park areas will be appropriately specified and incorporated through the detailed design stages.

9.7 Due to project confidentiality at the time of the surveys, liaison was not possible with the Cinema operator to allow a full study of sound insulation between the theatres and proposed development area.

9.8 A passive observational study into noise breakout from the Cinema was undertaken during site surveys. No noise from film soundtracks could be heard nor measured on the concrete separating wall, over the existing background levels. Limited low level activity (believed to be service activity or mechanical plant items) was, on occasion, audible within the wall at the Cinema demise boundary.

9.9 The current layout of the Cinema shows the main 148-seat theatre to be lobbied from the concrete outer walls by corridors and plantrooms. Proposed guestrooms adjacent to the Cinema demise will be fully isolated from the building structure, including the already substantial separating structure.

9.10 A smaller 55-seat theatre is the only screen not fully lobbied from the outer structure. This screen is understood to focus on documentary films. Current hotel layouts adjacent to this theatre are separated via a lightwell buffer zone, which would significantly increase the inherent sound insulation.

9.11 Risk of audible cinema noise within guestrooms, therefore, appears to be low, based on the audibility of the films shown during the survey.

9.12 Specific sound insulation tests are recommended between the theatres and basement areas to fully determine risk against potential future cinema noise intrusion and to be able to advise on additional structural isolation or enhancement requirements through detailed design stage.

10.0 CONCLUSIONS

10.1 Clarke Saunders Acoustics has undertaken a survey of environmental noise levels externally at rooftop level, and a survey of noise and vibration levels from underground trains within lower basement level of Brunswick Centre, London.

10.2 Environmental survey data has been used to establish new plant noise emissions criteria following the London Borough of Camden noise standards.

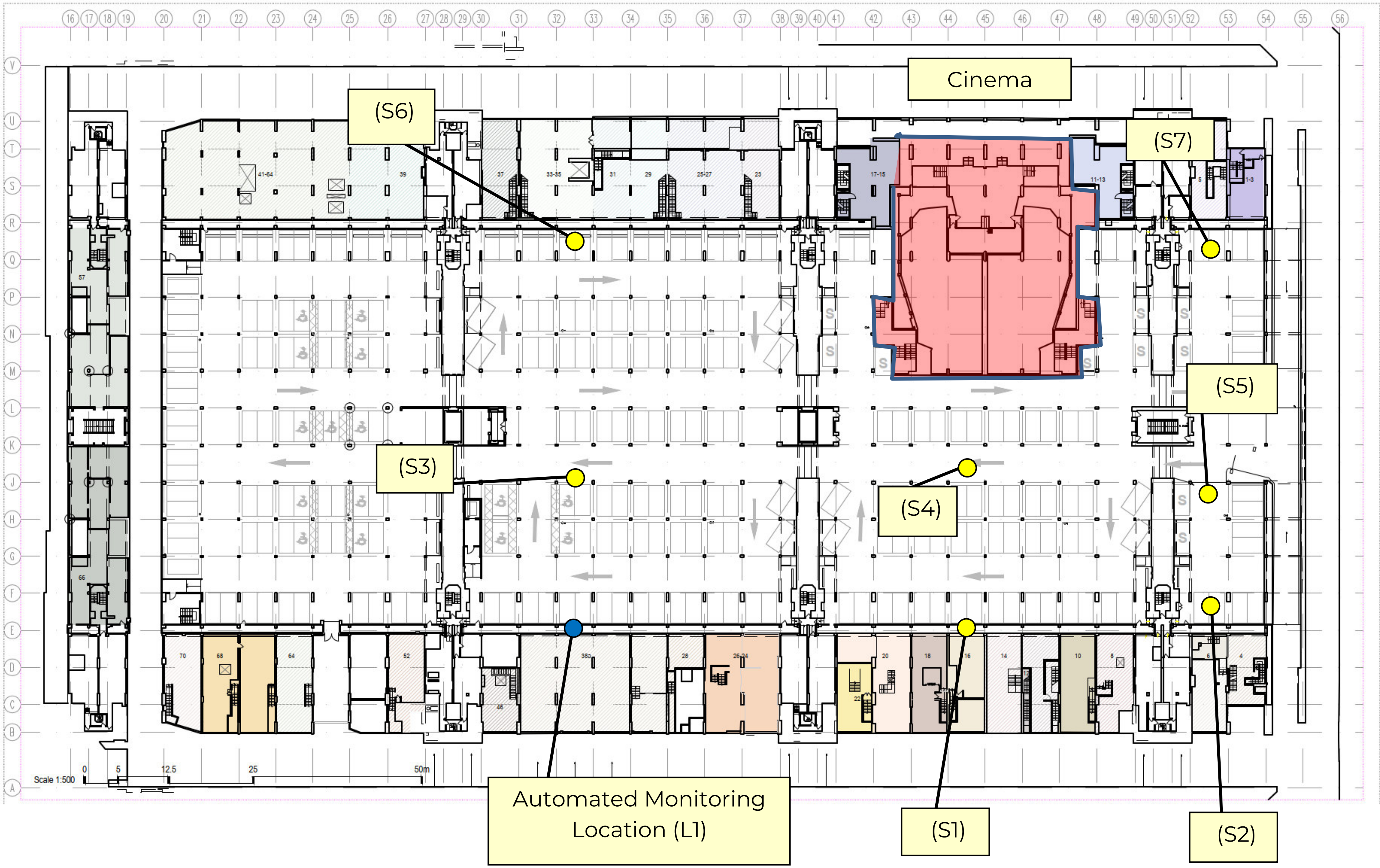
10.3 The proposed development rooftop plant, with allocated attenuation measures, can be shown to be compliant with these standards.

10.4 The basement noise and vibration surveys confirmed that vibration levels from underground trains are below tactile thresholds and would satisfy Camden and Premier Inn requirements.

10.5 Re-radiated noise levels from underground trains were shown to be in excess of the hotel operator’s performance standard. Initial design has, therefore, included provision for the hotel guestrooms to be constructed on an isolated concrete slab, with internal walls and ceilings isolated from the core building structure. This proposed design solution will meet the hotel operator’s requirements and that of London Borough of Camden.

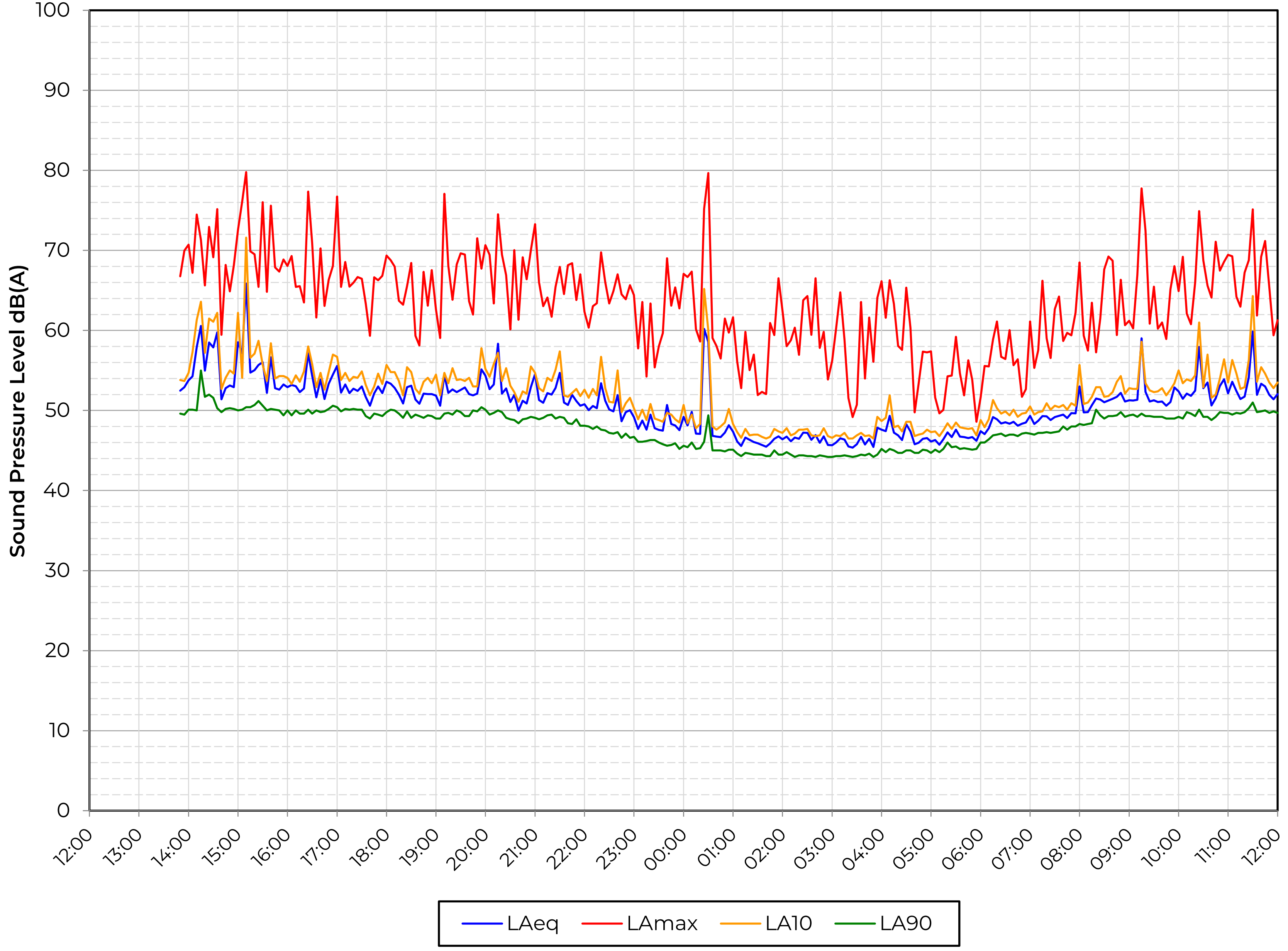
10.6 Film soundtrack noise breakout from the cinema demise was inaudible during the surveys. The current design incorporates full isolation of guestrooms from the building structure and suitable buffer zones to minimise risk. Detailed design will target compliance with the Camden and hotel operator internal noise level requirements.

Ian MacArthur MIOA
CLARKE SAUNDERS ACOUSTICS


Cinema
(S6)
(S7)
(S5)
(S3)
(S4)
Automated Monitoring Location (L1)
(S1)
(S2)
Scale 1:500
0
5
12.5
25
50m

Brunswick Centre

Position LT1



Wed 01 Feb to Thu 02 Feb

Figure AS12664/TH1

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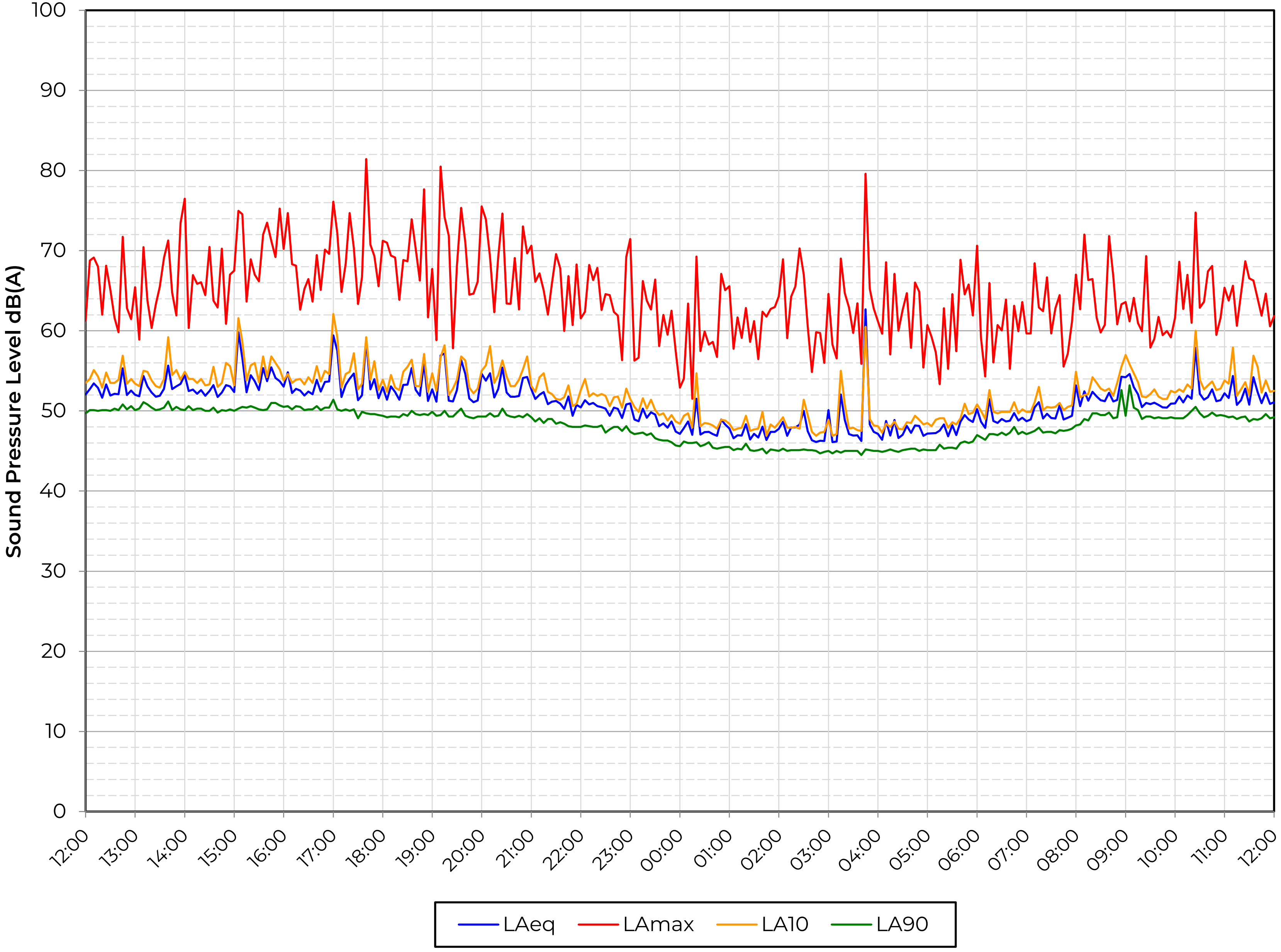
Brunswick Centre

Position LT1



Thu 02 Feb to Fri 03 Feb

Figure AS12664/TH2

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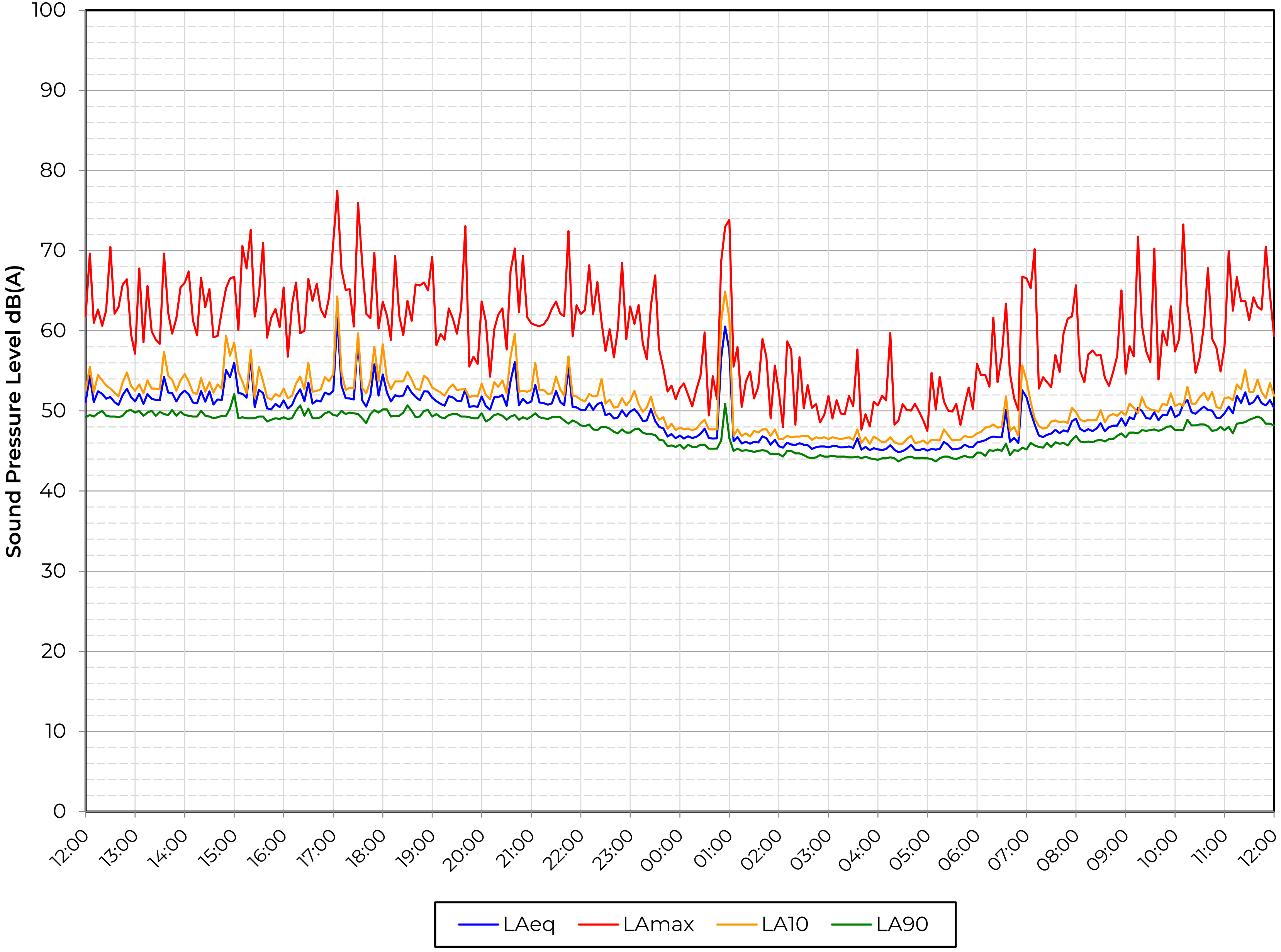
Brunswick Centre

Position LT1



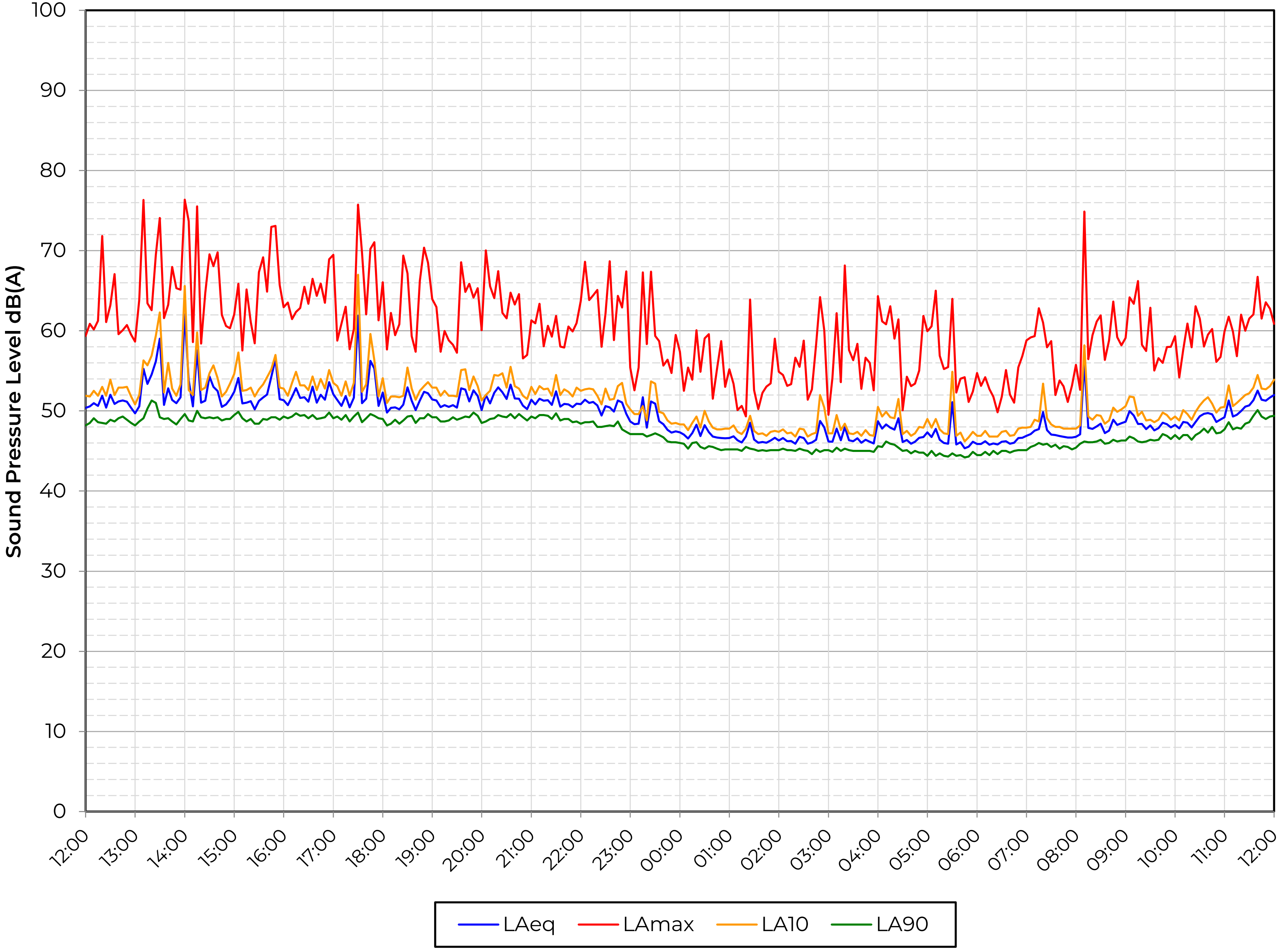
Fri 03 Feb to Sat 04 Feb

Figure AS12664/TH3

clarke saunders acoustics

Brunswick Centre

Position LT1



Sat 04 Feb to Sun 05 Feb

Figure AS12664/TH4

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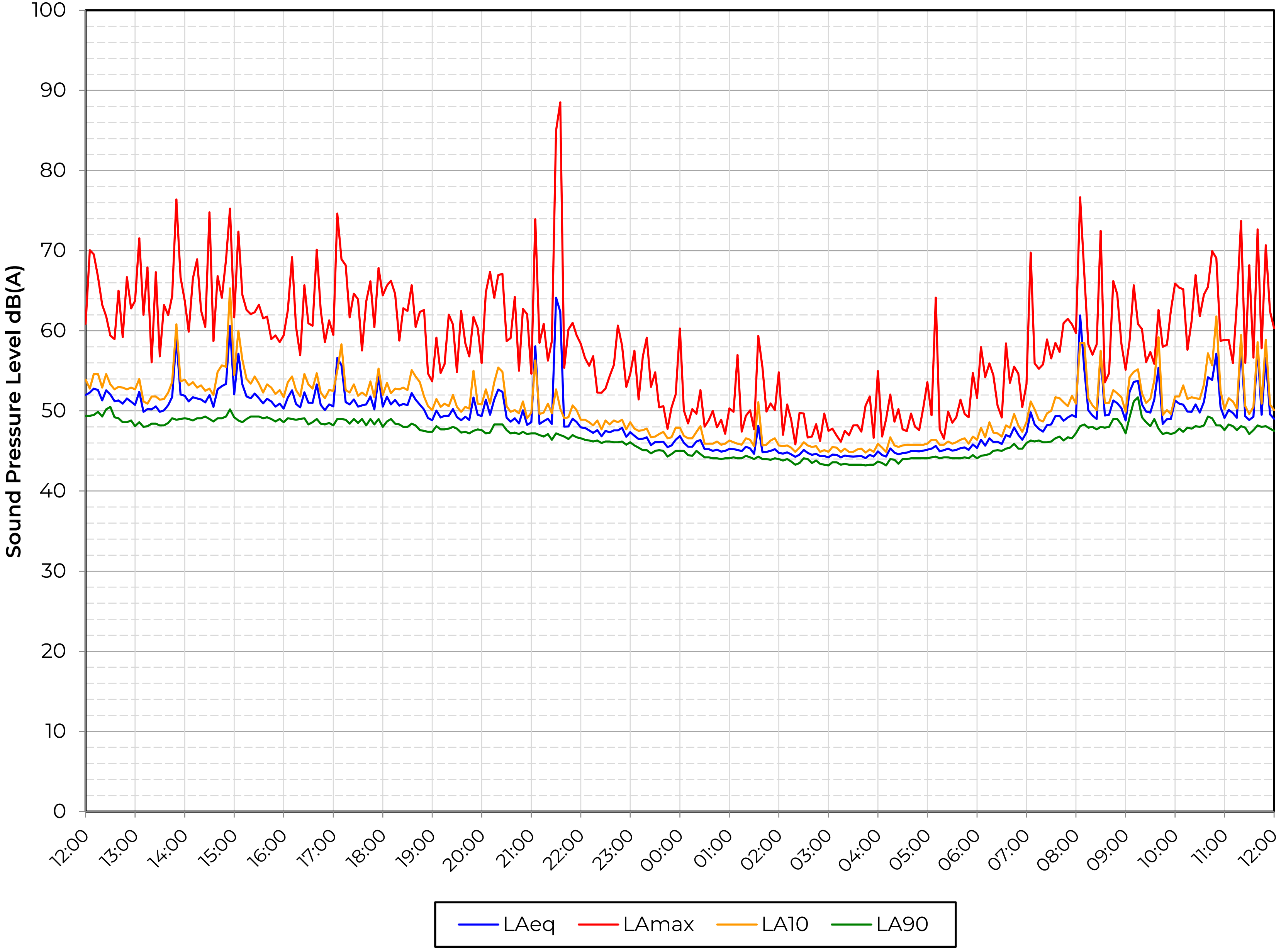
Brunswick Centre

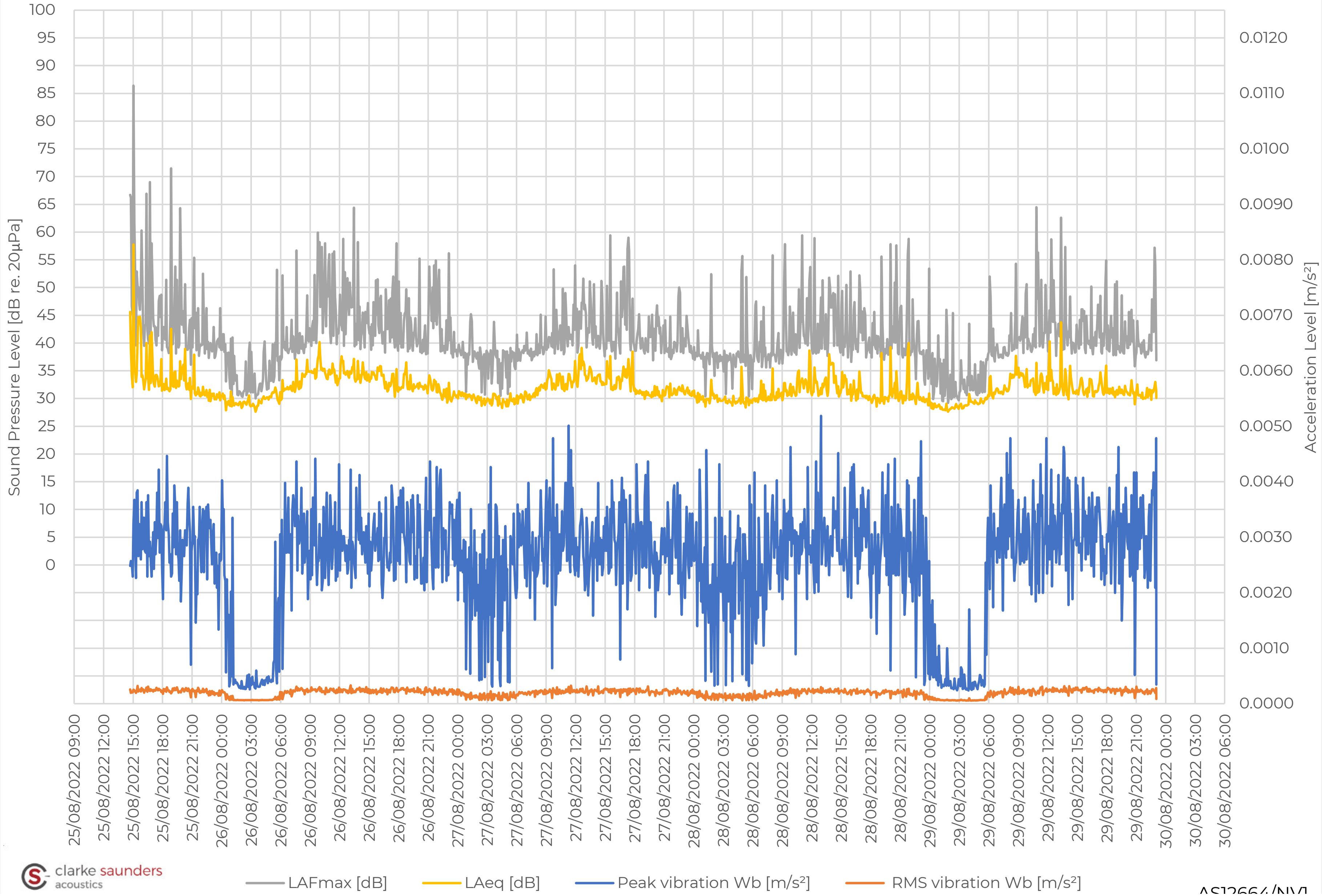
Position LT1

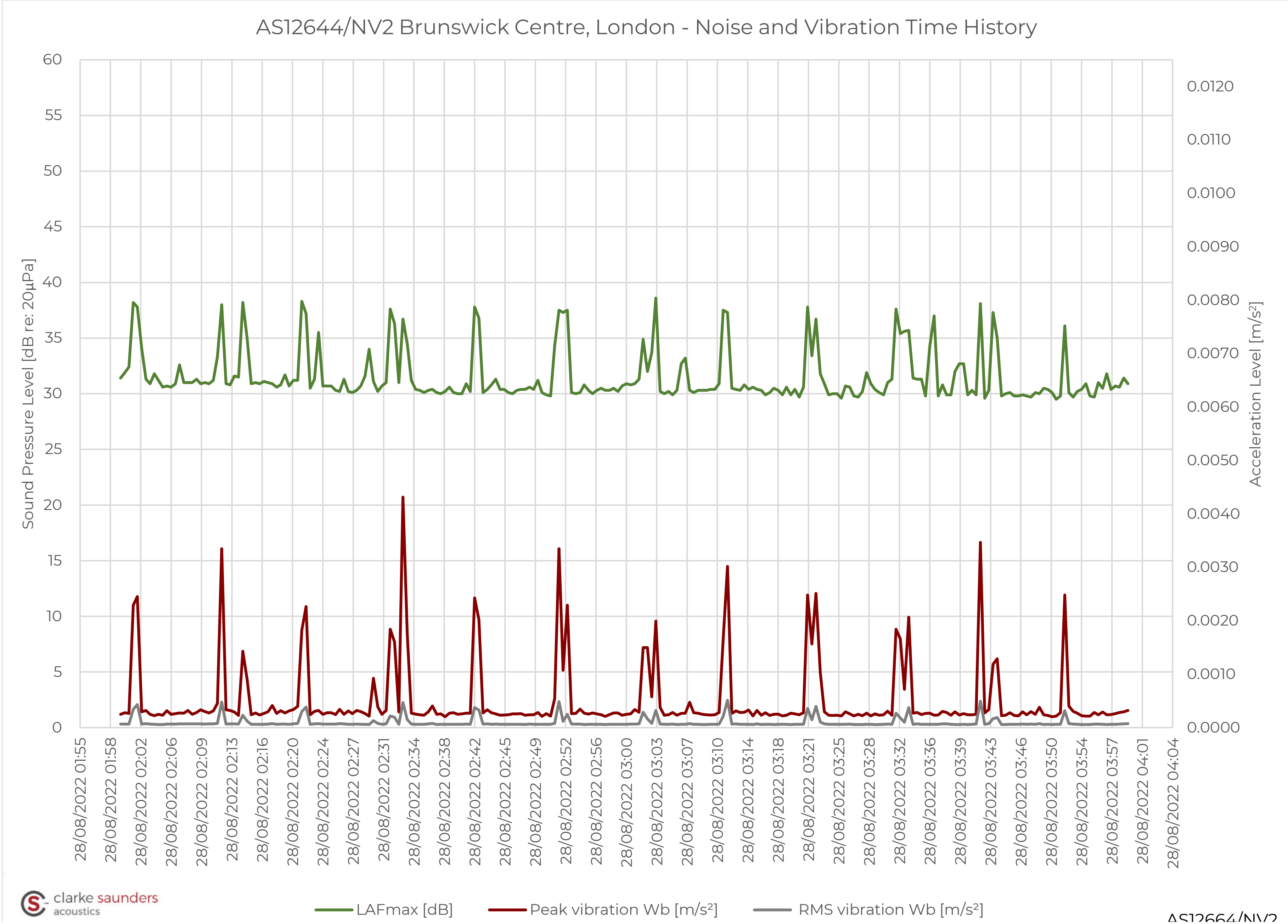


Sun 05 Feb to Mon 06 Feb

Figure AS12664/TH5

AS12664/NV1 Brunswick Centre, London - Noise and Vibration Time History





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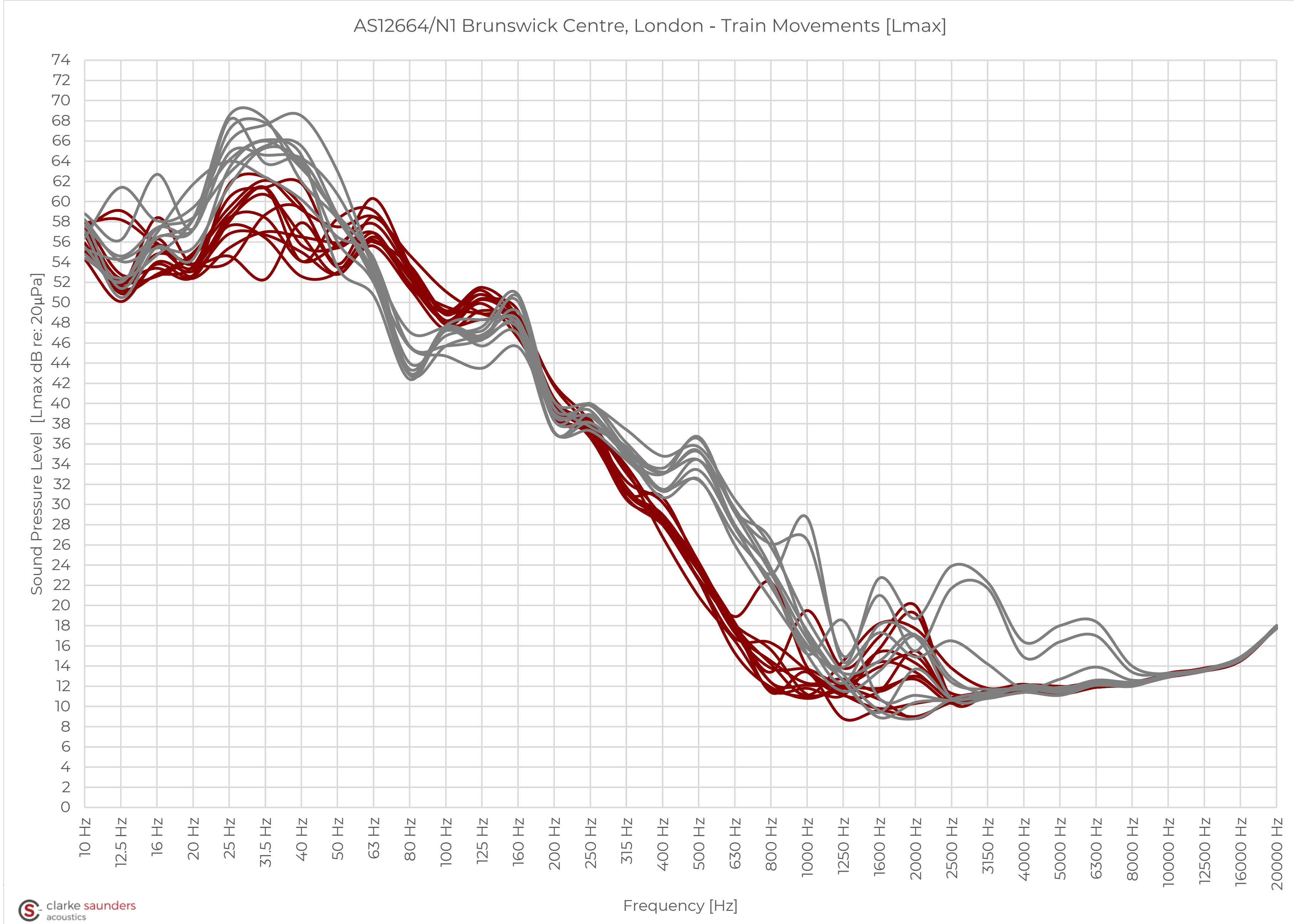
AS12644/NV2


AS12664/N1 Brunswick Centre, London - Train Movements [Lmax]
Sound Pressure Level [Lmax dB re: 20µPa]
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
10 Hz
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16000 Hz
20000 Hz
Frequency [Hz]
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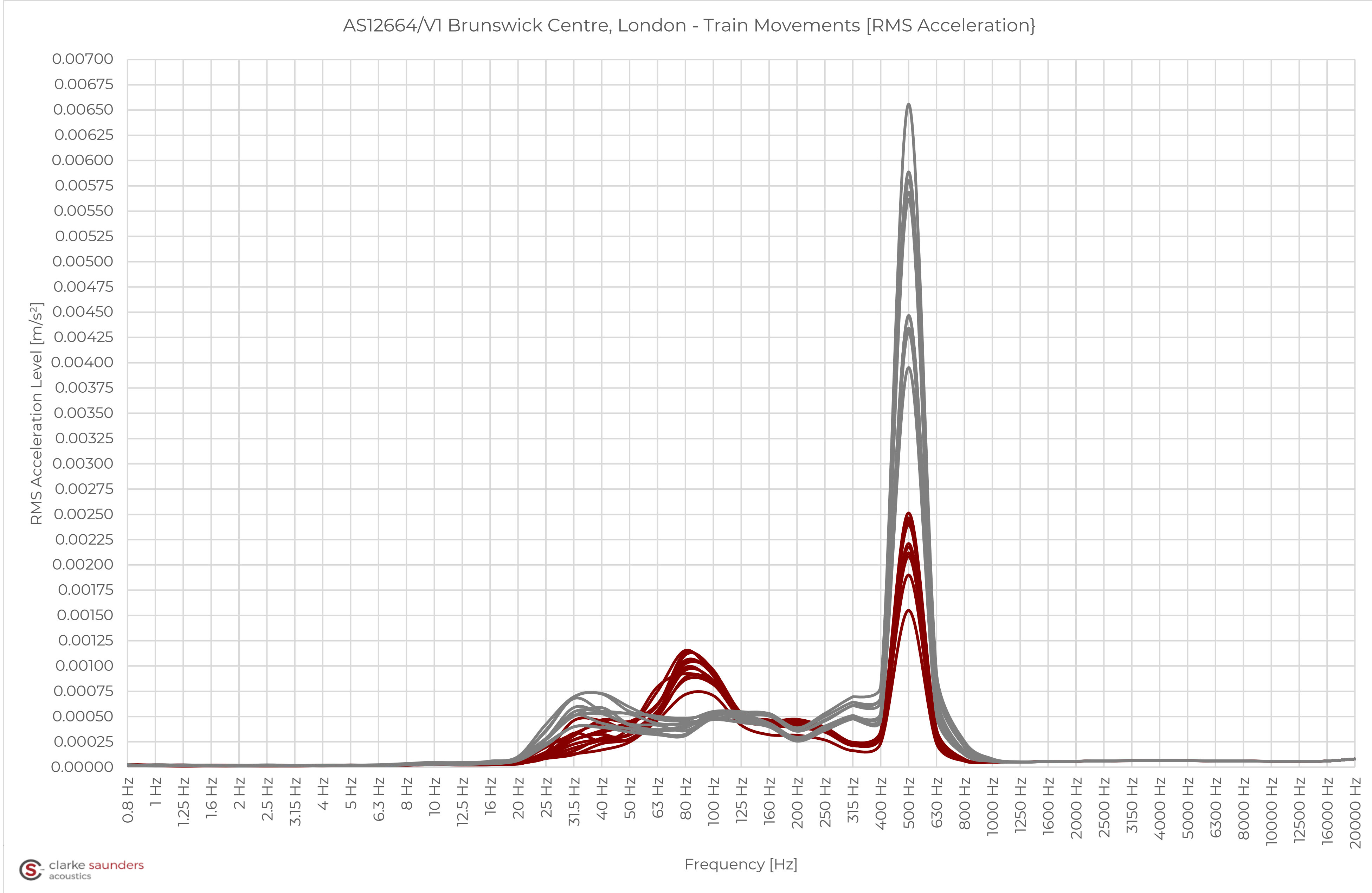

AS12664/V1 Brunswick Centre, London - Train Movements [RMS Acceleration}
RMS Acceleration Level [m/s²]
0.00700
0.00675
0.00650
0.00625
0.00600
0.00575
0.00550
0.00525
0.00500
0.00475
0.00450
0.00425
0.00400
0.00375
0.00350
0.00325
0.00300
0.00275
0.00250
0.00225
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
0.8 Hz
1 Hz
1.25 Hz
1.6 Hz
2 Hz
2.5 Hz
3.15 Hz
4 Hz
5 Hz
6.3 Hz
8 Hz
10 Hz
12.5 Hz
16 Hz
20 Hz
25 Hz
31.5 Hz
40 Hz
50 Hz
63 Hz
80 Hz
100 Hz
125 Hz
160 Hz
200 Hz
250 Hz
315 Hz
400 Hz
500 Hz
630 Hz
800 Hz
1000 Hz
1250 Hz
1600 Hz
2000 Hz
2500 Hz
3150 Hz
4000 Hz
5000 Hz
6300 Hz
8000 Hz
10000 Hz
12500 Hz
16000 Hz
20000 Hz
Frequency [Hz]
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Acoustic Terminology

The human impact of sounds is dependent upon many complex interrelated factors such as ‘loudness’, its frequency (or pitch) and variation in level. In order to have some objective measure of the annoyance, scales have been derived to allow for these subjective factors.

Sound	Vibrations propagating through a medium (air, water, etc.) that are detectable by the auditory system.
Noise	Sound that is unwanted by or disturbing to the perceiver.
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.

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

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.

INTERPRETATION

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

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APPENDIX B
AS12664 BRUNSWICK CENTRE
PLANT SOUND CALCULATIONS

West Plant to Closest Balcony		**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**dB(A)**
PUHY-P700YSNW-A1	Lp @ 1m	75	74	67	65	60	57	55	51	67
ECODAN CAHV-P500TB-HPB	Lp @ 1m	70	65	60	56	52	47	49	45	59
ECODAN CAHV-P500TB-HPB	Lp @ 1m	70	65	60	56	52	47	49	45	59
ECODAN CAHV-P500TB-HPB	Lp @ 1m	70	65	60	56	52	47	49	45	59
Pury-P300 YNW-A2	Lp @ 1m	75	70	69	66	61	57	52	48	67
Pury-P400 YNW-A2	Lp @ 1m	81	70	70	68	62	59	54	49	69
Pury-P400 YNW-A2	Lp @ 1m	81	70	70	68	62	59	54	49	69
Pury-P400 YNW-A2	Lp @ 1m	81	70	70	68	62	59	54	49	69
Pury-P400 YNW-A2	Lp @ 1m	81	70	70	68	62	59	54	49	69
Total Lp at 1m		88	79	77	75	70	66	62	58	76
Bolt-on Attenuation Loss		-4	-5	-7	-8	-12	-12	-10	-7	
Slimshield acoustic louvre	150mm	-6	-6	-8	-10	-14	-18	-16	-15	
Roof edge screening loss		-12	-14	-17	-18	-18	-18	-18	-18	
Distance Loss	5.6m	-15	-15	-15	-15	-15	-15	-15	-15	
Specific sound level at receptor	**$L_{eq\ 1hr}$**	**51**	**38**	**30**	**24**	**11**	**3**	**3**	**3**	**29**

East Plant to Closest Balcony		**63 Hz**	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**	**dB(A)**
Pury-P300 YNW-A2	Lp @ 1m	75	70	69	66	61	57	52	48	67
Pury-P300 YNW-A2	Lp @ 1m	75	70	69	66	61	57	52	48	67
Pury-P400 YNW-A2	Lp @ 1m	81	70	70	68	62	59	54	49	69
Pury-P400 YNW-A2	Lp @ 1m	81	70	70	68	62	59	54	49	69
Pury-P400 YNW-A2	Lp @ 1m	81	70	70	68	62	59	54	49	69
Total Lp at 1m		86	77	76	74	68	65	60	55	75
Bolt-on Attenuation Loss		-4	-5	-7	-8	-12	-12	-10	-7	
Slimshield acoustic louvre	150mm	-6	-6	-8	-10	-14	-18	-16	-15	
Roof edge screening loss		-12	-14	-17	-18	-18	-18	-18	-18	
Distance Loss	6.0m	-16	-16	-16	-16	-16	-16	-16	-16	
Specific sound level at receptor	**$L_{eq\ 1hr}$**	**49**	**36**	**28**	**23**	**9**	**2**	**1**	**0**	**27**