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F45 Bromley

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Limitations			
<p>This report has been prepared for the titled project and client in accordance with our agreed scope of work, document reference PA-01028/SC2, dated 14 November 2023.</p> <p>This report should not be used or relied upon for any other project or purpose without the written authorisation of Pulsar Acoustics Ltd. Pulsar Acoustics Ltd accepts no responsibility or liability for the consequences of this document if it is used for a purpose other than for the project to which it was intended. The findings and opinions included herein are based on measurements and information gathered prior to the date the report was issued. If additional information becomes available which may affect our comments, conclusions or recommendations, then Pulsar Acoustic Ltd should be informed. We then reserve the right to review the information, assess any new potential concerns, and modify our advice accordingly.</p>			



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1.0 - Introduction

F45 Training Bromley has recently opened at 3 St Mark's Square, Bromley BR2 9UY. Planning permission was granted with an acoustic planning condition.

Planning Permission reference: DC/23/00913/FULL1.

Dated: 10th May 2023.

Planning Condition 4 states:

"4. A scheme of noise mitigation to control amplified music must be submitted to and approved in writing by the Local Planning Authority prior to first use. The scheme should identify the exact details of the proposed system, including amplification equipment, speakers and their locations, and a noise limiting device set to ensure the individual L_{MAX} noise frequencies quoted on page 11 of the submitted noise report reference PAL-01028-01-Rev00, dated 8th September 2022, are not exceeded. The system should also include fully automated software controls to ensure 'Limiting Daytime music level (L_{MAX})' will be applied between 7am and 11pm, and 'Limiting night-time limit' applied outside of these hours. The approved scheme should be implemented and maintained thereafter, and no changes to the approved scheme permitted without the prior written approval of the Local Planning Authority.

Reason: In order to comply with Policies 37 and 119 of the Bromley Local Plan and in the interest of protecting neighbouring residential amenities and the area in general."

Pulsar Acoustics has been commissioned to undertake an acoustic assessment of the sound system in accordance with Planning Condition 4.



2.0 - Sound System Overview

The following system description and equipment list was provided to us by the audio system installer.

System Description:

The audio system comprises of a 3.5mm input cable running back to a mixer via the passive DI box. The audio from this is then fed through to the 100V amplifier, which in turn, powers the 6x 100V speakers throughout the space. We have installed an SL2000 limiter and set the cut-off for this at roughly 85dB. The limiter is set to cut the power to the audio rack if this threshold is reached. There is a signal warning light installed, which will alert the client if the audio level surpasses the threshold. This then triggers a 10 second timer, which gives the client the opportunity to turn the volume down, before the audio is cut completely.

Equipment List:

- 1x Sound Limiter and Installation kit - Adastral - SL2000
- 1x 100v Amplifier – SubZero - 216213
- 6x 30w 100V Wall-mounted speakers (White) - Toa - BS-1030W
- 1x 6-Channel Analogue Mixer – Yamaha - MG06
- 1x Passive DI Box - Klark Teknik - DI 10P

There are 6x loud speakers positioned around the perimeter of the main gym area. (There are no speakers in the reception area or in the changing rooms.) There is one speaker in each of the four corners and the other 2x strategically placed along the two sides. The feedback microphone for the limiter is situated in the centre of the room at a height of approximately 2.5m above ground. This reference signal is fed back to the SL2000 limiter which is locked away.

The music is selected by the gym instructors using an iPad and by choosing from various predetermined F45 playlists on Spotify which relate to different gym classes for different times of day.

The only volume control available to the gym instructors during a class is via the iPad. The amplifier and limiter equipment are locked away in a cupboard. The limiter was set with the iPad audio output set to maximum volume and as such it is only possible for a gym instructor to turn it down on the iPad.



3.0 - Criteria

As described in Section 1.0 above, Planning Condition 4 suggests the sound system should be restricted to not exceed the limiting daytime and night-time music levels described in the table on Page 11 of the Pulsar Acoustics report dated 08 September 2022.

The table from Page 11 is reproduced below.

Description	Limiting Sound Level (dB) at Octave Frequency Band (Hz)							dBA
	63	125	250	500	1000	2000	4000	
Limiting Daytime Music Level (Lmax)	91	87	84	84	80	76	73	85
Limiting Night-time Music Level (Lmax)	87	83	79	79	75	71	68	80
Adnitt Acoustics Daytime (Lmax)	80	80	85	85	80	80	75	87

There is some ambiguity relating to the sound system capabilities, our original report, and thus Planning Condition 4. To put these sound levels in context we feel we should discuss and expand on a few points as follows:

- The night-time limiting levels described spawn from aiming for inaudibility in the residential dwellings above, at all times as if a business was operating 24 hours.
- The period of night-time where the ambient background noise levels are at their lowest is typically around 03:00 hours in most town centres.
- Many acoustic industry standards suggest a full daytime period is to be assessed from 07:00 hours to 23:00 hours, and the night-time period is 23:00 hours to 07:00 hours. Some suggest criteria should be established for business operating hours only, and some consider separate individual hourly periods.



- As night-time turns to day and vice versa, the ambient background noise levels will increase or decrease proportionally, yet the limits described have a fixed 5dB difference between 85dBA daytime and 80dBA night-time, and do not allow the flexibility of business hours.
- The gym operating hours are restricted from 06:00 hours to 22:00 hours Monday to Friday, and from 08:00 hours to 13:00 hours Saturdays and Sundays.
- The only time that the gym is open which falls in to the 'night-time' period is from 06:00 to 07:00 hours. We would suggest this is 'the morning' and the limit for this 1-hour morning period should not be restricted by the most stringent 'night-time' limit which spawns from the ambient background levels at around 03:00 hours.
- All limiting levels were determined before fitout design, before the layout was known, and at a time when the unit was simply a 'concrete box'. These levels should therefore be considered pessimistic worst case, and were not intended to be a restriction 'set in stone' by a planning condition.
- In hindsight/practical terms an additional assessment could have been undertaken, which would allow the council to create a suitable planning condition which references a single sound limit for the opening hours from 06:00 hours to 22:00 hours.

With consideration for the above points, we suggest the night-time limit is too stringent for the 1-hour morning period from 06:00 hours to 07:00 hours. The ambient noise climate during this morning period will be considerably higher than when the 'night-time' limit was intended to occur (circa 03:00 hours) based on a business that could operate 24 hours.

We would therefore suggest the restriction for this morning period should lie somewhere between 80dBA night and 85dBA daytime. This situation is discussed in more detail alongside our measurement data in Section 4.0 below.



4.0 - Test Method and Measurement Data

Consulting engineer Adam Kershaw from Pulsar Acoustics Ltd visited site on Wednesday 8th November 2023 to undertake an acoustic assessment.

The following hand-held sound level meter equipment was used to undertake the sound level measurements.

Equipment	Make	Model	Serial Number
Multichannel Sound & Vibration Analyser	Svantek	SV958A	69071
Pre-amplifier	G.R.A.S.	GRAS-26CA	47577
Microphone	Casella	CEL-250	3611
Handheld Acoustic Calibrator	G.R.A.S.	GRAS-42AG	280968

The equipment calibration was spot checked using the hand-held calibrator before and after the survey and no significant change was found. (No more than 0.1dB). The equipment used complies with Type 1 (Class 1) measurement accuracy in accordance with IEC 60942 and IEC61672. The equipment has been calibrated to traceable ISO/IEC standards.

Firstly continuous broadband pink noise was played through the sound system to determine the balance of speakers around the room.

Whilst the pink noise was playing we walked around the gym watching the live sound pressure levels on the sound level meter.

We observed a sound level fluctuation of around 2dBA at a distance of approximately 1.5m away from each speaker as we walked around the room.

Both visually and subjectively the sound level balance across the speakers and around the room appeared suitably even.

Next we established which Spotify playlist had the most 'high energy' dance music. The F45 cardio sessions have the most intense workouts, and therefore the playlist used during the cardio session has the loudest songs comprising electronic dance music.



It must be noted that all songs have different magnitudes and fluctuating frequency characteristics, and as such we obviously cannot be expected to assess every song choice possible.

However, high energy electronic dance music is likely to be deemed the worst case, most likely to attract attention, and therefore should be deemed suitable for assessing the sound system and setting the limiter.

Whilst playing through a selection of songs we observed the Lmax levels on the sound level meter. We found the majority of the songs were currently in the range of around 83dBA to 88dBA Lmax, and as such some briefly exceeded the daytime limit.

We discussed the fact that the limiter does not have a separate daytime/night-time mode. Therefore the morning period from 06:00 hours to 07:00 hours could be a concern if technically speaking 'night-time' was the target. We therefore agreed to aim for the night-time limit of 80dBA Lmax at all times.

It was common for us to repeat some louder songs as we incrementally turned down the level. Although we were aiming for a night-time level it was agreed it subjectively sounded loud enough.

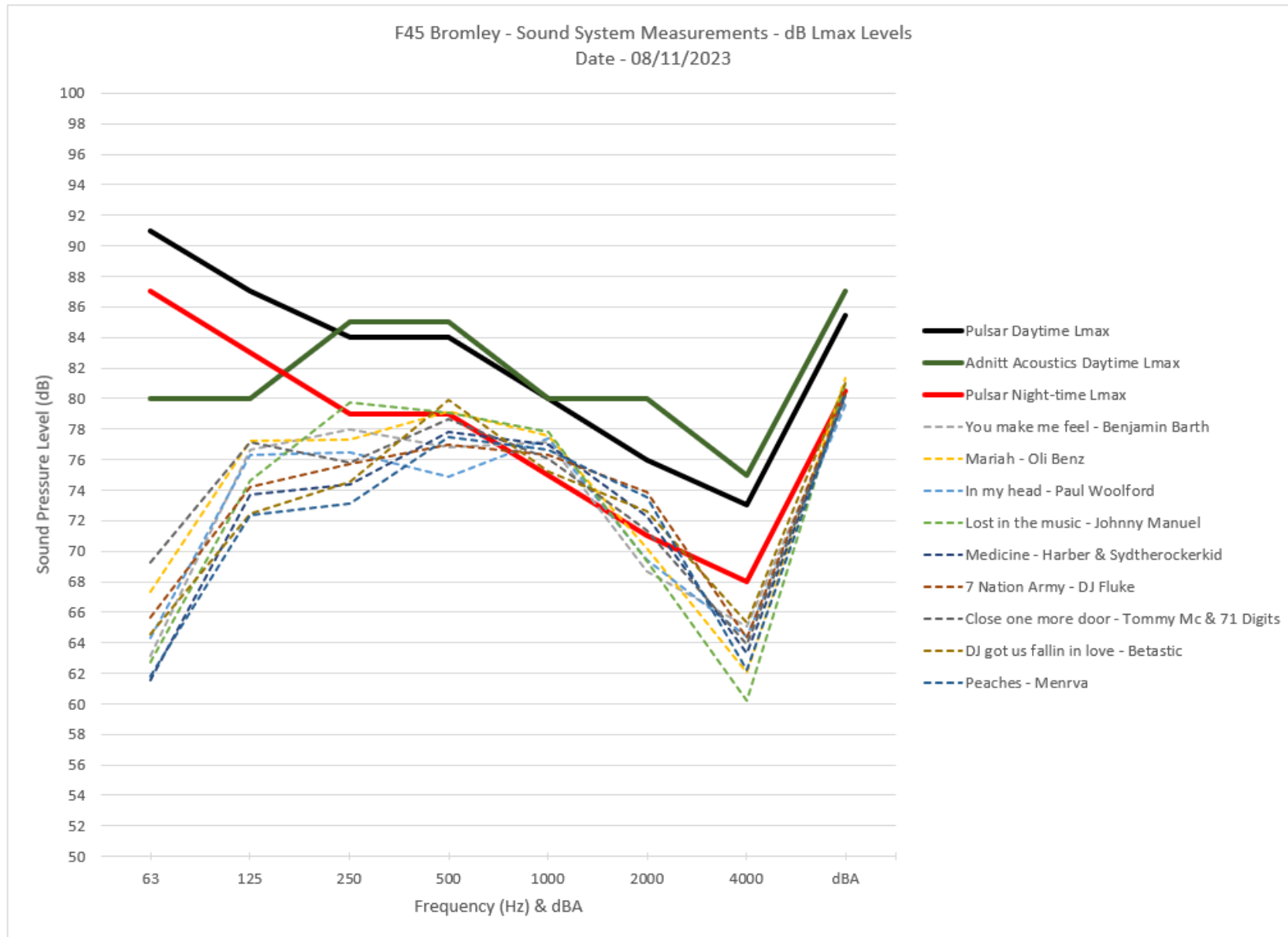
We turned down the master control volume on the power amplifier and limiter hardware, whilst playing through a selection of songs until 80dBA Lmax appeared to be achievable, whilst holding the sound level meter above head height in a position below the limiter feedback microphone.



The table below presents the selection of songs used to set the limit and the associated Lmax levels measured.

Description	Sound Pressure Levels Measured (dB, Lmax) at Octave Band Frequency (Hz)							dBA, Lmax
	63	125	250	500	1000	2000	4000	
Pulsar Acoustics - Daytime Lmax	91	87	84	84	80	76	73	85
Pulsar Acoustics - Night-time Lmax	87	83	79	79	75	71	68	80
Adnitt Acoustics - Daytime Lmax	80	80	85	85	80	80	75	87
You make me feel - Benjamin Barth	63	77	78	77	77	69	65	80
Mariah - Oli Benz	67	77	77	79	78	70	62	81
In my head - Paul Woolford	64	76	76	75	77	69	64	80
Lost in the music - Johnny Manuel	63	75	80	79	78	69	60	81
Medicine - Harber & Sydtherockerkid	62	74	74	78	77	72	63	80
7 Nation Army - DJ Fluke	66	74	76	77	76	74	64	80
Close one more door - Tommy Mc & 71 Digits	69	77	76	79	76	71	64	80
DJ got us falling in love - Betastic	65	72	75	80	75	73	65	81
Peaches - Menrva	62	72	73	77	77	74	62	80

The values in the table above are represented on the graph below.





5.0 - Discussion

As discussed in Section 3.0, the theory of a night-time limit is based on the quietest period of time if a business was able to operate 24 hours. Therefore the night-time limit of 80dBA L_{max} typically relates to a night-time period of around 03:00 hours.

The maximum F45 opening hours are from 06:00 hours to 22:00 hours Monday to Friday, and technically speaking the 1-hour morning period from 06:00 hours to 07:00 hours is classed as 'night-time'.

We suggest the absolute night-time restriction is too stringent for the 1-hour morning period between 06:00 to 07:00 hours, and the limit should really lie somewhere between 80dBA and 85dBA.

Outside of this 1-hour morning period the gym could turn the volume up to the 85dBA daytime limit for the remaining 15 hours but it will not. This permitted increase would be impractical because the sound system does not have a separate daytime versus night-time setting.

You can see from the measurement data in Section 4.0, we have managed to set the volume limit very closely to the night-time limit. All nine songs comfortably achieved the daytime limit.

Out of the nine high energy dance music songs assessed, there were three that briefly hit 81dBA L_{max} and with some negligible mid frequency exceedance. If we adjusted the maximum levels any lower to incorporate the mid frequency values around 2,000Hz, the music would sound strange, and the dBA values would be less than 77dBA L_{max} which would not be suitable for a gym which is ultimately allowed to be 85dBA daytime. A difference of 1dBA L_{max} is within industry standard measurement tolerance, and 2-3dBA would not be noticeable by any humans.

The dance music bass beats measured were below the lower frequency range of the night-time limit. These frequencies are typically the most noticeable radiating through a building from high mounted speakers. Also the speakers installed are relatively small so lack some bass 'punch' and as such there is some low frequency 'head -room' available in the limits. If you find the 'punch' of bass beats is lacking then we would suggest ground level subwoofer speakers could be considered and the system be rebalanced.

Based on the above, we believe the music should go unnoticed by those in the residential flats above, there should be no adverse comments or sleep disturbance, which is the ultimate aim. We believe our assessment is satisfactory to discharge Planning Condition 4.



APPENDIX A - Acoustic Terminology

The following is an explanation for some of the acoustic parameters used in this report to describe the measurements and mitigation.

- **dB** The decibel is used as a measurement of sound pressure level. It is the logarithmic ratio of the noise being assessed to a standard reference level. This approach is advantageous for handling sound levels, where the ratio of the highest to lowest sound which humans could encounter, can be as high as 1,000,000 : 1. The ratio is considered with respect to the quietest and loudest sound we can hear. This is the threshold of hearing at the frequency of 1000Hz, which is taken as 20 μ Pa (2x10⁻⁵ Pa) of pressure for the average person. (A decibel is simply a ratio and is used in many other industries too, but most commonly in acoustic or electrical signal analysis.)
- **dB A** The human ear is more susceptible to mid-frequency noise than to higher and lower frequencies. To take account of this when measuring noise, the 'A' weighting scale is used so that the measured noise corresponds to the overall level of perception by the average human. It is also possible to calculate the 'A' weighted noise level by applying certain corrections to an un-weighted frequency spectrum (Hz). The measured or calculated 'A' weighted noise level is known as the dBA level.
- **L_{eq,T}** The equivalent continuous sound level in decibels, equivalent to the total sound energy measured over a stated period of time and is also known as the time-averaged sound level.
- **dB A L_{eq,T}** The A-weighted equivalent continuous sound level in decibels measured over a stated period of time 'T', and is sometimes written dB LA_{eq,T}.
- **dB A L_{max}** The maximum dBA noise level recorded during the measurement interval period.

When discussing sound levels as decibels we use a logarithmic scale, therefore the dBA values do not follow a linear relationship. When discussing similar noises, a change of 10dBA represents a doubling or halving of subjective loudness. A change of 3dBA is just perceptible by a human, but is a doubling/halving of sound energy. (i.e. 50dBA + 50dBA = 53dBA).

If you require a more detailed explanation for any of the acoustic principles or parameters discussed in this report please do not hesitate to ask.